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External Shocks, Structural Change, and Economic Growth in Mexico 1979–2007

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Abstract

This paper finds that shocks to net financial inflows, world oil prices, the U.S. growth rate, and the lagged real exchange rate explain most of the fluctuations in Mexico's annual growth since 1979. The paper also estimates how the effects of these external constraints have changed since Mexico's liberalization policies of the late 1980s and the formation of NAFTA in 1994. Estimates of an investment function and other tests show that growth drives investment but not conversely, in the short run. Investment is driven mainly by oil prices and the accelerator effect; foreign direct investment has no significant impact.

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1. INTRODUCTION

Mexico represents an important example of a large Latin American country that has tried various types of export-led growth strategies since the late 1970s. At that time, Mexico sought to rescue its import-substitution industrialization approach by promoting oil exports and using the oil revenue to attract massive lending from international banks. After this strategy collapsed in the debt crisis of the early 1980s, Mexico abandoned import substitution and liberalized its trade on a multilateral basis when it joined the General Agreement on Tariffs and Trade (GATT) in 1986. When the subsequent increases in exports and foreign direct investment (FDI) proved disappointing, Mexico opted for preferential trade liberalization by forming the North American Free Trade Agreement (NAFTA) with the United States and Canada in 1994 (see Lustig, 1998). In addition, Mexico has also liberalized its financial markets since the late 1980s.

These policies of opening and liberalization have effectively linked the Mexican economy with the global economy in general, and the U.S. economy in particular, more than at any time since the country's 1910 revolution. However, after three decades of export-promotion efforts of various types, Mexico's growth performance remains disappointing. The growth rate of real gross domestic product (GDP) averaged 2.7% per year between 1981 and 2007, or 3.7% between 1996 and 2007 following the recovery from the peso crisis. These growth rates compare unfavorably with the average annual growth rate of 6.4% recorded during the import-substitution era of 1951-80, as well as with the more recent growth rates of the Asian economies.[1]

The academic literature has debated many explanations for the persistently slow growth of the Mexican economy since the 1980s.[2] Much of the literature has emphasized a variety of internal obstacles, such as the lack of fiscal reform and deficiencies in the rule of law, which have allegedly prevented Mexico from reaping the gains from its international integration (e.g., Hufbauer & Schott, 2005; Studer & Wise, 2007). Other studies have emphasized the low rate of capital formation, including public as well as private investment (e.g., Máttar *et al*., 2003). Still other studies have sought to explain why Mexico's export-promotion efforts have not had a greater impact on the country's overall economic growth, focusing on factors such as the high import content of its manufactured exports and competition from other emerging nations, especially China (see Ruiz-Nápoles, 2004; Moreno-Brid *et al*., 2005; Gallagher *et al*., 2008).

The central contention of this paper is that Mexico's various policies of opening and liberalization have made the country's growth highly vulnerable to certain external constraints or "shocks" since the late 1970s. Our econometric results show that Mexican growth has been tightly constrained by three key "external" variables: net financial inflows, defined as the sum of current transfers plus the financial account balance (excluding official reserve transactions) in the balance of payments; the world real price of oil; and the growth rate of the U.S. economy.[3] In addition, Mexico's export orientation and import liberalization have made the country's growth very sensitive to the real value of the peso, taken as a measure of external competitiveness (the lagged value of the peso is used to avoid endogeneity problems in the growth model and for other reasons discussed below). According to structural break tests, the precise effects of these variables have changed significantly since the liberalizing reforms of the late 1980s and the formation of NAFTA in 1994, but (taking the structural breaks into account) these variables together explain most of the annual variations in Mexico's growth between 1979 and 2007.

Furthermore, our estimates of a more complete model including an investment function suggest that the low rate of investment in Mexico since the 1980s is largely an effect, and not a cause, of the low rate of output growth in the short run. We also estimate the effects of other variables, including the real interest rate, real exchange rate, real oil prices, FDI inflows, and public investment spending on total domestic investment (gross capital formation) in Mexico. Perhaps surprisingly, we are unable to confirm statistically significant effects of either FDI or public investment on total investment spending during our sample period.

