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Anthony P. Thirlwall's Theory of Economic Development, Growth and Finance: An Analytical Appraisal from Mexico
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An appraisal of Thirlwall-Hussain model: Capital flows and economic dynamics in Mexico, 1994-2023

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Abstract

The present paper empirically assesses the role of capital flows in the output dynamics of the Mexican economy over the period 1994–2023. We hypothesize that capital flows have helped sustain a long-term economic growth rate that exceeds what is warranted by Mexico's current account equilibrium. Our main contribution is to furnish empirical evidence supporting the Thirlwall-Hussain (1982) hypothesis. That is, capital flows are needed to finance the current account gap of economies growing beyond their means. Our analysis represents the first empirical test ever of such a model for the case of Mexico. Furthermore, our estimates from a vector error-correction model show that capital flows (FDI), imports and exports are intimately linked. Moreover, exports and FDI together provide the foreign exchange used to cope with technological and capital goods dependence. We conclude that finance is the most salient variable of overall economic dependence along the global supply chains. The main limitation of our study is that further empirical comparative analysis is required before generalizations can be reasonably made, a task for future endeavors.
JEL Classification: C5, E1, F2, F3, O54.

Keywords: Balance of payments, capital flows, growth, Mexico, VEC models.

Una evaluación del modelo Thirlwall-Hussain: flujos de capital y crecimiento económico en México, 1994-2023

Resumen

Este trabajo evalúa empíricamente el papel de los flujos de capital en el crecimiento económico de México durante el período 1994-2023. La hipótesis central es que los flujos de capital contribuyen a mantener un crecimiento de largo plazo mayor al que se justificaría con equilibrio en la cuenta corriente. La principal contribución es proveer evidencia consistente con la hipótesis Thirlwall-Hussain (1982). Es decir, se requieren entradas de capital para financiar los déficits en la cuenta corriente de las economías que crecen más allá de sus medios. Este estudio es pionero en contrastar este modelo para el caso de México. Nuestras estimaciones, con base en un modelo de corrección de errores, muestran que los flujos de capital, las exportaciones y las importaciones están estrechamente ligadas. Las exportaciones y la inversión extranjera directa proveen las divisas necesarias para enfrentar la dependencia de tecnología y bienes de capital. La conclusión es que el financiamiento es una variable clave de la dependencia a lo largo de las cadenas globales de valor. La principal limitación es que se requiere investigación adicional para generalizar nuestros resultados.
Clasificación JEL: C5, E1, F2, F3, O54.

Palabras clave: Balanza de pagos, flujos de capital, crecimiento, México, modelos VEC.

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1. Introduction

Thirlwall (1979), in a well-praised article, established the proposition that the main constraint on the long-run growth rate of output of most countries tends to be their balance of payments position. Following Harrod's trade multiplier (Harrod, 1941 (1933)), A.P. Thirlwall (1979) explained that in the long run the economic growth rate consistent with balance of payments equilibrium (y_b) is given by the ratio between the growth rate of exports (x) and the income elasticity of imports (π), in other words:[2]

$$y_b = \frac{x}{\pi} \tag{1}$$

This is Thirlwall's fundamental equation, sometimes labeled the balance-of-payments-constrained-growth (BPCG) model or Thirlwall's law.

Mexico and other Latin American countries engaged -approximately during the period 1940-1980- in an import substitution industrialization strategy with the aim of circumventing -or at least relaxing- such a restraint fatefully related to their economic structure. Unfortunately, instead those countries experienced foreign debt crises, starting with Mexico in August 1982.

The 1980s foreign debt crisis bitterly proved that Mexico's and other developing economies' governments got it wrong: their real dependence was (and still is) mainly financial rather than technological (Tavares, 1985; Pérez and Vernengo, 2021). With the aim of confronting financial restrictions and overcoming the lost decade of the 1980s, in the late 1980s-early 1990s the Mexican government dismantled the so-called model of financial repression that supported the import substitution industrialization strategy, adopted financial liberalization via opening the capital account and privatized the commercial banking system. The liberal financial reform was expected to attract foreign savings, on the one hand, and ease the conditions for spurring and accelerating economic growth, on the other. Foreign capital did flow in, yet fast output growth has failed to appear after almost four decades of capital account liberalization.

Financial liberalization in Mexico and most Latin American countries was designed according to what we call the Mckinnon-Shaw hypothesis (Mckinnon, 1973, 1993; Shaw, 1973). The McKinnon and Shaw doctrines argue that free capital movements and high interest rates are key to achieve fast economic growth rates with price and financial stability. On the other hand, Thirlwall and Hussain (1982) contest the thesis that financial liberalization will necessarily lead to optimum output growth with balance-of-payments equilibrium. Moreover, the latter maintain that capital flows simply serve the purpose of widening the current account gap of developing economies producing and exporting goods and services characterized by low-income elasticities of demand for exports *vis à vis* that of imports. Hence, the balance of payments crises along with banking and exchange rate crises, sudden capital stops and interruption of access to international liquidity frequently seen in Mexico, South

[2] He also pioneered an explanation of the causes of long-term growth differentials among countries given by the different ratios between the income elasticities of exports and imports of the economies participating in international trade. For partial surveys of the vast literature cf. *Investigación Económica* vol. 82(326), 2023; McCombie (1997, 2011); McCombie and Thirlwall (1994); Pérez Caldentey and Vernengo (2019) and Perrotini Hernández (2003).

Korea, Argentina, Brazil, Russia, Sweden, and even the United States and the European Union since the advent of financial liberalization.

This paper is aimed at assessing the role of capital flows in the output dynamics of the Mexican economy over the period 1994 –2023. We claim that, over time, capital inflows have helped sustain a long-term economic growth rate greater than that warranted by Mexico's current account equilibrium. In this sense, foreign direct investment (FDI) has been a steadfast source of foreign exchange, which is crucial for financing the range of imports needed to ensure the adequate functioning of the export-led growth model adopted since the inception of the North American Free Trade Agreement (NAFTA) back in 1994.