This paper focuses exclusively on the years since Mexico first opened up to the global economy by promoting oil exports and borrowing from international banks in the late 1970s. The starting point for our sample period (1979) is determined partly by data constraints and partly by a desire to focus on a period during which external constraints or "shocks" can reasonably be hypothesized to have been of decisive importance. Given this starting point, our analysis cannot address why average growth has been slower during most of this period than it was previously.[4] Nevertheless, the results in this paper shed light on the principal determinants of the wide fluctuations in Mexican growth during the nearly three decades of slower average growth. Another caveat is that Mexico is not necessarily "typical" of all major Latin American nations. Mexico's geographic proximity to the United States is unique, as is its unusual status as a major exporter of both petroleum and manufactures. Nevertheless, Mexico's experience may contain valuable lessons for other countries attempting to promote their growth through similar types of export-promotion and trade liberalization policies.

The rest of the paper is organized as follows. Section 2 surveys the existing literature on Mexican growth and external constraints. Section 3 presents the growth model and data set. Section 4 discusses the econometric estimates of the growth model, while section 5 covers the estimates of the investment function. Section 6 then considers estimates using simultaneous equations methods and presents simulations of the impact of the various external shock factors on the growth and investment rates. Section 7 concludes.

2. LITERATURE SURVEY

Studies of external constraints on Mexico's growth and the effects of international shocks (e.g., in oil prices and interest rates) were commonplace in the aftermath of the debt crisis of the 1980s (e.g., Zedillo, 1986; Lustig & Ros, 1993). Since the recoveries from that crisis and the subsequent peso crisis of 1994-95, a more common theme has been the conflict between the macroeconomic stabilization policies that were adopted following each of those crises—which in each case led to a significant real appreciation of the peso—and the trade liberalization policies that made the economy highly dependent on net exports (e.g., Dornbusch & Werner, 1994; Ros, 1995; Nadal, 2003; Ramírez de la O, 2004). Galindo and Ros (2008) specifically identify a bias toward appreciation of the peso in the operation of Mexican monetary policy since the recovery from the peso crisis. They find that, between 1995 and 2004, the Banco de México followed an asymmetrical policy in which it usually tightened monetary policy when the peso depreciated, but did not relax monetary policy when the peso appreciated.

Moreno-Brid (1999, 2002) and Pacheco-López (2005) found that Mexico experienced an increase in the income elasticity of its demand for imports after the trade liberalization of the 1980s, thus offsetting much of the gains from export expansion and reducing the growth rate consistent with balanced trade for any given rate of export expansion. According to Pacheco-López and Thirlwall (2004) and Pachecho-López (2005), Mexican exports are highly elastic with respect to U.S. income in the short run. Although simple accounting decompositions show that exports account for most of the growth of aggregate demand since the 1980s (Ibarra, 2008a), many observers have lamented that the growth of exports (primarily of manufactures) has not imparted more dynamism to the domestic economy. This is often attributed to a lack of "backward linkages" of the export industries to the domestic economy, especially in the maquiladora sector (e.g., Ruiz-Nápoles, 2004; Moreno-Brid, et al., 2005; Ibarra, 2008b).

A few studies have estimated econometric models that directly test for the causes of Mexico's slow growth and low investment rate. Ibarra (2008a) estimates a structural model including equations for investment, saving, the profit share, and the growth of manufactured exports. He finds that the real value of the peso has a negative effect not only on export growth, but also on the profit share of national income and thereby on real fixed investment, although this is partly offset by a positive effect on consumption (negative effect on saving). Galindo and Ros (2008) estimate a cointegration model using four variables: Mexican output, Mexican investment, U.S. output, and the real exchange rate. Using quarterly data from 1982:1 to 2003:4, the authors report results for both the entire sample and split samples before and after NAFTA went into effect in 1994. These results show a notably greater positive effect of real depreciation on output in 1994:1 to 2003:4 compared with 1982:1 to 1993:4, but only a slightly greater effect of U.S. output on Mexican output in the post-NAFTA period. However, several studies using other methodologies have found large and significant increases in the "synchronization" of Mexican output and industrial production with U.S. business cycles since NAFTA (e.g., Chiquiar & Ramos-Francia, 2004; Lederman et al., 2005, pp. 91-92; Mejía Reyes, et al., 2006).

No study to date has conducted a comprehensive evaluation of the role of external shocks and constraints for the entire period since the initial opening of the Mexican economy in the late 1970s, and how the effects of external variables were either weakened or strengthened by major policy changes such as trade liberalization and the formation of NAFTA. Surprisingly, none of the recent empirical studies has estimated or controlled for the effects of fluctuations in oil prices, which have become important again in the 2000s. Therefore, this paper will address these concerns by estimating a model of the effects of the four major external variables that have been identified in the literature: net financial flows, real oil prices, U.S. growth, and the real exchange rate. In addition, this paper will also investigate the feedback effects of the growth rate onto the investment rate via the accelerator mechanism in an investment function and try to sort out the direction of causality (and test for simultaneity) between investment and growth.