The relevance of our main contribution hinges upon the provision of empirical evidence supporting the Thirlwall-Hussain (1982) hypothesis, which extends and complements Thirlwall's original BPCG model by considering the capital inflows needed to finance current account deficits stemming from output growth rates in excess of the level corresponding to current account equilibrium. To the best of our knowledge, the present paper represents the first empirical test ever of such a model for the case of Mexico´s growth experience. Furthermore, our estimates show that capital flows (FDI), imports and exports are intimately linked. For instance, the long-term response of exports and imports to FDI is roughly the same. Moreover, together FDI and exports furnish the foreign exchange needed to cope with technological and capital goods dependence. Thus, finance is the most salient variable of overall economic dependence along the global supply chains.

This article is organized as follows. In addition to this introduction, section 2 summarizes the relevant ideas of both the McKinnon-Shaw hypothesis and the Thirlwall-Hussain model; here we are concerned only with those features of both hypotheses which we consider are strictly related to our main objective, namely the role of finance (capital flows) in the growth performance of the Mexican economy. Then, in section 3, the empirical estimation is carried out, while final remarks and conclusions are discussed in section 4.

2. A Brief review of some relevant theories

2.1 The McKinnon-Shaw hypothesis

The downfall of the Bretton Woods international monetary and financial system in the early 1970s triggered a deep process of deregulated global financial markets. Ronald I. McKinnon and Edward Shaw provided the theoretical justification and the rationale for worldwide financial markets integration.

The McKinnon-Shaw[3] hypothesis is composed of two elements, the financial repression (FR) and the financial liberalization (FL) theories: 'If governments tax or otherwise distort their domestic capital markets, the economy is said to be "repressed"' (McKinnon, 1993, p. 11; cf. also Fry, 1988, caps. 1, 2 and 3). The main instruments for repressing the economy are:

[3] It is worth mentioning that, while both authors agree theoretically in all respects, Mckinnon´s empirical analysis is focused on developing economies and Shaw's deals with developed countries.

1) High reserve requirements: commercial banks are forced to keep a high "percent of their deposits as non-interest-bearing with the central bank" (ibid., p. 43). This reduces the supply of credit and makes the banking sector inefficient, which contradicts Schumpeter's theorem about the positive role of finance for economic development.
2) Predesignated credit allocation to specialized agencies (including the government itself for the financing of fiscal deficits) ex ante and arbitrarily selected by the government. Allocation of credit lines decided on political grounds are usually lent at disequilibrium interest rates, thus distorting the time structure of interest rates and the relative prices of tradables and non-tradables.
3) "Interest rate ceilings on deposits and loans" (ibid., p. 44). The control of interest rates tends to reduce savings and the supply of loanable funds.

These instruments of FR sooner or later impair the quality of investment, bring about low productivity, suboptimal economic growth, high unemployment, exchange rate and balance of payments instability and increasing foreign debt to bridge the gap between savings and investment.

The solution to FR is straightforward and leads to FL, according to McKinnon and Shaw. FL involves keeping positive and high interest rates, eliminating interest rate ceilings and predesignated credit lines, removing reserve requirements on bank deposits, and stabilizing domestic inflation to uncover "the true scarcity price of capital" (McKinnon, 1973, 1993, p. 12).

McKinnon (1993) argues that in the transition from FR to FL countries must follow "the order of economic liberalization", otherwise the process may fail to deliver a Pareto-optimum result. Not only that: governments must also avoid incurring the overborrowing syndrome during the process of FL. According to Mckinnon, Argentina, Chile and Uruguay failed to follow such a sequence and ended up experiencing financial crash back in the 1970s and early 1980s (McKinnon, p. 113, passim).

The assumptions of the McKinnon-Shaw hypothesis make us believe that the road from FR to FL paves the way to overcome not only technological dependence but, above all, financial dependence. In this context, Mexico -among many other countries- liberalized financially starting in the late 1980s-early 1990s. Unfortunately, after more than three decades of financial liberalization not much seems to have changed in terms of improvements of the economic dynamic-balance of payments trade-off: the empirical evidence in Figure 1 reveals that most of the statistical observations fall in the fourth quadrant, where growth is characterized by increasing balance-of-payments constraints. In Figure 1, a balance-of-payments constraint must be thought of as a significant current account deficit as a share of GDP. The journey from FR to FL left Mexico with the same problem of financial dependence we encountered in the demise of the import substitution industrialization model (Vernengo, 2006). Furthermore, it has been argued that financial liberalization has produced not only the truncation of industrialization, but above all instability, premature financialization and deindustrialization (Pérez Caldentey and Vernengo, 2021).

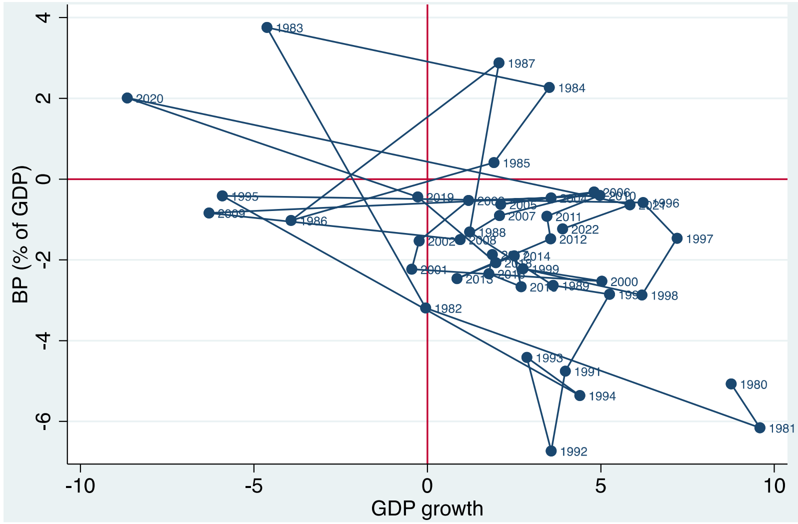

Figure 1. Output growth and Balance-of-Payments Trade-off
Note: The fourth quadrant shows that higher GDP growth gives rise to higher current account deficits as a share of GDP.
Source: Authors' estimations based on data from the National Institute of Statistics and Geography.

2.2 The Thirlwall-Hussain model

Unless one shares the Panglossian outlook that current account disequilibria are immaterial (on the grounds that deficits just signal foreign investors' preference for domestic assets), admittedly current account deficits reflect financial dependence, at least in the case of today's Mexican economy. Current account disequilibria imply foreign debt and capital movements.

As discussed previously, Thirlwall (1979) presented a model without considering financial flows or, in other words, if the long-term growth rate of output is approximated by equation (1) $y_b = x/\pi$, then it is implicitly assumed that exports earnings (σ) are enough to cover the imports bill totally (σ = 1). Actual growth experience may in fact deviate from equation (1) due to either real terms of trade fluctuations or capital flows letting a current account disequilibrium (Thirlwall and Hussain, 1982, p. 500).

Historical growth experience of most -if not all- developing economies shows that these countries tend to accumulate *in crescendo* current account deficits through time (Figure 1 summarizes Mexico's experience). These deficits must be financed somehow by capital inflows, so international financial markets allow developing economies to temporarily expand at rates faster than the speed predicted by equation (1). This is where financial dependence kicks in: "growth becomes constrained ultimately by the rate of growth of capital inflows, and, by itself, the simple growth rule enunciated would not be a good predictor of long run growth performance." (op. cit., p. 501). Hence the Thirlwall-Hussain (1982) extension of the original BPCG model accounting for the influence of financial flows on long-run economic growth[4]:

$$y_{b^*} = \frac{\sigma(x_t)+(1-\sigma)(c_t)}{\pi} \tag{2}$$

[4] Equation (2) assumes that relative prices measured in a common currency remain constant over the long run.

where c_t stands for the growth of real capital flows, σ and (1-σ) are the shares of the import bill financed by export earnings and real capital flows, respectively, x_t and π are as before, the growth rate of exports and the income elasticity of imports, respectively, and y_{b^*} is the balance of payments long-run constrained growth rate of output with initial current account disequilibrium.

It can readily be seen from equation (2) that, ceteris paribus, capital inflows can cause y_{b^*} to deviate from y_b, unless c_t = 0. Yet, initial disequilibrium ($y_{b^*} > y_b$) requires $c_t > 0$ to offset the proportion of the import bill not covered by export earnings. Thirlwall-Hussain (1982) amends the original BPCG model by making explicit the role of financial transfers in the dynamics of developing open economies. An important point in this regard is that current account deficits are generally financed by debt-creating financial flows which must be repaid sooner or later.

All in all, while amending the canonical BPCG model the Thirlwall-Hussain extension appears to leave with us two extreme solutions: first, unless international financial markets will never become reluctant to finance an ever-increasing trade imbalance, which is not the case, deficit economies must generate a current account surplus through deflationary and recessionary regimes to make up for the accumulated financial hole. This implies that equation (1) must hold in the long-term, in which case σ =1 and c_t = 0. Secondly, there is a sustainability issue[5]: a) since current account imbalances are financed by debt-generating financial flows, interest payments on accumulated liabilities should play a part in the model, and b) an upper bound to current account imbalances and, therefore, a limit to debt-accumulation should also be in place, in case the economy becomes fundamentally unstable and deteriorates into a Ponzi scheme.

3. Empirical analysis

The next step is to present equation (3), which is the vector auto-regression (VAR) model used to contrast the Thirlwall-Hussain (1982) theory with the reality of the Mexican economy.

$$Z_t = B_1 Z_{t-1} + B_2 Z_{t-2} +, \dots\dots, + B_P Z_{t-p} + \Theta W_t + \eta_t \tag{3}$$

where $Z_t = [Y_t, X_t, M_t, Q_t, EV_t, TT_t]'$. All the variables within the bracket are stated in natural logarithms. Along these lines, Y_t is real domestic output while X_t and M_t are exports and imports of goods and services, respectively; Q_t is the peso-dollar real exchange rate, EV_t is a foreign variable affecting domestic output, and TT_t stands for the terms of trade, which are included as a control variable. Moreover, W_t in equation (3) is a vector of intercept terms while η_t is a vector of innovations, which are free of contemporaneous correlations.[6] Lastly, B_i, with i=1, 2,…,p, are 6X6 coefficient matrices.

The external variable (EV_t) is represented by foreign direct investment (FDI) in the first VAR model that we estimate, whereas in the second VAR such a variable is represented by US real output (Y_t^*). Unfortunately, FDI and US real GDP cannot be included in the same VAR model because of multicollinearity problems. Therefore, we estimate two six-variable VAR models that are not only

[5] This issue has been discussed by McCombie and Thirlwall (1997), Moreno-Brid (1998), and Barbosa-Filho (2001).
[6] This condition is satisfied through an orthogonalization procedure.

relatively well-behaved and parsimonious, but also highlight the relevance of FDI and foreign output to sustain economic growth in Mexico. Our benchmark VAR model (Z_t^B) is the one including FDI, that is, $Z_t^B = [Y_t, X_t, M_t, Q_t, FDI_t, TT_t]'$, where FDI_t is the logarithm of FDI at time t. The alternative VAR model (Z_t^A) includes US real output, that is, $Z_t^A = [Y_t, X_t, M_t, Q_t, Y_t^*, TT_t]'$. For the sake of brevity, the main results of the alternative model are presented in Appendixes 1, 2 and 3.

For each of the above-mentioned variables, we gathered quarterly data from the first quarter of 1994 to the third quarter of 2023. Therefore, the study period begins with the implementation of the North American Free Trade Agreement (NAFTA) and comprises almost 30 years, which is a long enough time interval to conduct integration and cointegration analysis. All variables are seasonally adjusted, in addition to being expressed in natural logarithms. Mexican real output is proxied by the global economic activity index (GEAI) and not by the gross domestic product (GDP). The use of the GEAI was more convenient to estimate a well-behaved VAR model. On the other hand, real foreign output is measured by US GDP. All the statistical information regarding the Mexican economy was obtained from the National Institute of Statistics and Geography, the Bank of Mexico, and the Mexican Secretariat of Economy, whereas the information regarding US GDP stems from the Federal Reserve Bank of Saint Louis.