3. GROWTH MODEL AND DATA SET

Based on the preceding discussion, we postulate a basic model in which the Mexican growth rate is determined in the short run by four variables representing external constraints:

$$\text{MexGrowth}_t = \beta_0 + \beta_1 \text{ FinInflows}_t + \beta_2 \text{ USGrowth}_t + \beta_3 \text{ RealOil}_t + \beta_4 \text{ RealPeso}_{t-1} + u_t \qquad (1)$$

where MexGrowth is the growth rate of real Mexican GDP, FinInflows is net financial inflows (as a percentage of GDP), USGrowth is the growth rate of real U.S. GDP, RealOil is an index of the world real price of oil, RealPeso is an index of the real value of the peso, and u is the error term (the subscript t indicates the year). Equation (1) is intended to be a "reduced form" model in which the right-hand side variables are all exogenous to the Mexican economy (or, in the case of the lagged exchange rate index, predetermined). Our initial hypotheses are that β_1, β_2, $\beta_3 > 0$ and $\beta_4 < 0$. Modifications of this basic model to take account of additional lags and time-series issues are discussed in the next section.

The data set used in the regressions consists of annual data for 1979-2007. Some of our most important variables, including the interest rates and net financial inflows, are not available on a consistent basis before the late 1970s.[5] This sample period coincides with the period since

Mexico's initial opening to the global economy via oil exports and international borrowing, but includes possible structural breaks when Mexico liberalized its economy in the late 1980s and joined NAFTA in 1994. The specific variables included in the data set are:

Mexican growth rate. The dependent variable is the annual percentage change in the volume index for real GDP in the IFS. This series illustrates the enormous volatility of Mexico's economy from the 1970s through the mid-1990s (see figure 1). After recovering from a slowdown in 1975-77, Mexico enjoyed a strong but brief oil boom in 1978-81. This was cut short by the debt crisis of 1982-83, followed by another steep recession in 1986. The recovery in the late 1980s and early 1990s ended in the peso ("tequila") crisis of 1994-95. The post-crisis period (1996-2007) exhibits less extreme volatility than the preceding two decades, but the average growth rate during this period (3.7% per annum) remained disappointing.

[Insert Figure 1 about here]

Net financial inflows. This variable is defined as the sum of the financial account balance (excluding official reserve asset transactions) plus current transfers received in the balance of payments, measured as a percentage of GDP. Figure 2 shows the volatility of these inflows, as well as how their composition has changed over time. "Other inflows" predominated during the oil boom in 1979-81 (at which time they were primarily bank loans) and in the early 1990s (when they were primarily portfolio capital). FDI inflows increased strongly in the late 1990s, but stagnated after 2001. Transfers (mainly worker remittances) surged in the 2000s, while other inflows turned negative and total inflows fell.[6] Each major growth crisis since 1982 is associated with a sharp reversal in net financial inflows.[7]

[Insert Figure 2 about here]

U.S. growth rate. Although most of Mexico's exports have been sold in the U.S. market throughout the sample period, it is only since the liberalization policies and formation of NAFTA that trade has become a large enough share of Mexican GDP for U.S. growth to have a large quantitative impact on Mexican growth. Figure 1 shows that the correlation of the two countries' growth rates appears to have become stronger since the recovery from the peso crisis in 1996, but this is likely to be a delayed (post-crisis) reaction to the formation of NAFTA in 1994.

The world real price of oil. This index was constructed by taking the IMF's average index of three internationally quoted spot oil prices (Dubai, U.K. Brent, and Texas) in nominal terms and deflating it by the U.S. producer price index (PPI) for industrial commodities (since oil is priced in U.S. dollars). We use the world real price of oil because it is clearly exogenous to the Mexican economy, while actual oil revenue depends partly on decisions of the Mexican government concerning the state-owned oil company Pemex that may respond to current economic conditions (see Puyana, 2006).[8]

The (lagged) real value of the peso. We tried two alternative indexes for Mexico's real exchange rate. The multilateral real peso index is the reciprocal of the Banco de México's index of the real, consumer-price adjusted, multilateral exchange rate with 111 countries (the reciprocal is used so that a higher number indicates real appreciation). The bilateral real peso-dollar index is defined as $CPI_{Mex}/(E \times CPI_{US})$, where CPI_i is the consumer price index of country i and E is the nominal exchange rate in pesos per U.S. dollar. Both indexes yield qualitatively similar results in the regressions, but the estimates with the bilateral index generally have better statistical properties and for reasons of space only these are reported in the following sections.[9] The real peso index is lagged for two reasons. First, the current-year real exchange rate can be affected by Mexico's growth (for example, because strong growth may attract capital inflows or spark higher inflation). Second, the exchange rate affects growth primarily through its effects on international trade, and trade effects typically occur with so-called "J-curve" lags due to the time it takes to order, produce, and ship goods across national borders in response to exchange rate changes.