The first step in the empirical work is to conduct breakpoint unit root and stationarity tests, with a view to determine the order of integration of each variable. Table 1 shows the outcome of this exercise.

Table 1. Breakpoint unit root and stationarity tests

Variable	Breakpoint unit root (Ho: unit root)	KPSS stationarity test (Ho: stationarity)	Conclusion
Y_t	-2.5502	1.2691***	I(1)
ΔY_t	-14.5713***	0.1082	I(0)
Y_t^*	-1.9789	1.2863***	I(1)
ΔY_t^*	-23.7048***	0.1054	I(0)
X_t	-2.0924	1.2901***	I(1)
ΔX_t	-14.5551***	0.1683	I(0)
M_t	-1.8912	1.2822***	I(1)
ΔM_t	-10.1694***	0.0717	I(0)
Q_t	-3.9558	0.1678	I(1) or I(0)
ΔQ_t	-17.0840***	0.0922	I(0)
TT_t	-3.4806	0.2978	I(1) or I(0)
ΔTT_t	-11.2376***	0.1663	I(0)
FDI_t	-10.8391***	1.0875***	I(1) or I(0)
ΔFDI_t	18.9246***	0.2393	I(0)

Notes: Asterisks *, ** and *** indicate the rejection of the null hypothesis at the 10%, 5% and 1% percent significance levels, respectively, whereas Δ is the first difference operator. Given that most variables do not include a time trend, the break specification reported for the breakpoint unit root test is intercept only. Moreover, the break type is additive outlier, which assumes that the structural change took place rapidly.

Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

In this case, the breakpoint unit root tests are suitable because the period of analysis includes the global economic crisis of 2007-2009 and the recent COVID-19 pandemic. Those events are likely to have caused structural changes in the Mexican economy. In this context, some stationary variables may seem to be nonstationary because of the occurrence of a structural change. The breakpoint unit root tests prevent that from taking place. The type of structural change reported in table 1 is the one corresponding to a change in the intercept (or the level) of the time series. Another important aspect of the tests performed concerns the specification of the test equation, which was selected through Hamilton's (1994) methodology. Put differently, each test equation was specified based on the dynamic behavior of each variable. To reach a more certain conclusion regarding the order of integration of each variable, we complemented the breakpoint unit root tests with Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests, which depart from the opposite null hypothesis: stationarity.[7]

The outcome of the tests indicates that the global economic activity index (Y_t), exports (X_t) and imports (M_t) of goods and services, and US GDP (Y_t^*) are clearly integrated of order 1 (I(1)) in levels and stationary in first differences. There is some controversy, however, as regards the peso-dollar exchange rate (Q_t), the terms of trade (TT_t) and the FDI (FDI_t). The controversy arises from the fact that breakpoint unit root tests and KPSS tests contradict each other when those variables are in levels, that is, one test indicates nonstationarity while the other indicates stationarity. Nonetheless, not only are most economic variables I(1) but the three variables in question are typically nonstationary. Therefore, all the variables are to be treated as I(1) and we can proceed with Johansen's cointegration tests.

3.1 Long-term analysis

Johansen's cointegration tests are based on VAR models and are thus multivariate, which means that they can be useful to identify more than one cointegrating relationship. To perform such tests, we must first ensure that the benchmark and the alternative VAR models are congruent, which means that their residuals must not be plagued by serial correlation and heteroscedasticity. To eliminate or lessen such problems, we tested several lag structures for both VAR models. In the case of the benchmark model, nine lags for each variable in each equation was found to be the best possible lag length specification. In the case of the alternative VAR model, the more convenient lag length specification was ten lags for each variable in each equation. For the sake of brevity, we report the test results only for the benchmark VAR model.[8] In the case of the alternative VAR model we will only present the outcome of the cointegration tests, the long-term equations, and the impulse response functions in appendixes 1, 2 and 3, respectively, for comparative purposes. Table 2 displays the outcome of the serial correlation Lagrange multiplier tests for the benchmark model:

[7] The breakpoint unit root and the stationarity tests allow for choosing only two specifications for the test equations: an intercept only or an intercept and a time trend.
[8] The test results for the alternative VAR model are available upon request.

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Table 2. Serial correlation Lagrange multiplier (LM) tests for the benchmark VAR model
Null hypothesis: no serial correlation at lag order *p*.

Lag order p	LM statistics	Probability values
1	37.68879	0.3958
2	44.43962	0.1607
3	18.87784	0.9917
4	31.53157	0.6842
5	44.92116	0.1490
6	44.80567	0.1518
7	37.41895	0.4077
8	42.56344	0.2127
9	27.19375	0.8565
10	32.95704	0.6176

Note: the probability values stem from a chi-squared distribution with 36 degrees of freedom.
Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

The probability values corresponding the null hypothesis of absence of serial correlation suggest that VAR residuals are essentially free of serial correlation up to lag order 10. Now, table 3 presents the result of the White heteroscedasticity test.

Table 3. White heteroscedasticity test for the benchmark VAR model
Null hypothesis: VAR residuals are homoscedastic.

Chi-squared statistic	Degrees of freedom	Probability value
2292.642	2268	0.3540

Note: the test was conducted with no cross terms.
Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

Table 3 shows that VAR residuals are homoscedastic. Therefore, the benchmark VAR model is congruent.[9] However, VAR residuals do not follow a normal distribution according to the Jarque-Bera normality test.[10] Achieving multivariate normality is not an easy task in this case because the 2007-2009 global economic crisis and the COVID-19 pandemic brought about macroeconomic volatility and thus atypical observations. Nonetheless, Johansen (1995, p. 20) relaxes the normality requirement to perform cointegration analysis, whereas Cheung and Lai (1993, p. 314) acknowledge that such a requirement can be somewhat restrictive in econometric analysis.