4. GROWTH EQUATIONS AND STRUCTURAL BREAK TESTS

Unit root tests (see Appendix) show that most of the variables in equation (1) are stationary according to most tests, but the evidence is mixed for a few variables (especially RealOil and RealPeso). Since some of the data series are unambiguously stationary (especially the growth rates and financial inflows), the use of cointegration procedures would be inappropriate. Nevertheless, equation (1) should be estimated by a method that is robust to the inclusion of variables with possibly different orders of integration. For this purpose we utilize the dynamic ordinary least squares (DOLS) approach of Stock and Watson (1993), in which each right-hand-side variable is entered both in level and first-difference form; the coefficients on the first difference terms control for dynamic adjustments to the "long-run" equilibrium while the coefficients on the levels are estimates of the "long-run" effects.[10] The general form of equation (1) using the DOLS approach is:

$$
\begin{aligned}
\text{MexGrowth}_t = {} & \beta_0 + \beta_1 \text{ FinInflows}_t + \sum_{j=1}^{n} \beta_{2j} \,\Delta\text{FinInflows}_{t-j} + \beta_3 \text{ USGrowth}_t + \\
& \sum_{j=1}^{n} \beta_{4j} \,\Delta\text{USGrowth}_{t-j} + \beta_5 \text{ RealOil}_t + \sum_{j=1}^{n} \beta_{6j} \,\Delta\text{RealOil}_{t-j} + \\
& \beta_7 \text{ RealPeso}_{t-1} + \sum_{j=1}^{n} \beta_{8j} \,\Delta\text{RealPeso}_{t-1-j} + v_t \qquad (2)
\end{aligned}
$$

where Δ is the difference operator and v is the error term. We started with a maximum lag length of n = 2 (longer lags were not feasible since we have annual data and a short sample), and then all insignificant first differences (either lagged or current) according to (individual) *t*-tests and (joint) *F*-tests were eliminated to obtain more efficient estimates. We found uniformly that only $\Delta\text{RealOil}_t$ and $\Delta\text{RealPeso}_{t-1}$ were significant; all other first differences, current or lagged, were insignificant in all equations and were dropped (this is not surprising, since RealOil and RealPeso are the only two variables for which some of the stationarity tests show unit roots).

This leaves us with the following specific form of (2):

$$\text{MexGrowth}_t = \beta_0 + \beta_1 \text{ FinInflows}_t + \beta_2 \text{ USGrowth}_t + \beta_3 \text{ RealOil}_t + \beta_4 \,\Delta\text{RealOil}_t + \beta_5 \text{ RealPeso}_{t-1} + \beta_6 \,\Delta\text{RealPeso}_{t-1} + v_t \qquad (2')$$

Our hypotheses can now be restated as $\beta_1, \beta_2, \beta_3 > 0$ and $\beta_5 < 0$ (we are not concerned with the signs of the differenced terms), and we hypothesize that $\beta_2 > 0$ only in the post-NAFTA period.

The results of estimating equation (2′), including several variations testing for structural breaks, are shown in Table 1. Our initial baseline equation, column (1.1) in Table 1, passes several standard diagnostic tests for a well-specified econometric model: the Durbin-Watson and Breusch-Godfrey tests show no serial correlation of the residuals, the null hypothesis that the residuals are normally distributed cannot be rejected according to Jarque-Bera, and there is no significant misspecification bias according to Ramsey's RESET. All four variables have their expected signs in levels, but USGrowth is statistically insignificant. However, a Chow breakpoint test indicates a significant structural break when NAFTA went into effect in 1994, at the 5% level using the *F*-statistic and at the 0.1% level using the likelihood ratio (LR) and Wald tests. A Chow test for a break in 1988, around the beginning of Mexico's liberalization policies, shows a significant break (5% level) according to the LR test but not the other two tests.