[9] In the case of the alternative VAR model, ten lags for each variable of each equation eliminates serial correlation at lags one to six and eight to eleven, which is the last lag considered in the serial correlation LM test. This means that some serial correlation remains at lag seven. Moreover, the White heteroscedasticity test could not be performed in this particular case, likely because of multicollinearity problems in the test equation. Nonetheless, we can reasonably infer that VAR residuals are homoscedastic because such a test can be conducted with fewer lags. In fact, when this VAR model includes between six and nine lags the residuals are clearly homoscedastic.
[10] The same applies to the alternative VAR model.

For a set of variables to be cointegrated, the following requirements must be satisfied: 1) The variables must be nonstationary, 2) there must be at least one stationary linear combination involving those variables, and 3) such a linear combination must have a reasonable economic interpretation (Johansen, 1995). When those requirements are satisfied, the Granger representation theorem (Engle and Granger, 1987) states that equation (3), which is an unrestricted VAR model, can be rewritten as a vector error-correction (VEC) model of the following form:

$$\Delta Z_t = \Pi Z_{t-1} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} +, \ldots\ldots, +\Gamma_{P-1} \Delta Z_{t-P} + \Theta W_t + \eta_t \tag{4}$$

where $\Pi = \sum_{i=1}^{p} \mathrm{B}_i - I_6$ and I_6 is a 6x6 identity matrix, given that the model includes six variables. Furthermore, $\Gamma_i = -\sum_{j=i+1}^{p} B_j$. In this manner, the p-order VAR model can be rewritten as a (p-1) VEC model. The VEC model is the restricted version of the VAR model, where the restrictions are given by the cointegrating relationships that the VEC model incorporates. Now, if such a VEC model exists, then, according to the Granger representation theorem, matrix Π must have a reduced rank and the following two conditions must be fulfilled:

1) $\Pi = \alpha\theta'$, where α is a short-term coefficient matrix containing the adjustment coefficients and θ' is a long-term coefficient matrix containing the cointegrating vectors.
2) $\theta' Z_{t-1}$ contains the cointegrating relationships (or stationary linear combinations) among the nonstationary variables.

Further, the number of cointegrating equations in $\theta' Z_{t-1}$ is equal to the rank of matrix Π. The intuition behind equation (4) is that the variables of the model share one or more long-term or equilibrium relationships, given by $\theta' Z_{t-1}$. In fact, $\theta' Z_{t-1} = VECT_{t-1}$, where VECT stands for the vector of error-corrections terms. In this manner, $VECT_{t-1}$ contains the set of cointegrating equations or long-term relationships. However, when innovations or disturbances (captured by vector η_t) occur, then the variables in $VECT_{t-1}$ temporarily deviate from equilibrium (*i.e.*, an error is generated). Such deviations or "errors" are then corrected through an adjustment mechanism given by matrix α and by matrices Γ_i (i=1, 2,..., p-1), so that equilibrium is eventually restored (*i.e.*, variables go back to their cointegrating relationship). In this manner, equation (4) can be rewritten as follows:

$$\Delta Z_t = \alpha VECT_{t-1} + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} +, \ldots\ldots, +\Gamma_{P-1} \Delta Z_{t-P} + \Theta W_t + \eta_t \tag{5}$$

To determine the number of cointegrating equations, if any, Johansen cointegration tests must be performed. Such tests were carried out under the assumption that the VAR model includes a vector of constant terms (*i.e.*, W_t in equations (3), (4) and (5) is a vector of intercepts), which is a standard assumption. Moreover, an intercept term is also included in each cointegrating equation, so that the long-term relationships are not forced to cross the origin (Patterson, 2000, p. 625). The result of the cointegration tests for the benchmark model is depicted in Table 4:

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Table 4. Johansen cointegration tests for the benchmark VAR/VEC model

Null hypothesis regarding the number of cointegrating equations	Probability values of the trace statistics	Null hypothesis regarding the number of cointegrating equations	Probability values of the maximum eigenvalue statistics
None***	0.0000	None***	0.0000
No more than 1***	0.0081	No more than 1	0.1086
No more than 2**	0.0496	No more than 2	0.2530
No more than 3	0.1145	No more than 3*	0.0714
No more than 4	0.6366	No more than 4	0.7929
No more than 5	0.1667	No more than 5	0.1667

Notes: Asterisks *, ** and *** indicate the rejection of the null hypothesis at the 10%, 5% and 1% percent significance levels, respectively. The tests are conducted in a sequential manner and the conclusion can be drawn as soon as the null hypothesis can no longer be rejected at the 5% significance level, which is the reference level in Johansen cointegration tests. Therefore, the trace statistics indicate the existence of three cointegrating equations, whereas the maximum eigenvalue statistics indicate the existence of only one cointegrating equation. Lastly, we use MacKinnon-Haug-Michelis (1999) probability values.
Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

Johansen cointegration tests are carried out sequentially and the conclusion regarding the number of cointegrating equations can be drawn as soon as we fail to reject the null hypothesis. Moreover, Johansen cointegration tests yield two test statistics: the trace statistics and the maximum eigenvalue statistics. The probability values corresponding to the trace statistics suggest that we have three cointegrating equations at the 5% significance level, whereas the probability values of the maximum eigenvalue statistics indicate that we have only one. When a contradiction like this occurs, Johansen's (1995) recommendation is to decide based on the number of cointegrating equations that is more consistent with economic theory. After estimating several normalizations of the cointegrating equations, we decided in favor the trace statistics, so we have the following three cointegrating equations:

$$Y_t = 3.1738 + 0.5559^{***}FDI_t + 0.3357Q_t + 0.3117TT_t \tag{6}$$

$$X_t = 21.7453 + 2.3849^{***}FDI_t + 0.9376Q_t + 2.0050TT_t \tag{7}$$

$$M_t = 20.6909 + 2.3697^{***}FDI_t + 0.8084Q_t + 1.9318TT_t \tag{8}$$

Equations (6), (7) and (8) were normalized for the real output (Y_t), exports of goods and services (X_t), and imports of goods and services (M_t), respectively. This means that each of these variables cannot be included as regressors in any other cointegrating equations, which poses a severe limitation for specification purposes. Nonetheless, the estimated coefficient of FDI is statistically significant at the 1% level in the three long-term equations.[11] Equation (6) shows that the long-term

[11] Just as before, the use of three asterisks indicates statistical significance at the 1% level.

elasticity of real output with respect to FDI is 0.5559, which highlights the relevance of this variable to sustain economic growth. The rationale is that to be able to grow in the long run, the Mexican economy requires a wide range of imported intermediate inputs and FDI is largely responsible for financing their acquisition. Therefore, this evidence is consistent with the balance-of-payments restraint on economic growth explained by the Thirlwall-Hussain model. Such a restraint can be alleviated by a prominent and relatively stable source of foreign exchange like FDI.

Furthermore, equation (8) shows that FDI has a positive long-term impact on imports of goods and services. The long-term elasticity of imports with respect to FDI is 2.3697. Lastly, FDI translates into capital stock and technology for the recipient country. This, in turn, allows economies like Mexico to export goods and services. In this perspective, the long-term elasticity of exports with respect to FDI is 2.3849 (equation (7)). This means that the long-term impact of FDI on exports and imports is positive and very similar. Lastly, the estimated coefficients of the other regressors (the peso-dollar real exchange rate and the terms of trade) are not statistically significant in any of the three equations, whereas the *t*-statistics and probability values of the intercepts terms are not provided by the econometric software.[12]

In appendix 1 we display the outcome of Johansen cointegration tests for the alternative model. In this case, the conclusion is the same: there are 3 cointegrating equations at the 5% significance level. In appendix 2, we can see the three cointegrating equations corresponding to the alternative VAR model. Broadly speaking, the estimated coefficient of US real GDP is positive and statistically significant at the 1% level in the three equations. In the growth equation, we can see the elasticity of Mexican output with respect to US output is 1.1594, which highlights the extent to which domestic growth is conditioned by foreign growth. The influence of US GDP on Mexican trade is reflected in the export and import equations as well. The elasticity of exports with respect to US output is 3.6468, whereas the elasticity of imports with respect to the same variable is 3.7345. Therefore, US economic activity abroad increases Mexican exports through an enhanced external demand for domestic goods and services. On the other hand, US economic activity raises Mexican imports, presumably by way of stimulating economic growth in Mexico. Lastly, in this case, the estimated coefficient linked to the real bilateral exchange rate is statistically significant in the three equations. In this perspective, real currency depreciation encourages exports, economic growth and even imports. The positive effect of the real exchange rate on imports is counterintuitive but can be explained by the fact that higher exports translate into higher imports due to processing trade (Hicks's supermultiplier, Perrotini and Vázquez, 2019). Moreover, real currency depreciation fuels economic growth and thus elevates imports as the Mexican economy is highly dependent on imported capital goods, parts, and components.

3.2 Short-term sensitivity analysis

The VEC model previously estimated works to obtain the long-term equations. Unfortunately, the short-term coefficient matrix (α) indicates that real output (Y_t), exports (X_t) and imports (M_t) are weakly exogenous, given that none of the short-term coefficients (i.e., the coefficients of matrix α) are

[12] EViews, version 13.

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statistically significant for the first three equations of the VEC model,[13] represented by equation (5). The weak exogeneity of these variables means that they pertain to the long-term equations but cannot be included in the impulse-response analysis stemming from the VEC model (Johansen, 1995; Patterson, 2000, pp. 674–676).

In this context, we resort to a stationary VAR model of the form: $\Delta Z_t^B = [\Delta Y_t, \Delta X_t, \Delta M_t, \Delta Q_t, \Delta FDI_t, \Delta TT_t]'$. Such a model corresponds to the benchmark specification, except that the variables are in first differences. When this model is estimated with five lags for each variable in each equation, its residuals are free from serial correlation and heteroscedasticity.[14] Figure 2 shows the dynamic response of the Mexican output to a one-standard deviation increase in each of the other variables of the model. This is done through a set of generalized impulse-response functions (GIRFs) with 95% confidence intervals.[15] Such GIRFs are estimated over a six-quarter time horizon.