[Insert Table 1 about here]

To conduct tests for structural change in the growth equation, we used two alternative dummies: DLiberal, which is 1 during the liberalization period (defined as 1988-2007) and 0 otherwise;[11] and DNAFTA, which is 1 in 1994-2007 and 0 otherwise. These dummies were employed in an interactive fashion by multiplying them by each of the regressors, to test for structural changes in the effects of each variable. In equation (1.2), the interactive variable DLiberal*USGrowth is positive but insignificant, while in equation (1.3) DNAFTA*USGrowth is positive and significant at the 5% level (in each case, the plain USGrowth variable is insignificant).[12] Since estimates with insignificant variables included are inefficient, we re-ran the latter equation omitting USGrowth (without the dummy) and including only the interactive term DNAFTA*USGrowth, resulting in the estimates shown as equation (1.4) in Table 1. In this equation, all variables are significant and have their expected signs, and the diagnostic tests indicate no problems with the residuals or specification.

Then, using equation (1.4) as a new baseline model, we proceed to test for structural breaks in the effects of the other independent variables.[13] Equations (1.5) and (1.6) appear to show significant reductions in the effects of net financial inflows and real oil prices, respectively, during the post-1988 liberalization periods, although in both equations the variable in question remains significant (with a smaller effect) after 1988.[14] However, equations (1.5) and (1.6) both suffer from misspecification bias according to the Ramset RESET statistics, which are significant at the 5% level in each equation, and in addition (1.5) has serially correlated residuals according to the Breusch-Godfrey statistic (also significant at 5%). This means that we cannot be certain of the validity of the structural break tests or other hypothesis tests in these equations.[15]

Finally, columns (1.7) and (1.8) of Table 1 report tests for whether either the trade liberalization of the late 1980s or the formation of NAFTA in 1994 increased the sensitivity of the Mexican growth rate to the real exchange rate. The estimated coefficients on the interactive terms DLiberal*RealPeso and DNAFTA*RealPeso have negative signs in both equations, indicating stronger negative effects, and these structural breaks are significant at the 10% level using DLiberal and at the 5% level using DNAFTA. Neither of these structural shifts is very large, but there is evidence that a high value of the peso has had a more negative (lagged) effect on growth since trade liberalization and especially since NAFTA was formed.

5. INVESTMENT FUNCTIONS

For the investment function, we begin with a conventional flexible-accelerator model modified to take account of the structural conditions of the Mexican economy and the limitations of the available data.[16] Ignoring lags initially for simplicity, our baseline specification is

$$\text{InvRate}_t = \alpha_0 + \alpha_1 \text{ MexGrowth}_t + \alpha_2 \text{ }\Delta\text{RealInterest}_t + \alpha_3 \text{ RealPeso}_t + \alpha_4 \text{ RealOil}_t + \varepsilon_t \qquad (3)$$

where InvRate is the real investment rate, MexGrowth represents the accelerator effect, ΔRealInterest is the change in the real interest rate, ε is the error term, and the other variables are defined as before. The expected signs on MexGrowth and ΔRealInterest are $\alpha_1 > 0$ and $\alpha_2 < 0$.

Several measurement issues need to be addressed. First, the theoretically desirable dependent variable is the rate of capital accumulation, i.e., the ratio of real net investment to the (end-of-previous-period) real capital stock. However, given the difficulties in obtaining reliable measures of depreciation and the capital stock for Mexico,[17] we use instead the ratio of real gross investment to real GDP, where investment is measured by "gross fixed capital formation" and real GDP is expressed as a Hodrick-Prescott filter of the actual series (on the presumption that a correct capital stock series would be much smoother than actual GDP).[18]

To explain the investment rate, the two most standard variables to use are measures of output growth or capacity utilization (accelerator effect) and the cost of capital funds (see

Chirinko, 1993; Chirinko et al., 1999). For the accelerator effect, we used the Mexican growth rate shown in Figure 1. Due to data limitations, it was not possible to obtain the user cost of capital for Mexico, so the real interest rate (three-month treasury bill rate minus the percentage change in the consumer price index) was used instead. The interest rate variable is entered in differenced form because it affects the desired stock of capital, and investment is the *change* in the capital stock (Chirinko et al., 1999; Campa and Goldberg, 1999).

In addition, investment in Mexico has historically been highly correlated with oil prices due to the leading role of oil exports in government revenue and hence in financing public investment, which is included in the data for "gross fixed capital formation" used here. Also, in an open economy, the real exchange rate can be an important determinant of the national location of investment (Campa and Goldberg, 1999; Blecker, 2007). A higher value of the home currency makes a country a less competitive location for the production of traded goods, because it makes local products relatively more expensive, but it also cheapens imports of capital and intermediate goods and therefore can stimulate investment in activities that are intensive in imported inputs. Hence, the net effect of RealPeso on total investment (the sign of α_3) is ambiguous *a priori*.