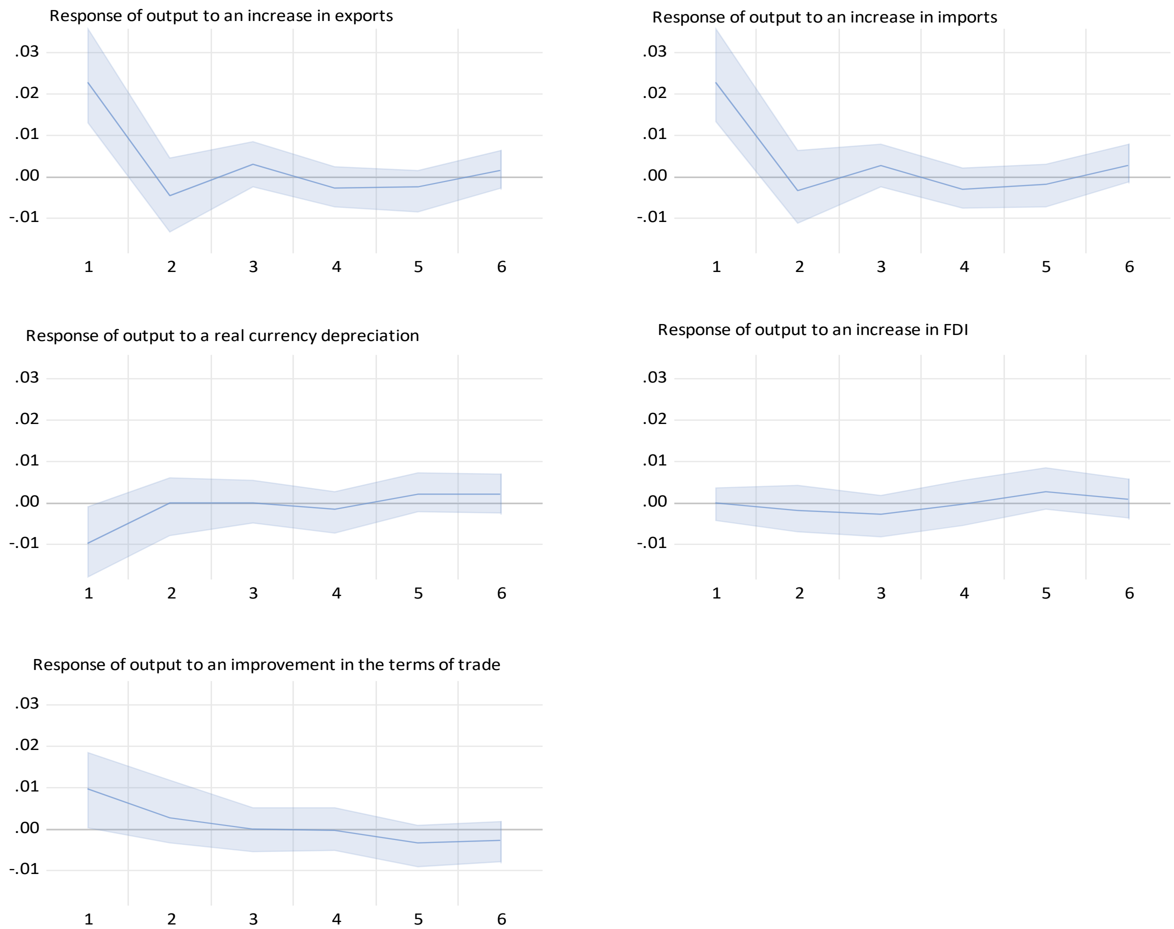

Figure 2. Generalized impulse-response functions with 95% confidence intervals

Note: The 95% confidence intervals were estimated through Hall's (1992) percentile bootstrap procedure.

Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

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[13] That is, the equations for real output, exports, and imports. Moreover, the matrix of estimated adjustment coefficients (matrix α) is omitted here for brevity but can be provided upon request.

[14] This evidence is not included for the sake of brevity but is available upon request.

[15] As opposed to the recursive impulse-response functions, the GIRFs do not depend on the ordering of the equations in the VAR model.

First, we can observe that an increase in exports raises Mexican output on impact and this effect dissipates at the end of the first quarter. This can be inferred from the confidence interval, which is above zero during the first quarter and includes zero as of the second quarter. Second, an increase in imports renders a similar effect on output. Third, real currency depreciation lowers output initially, but the effect is short-lived. The intuition behind this is that a real depreciation of the peso makes foreign intermediate inputs more expensive, thereby discouraging production. This is the supply-side effect of currency depreciation. In the long term, however, the alternative VAR model shows that a real depreciation of the peso stimulates production, presumably because it fosters exports by lowering its price in terms of dollars. This is the demand-side effect of exchange rate depreciation. It is worth mentioning that FDI does not yield a statistically significant effect on output in the short term. Lastly, an improvement in the terms of trade produces a slight positive effect on output, which can barely be observed at the beginning of the first quarter.

In the case of the alternative VAR model, $\Delta Z_t^A = [\Delta Y_t, \Delta X_t, \Delta M_t, \Delta Q_t, \Delta Y_t^*, \Delta TT_t]'$, which is also a five-lag stationary VAR model whose residuals are free of serial correlation and heteroscedasticity, the evidence indicates that an increase in US GDP yields a strong positive effect on Mexican production. Furthermore, the dynamic effect of the other variables on Mexican output is similar to the one observed through the benchmark VAR model, except that the negative effect of real currency depreciation and the positive effect of a terms-of-trade improvement are more noticeable (see appendix 3).

4. Final remarks and conclusions

The cointegrating equations of the benchmark model show that FDI has a positive impact not only on Mexican output, but also on the volume of exports and imports. In all the cointegrating equations, the estimated coefficient of FDI is statistically significant at the 1% level. In particular, the long-term elasticity of Mexico's economic activity with respect to FDI is 0.5559, which means that a one-percentage point increase in FDI leads to a rise in Mexico's economic activity of around 56 basis points; that is, more than half of a percentage point. It is well known that the Mexican economy is highly dependent on a bulk of imported intermediate inputs, whose continuous acquisition is conditioned on the country's availability of foreign exchange. Along these lines, the long-term positive effect of FDI on imports is consistent with the notion that FDI works as a stable source of dollar-denominated funds, which are used to pay for a variety of critical imports and, consequently, to sustain long-term economic growth. Therefore, our evidence also supports the Thirlwall-Hussain conclusion that there is a long-term balance-of-payments constraint on economic growth, which in the case of Mexico can be circumvented -to a certain extent- through the attraction of FDI. In the short term, however, FDI does not seem to have a bearing on domestic production.

Furthermore, the cointegrating equations also exhibit the positive linkage between FDI and exports which, in turn, are also a source of foreign exchange. Such a linkage is mainly explained by the fact that FDI translates into technology transfers and capital goods that strengthen Mexico's international competitiveness. On the other hand, it is not surprising that FDI has roughly the same parameter estimate in the export and the import equations (i.e., equations (7) and (8)), given that Mexican exports and imports are closely related due to the country's role in the international production networks. In fact, the substantial import content of Mexican manufacturing exports reflects the country's heavy reliance on assembly trade, even though some Mexican industries have been able to produce some key components and semi-finished goods along the global supply chain.

The alternative model shows the long-term positive impact of US GDP on Mexican economic activity, exports, and imports. The long-term elasticity of Mexican production to US output is slightly greater than 1 and is statistically significant at the 1% level. Furthermore, in the short term we can also observe that a one-standard deviation increase in US production raises Mexican output on impact and such an effect lasts slightly more than one quarter. This evidence highlights the dragging capacity of the US economy over the Mexican economy. The alternative model also unveils the positive long-term relationship between the real peso-dollar exchange rate and economic activity, which contradicts the short-term evidence that real currency depreciation discourages production. As previously mentioned, real currency depreciation triggers a demand- and a supply-side effect. On the demand side, currency depreciation makes exports cheaper in terms of dollars while on the supply side it makes imports more expensive in terms of pesos. These two effects interact over time, and one seems to prevail over the other depending on the time horizon. In the long term, however, a competitive exchange rate is likely to encourage economic growth subject to the availability of foreign funds to cover the resulting increase in import volume. In other words, it seems that we have a paradox: a competitive exchange rate might accelerate economic growth if and only if it is supported by increasing financial dependence and deindustrialization, a dreadful condition overlooked by some conspicuous promoters of a regime of competitive exchange rate to improve growth performance and overcome economic stagnation (Rodrik, 2008; Ros, 2015).

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Revista Mexicana de Economía y Finanzas, Nueva Época, Vol. 19 Issue 3, pp. 1-18, e1052
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Appendix 1.
Johansen cointegration tests for the alternative VAR/VEC model

Null hypothesis regarding the value of cointegrating equations	Probability values of the trace statistics	Null hypothesis regarding the value of cointegrating equations	Probability values of the maximum eigenvalue statistics
None***	0.0000	None**	0.0110
No more than 1***	0.0000	No more than 1***	0.0019
No more than 2***	0.0067	No more than 2**	0.0372
No more than 3*	0.0860	No more than 3*	0.0927
No more than 4	0.4098	No more than 4	0.5353
No more than 5	0.1658	No more than 5	0.1658

Notes: Asterisks *, ** and *** indicate the rejection of the null hypothesis at the 10%, 5% and 1% percent significance levels, respectively. The tests are conducted in a sequential manner and the conclusion can be drawn as soon as the null hypothesis can no longer be rejected at the 5% significance level, which is the reference level in Johansen cointegration tests. Therefore, at the 5% level the trace statistics and the maximum eigenvalue statistics both indicate the existence of three cointegrating equations. Lastly, we use MacKinnon-Haug-Michelis (1999) probability values.

Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.

Appendix 2.
Cointegrating equations for the alternative VEC model

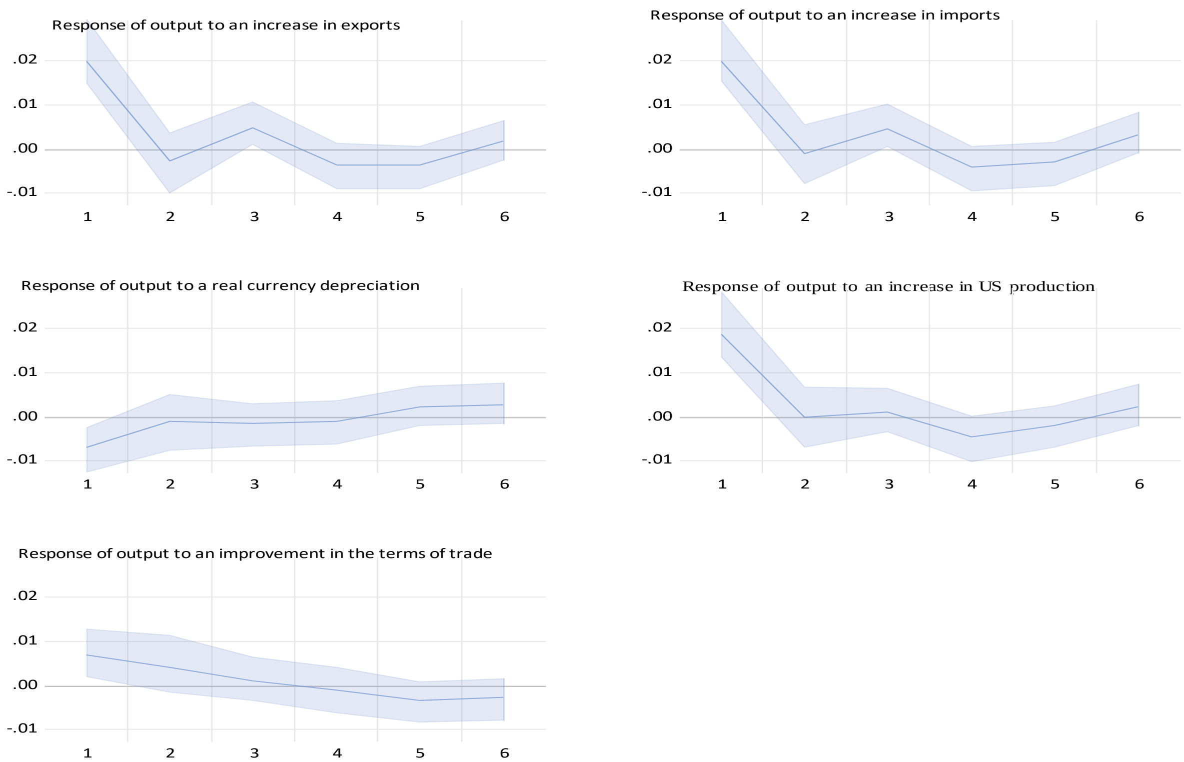
$$Y_t = -2.085 + 1.1594^{***} Y_t^* + 0.2816^{**} Q_t - 0.0123 TT_t \quad (9)$$

$$X_t = -15.2685 + 3.6468^{***} Y_t^* + 1.2097^{**} Q_t + 1.1050 TT_t \quad (10)$$

$$M_t = -14.3205 + 3.7345^{***} Y_t^* + 1.0430^{*} Q_t + 0.9675 TT_t \quad (11)$$

Appendix 3.

Figure A3. Generalized impulse-response functions with 95% confidence intervals



Note: The 95% confidence intervals were estimated through Hall's (1992) percentile bootstrap procedure.
Source: Authors' estimations based on data from the National Institute of Statistics and Geography, the Bank of Mexico, the Mexican Secretariat of Economy, and the Federal Reserve Bank of Saint Louis.