Although the evidence about stationarity of the variables in the investment function (3) is mixed, most of them are stationary according to at least one test and MexGrowth is stationary according to all tests used (see Appendix). Efforts to use the DOLS procedure to correct for variables that might have unit roots ran into problems of equation misspecification as indicated by significant Ramsey RESET statistics for cubed residuals. Since there are strong theoretical reasons to estimate an investment function in the general form (3), we instead tested for longer lags of the independent variables in (3), and after eliminating insignificant lags based on *t*-tests and *F*-tests, we arrived at the following distributed lag model:

$$\text{InvRate}_t = \alpha_0 + \sum_{i=0}^{2} \alpha_{1i}\ \text{MexGrowth}_{t-i} + \sum_{j=0}^{1} \alpha_{2j}\ \Delta\text{RealInterest}_{t-j} + \alpha_3\ \text{RealPeso}_t + \alpha_4\ \text{RealOil}_t + \nu_t. \tag{4}$$

Results of estimating several versions of (4) are shown in Table 2 (the coefficients shown for MexGrowth and ΔRealInterest are the sums of the coefficients α_{1i} and α_{2j}, respectively, representing the long-run effects). In equation (2.1), the accelerator effect is strong and significant at the 0.1% level, with a long-run coefficient of 0.557 on MexGrowth. The real interest rate effect is negative and significant at the 5% level, but small with a coefficient of –0.024. RealPeso and RealOil are both positive and significant at the 0.1% level, although it should be noted that RealPeso also has an indirect negative effect via MexGrowth while RealOil has an indirect positive effect via the same channel (the net impact of these direct and indirect effects for each variable will be considered in the next section). The equation passes all tests for the normality of the residuals and the absence of serial correlation or equation misspecification.

[Insert Table 2 about here]

The remaining equations in Table 2 test for additional variables that might be thought to affect total investment in Mexico. First, since Mexico successfully increased its inflows of foreign direct investment (FDI) after the passage of NAFTA,[19] equation (2.2) tests for the effects of FDI measured as a percentage of GDP. The coefficient on the FDI-GDP ratio is positive but small (0.187) and insignificant, indicating that FDI inflows do not appear to have significantly raised the overall rate of capital formation in Mexico.[20] However, the serial correlation of the residuals (according to the Breusch-Godfrey test) and possible nonstationarity of the FDI-GDP ratio (see Appendix) make the hypothesis tests of uncertain validity.

Since several authors cited earlier have focused on the decrease in public investment in Mexico since the 1980s, we also test for a positive effect of public investment spending (measured as a percentage of GDP) on total investment in equation (2.3).[21] The coefficient on the public investment rate is negative, small, and insignificant (and this equation is misspecified according to the Ramsey RESET test with cubed fitted values). Equation (2.4) shows that the coefficient on public investment becomes positive and appears significant at the 5% level if we omit RealOil from the investment function, but this equation suffers from serial correlation of the residuals (according to the Breusch-Godfrey test as well as the low Durbin-Watson statistic). Since serial correlation can be a result of a missing variable, and an omitted variable LR test (not shown in the table) shows that RealOil should be included at the 0.1% level, we conclude that this variable does belong in the model and public investment does not significantly boost total capital formation in Mexico in the short run after oil prices are controlled for.

6. SIMULTANEOUS EQUATIONS ESTIMATES AND SIMULATED EFFECTS

Equations (4) for investment and (2′) for growth constitute a special type of simultaneous equations system known as a "triangular" or "recursive" system, since the investment rate is modeled as a function of the growth rate, but the growth rate is assumed not to depend on the investment rate. Whether this is a valid specification is discussed further below; first we consider whether the ordinary least squares (OLS) estimates of these equations in the previous two sections yield reliable results.[22] OLS estimates of a recursive system of equations are unbiased and consistent, provided that the residuals from the equations are not correlated (see Greene, 1997, pp. 715-16, 732, 736-37). Therefore, we used Breusch-Pagan Lagrange multiplier (LM) tests for correlation of the OLS residuals for various pairs of growth and investment equations from Tables 1 and 2.[23] These tests (results of which are available on request) show that none of the residuals from the various pairs of growth and investment equations are significantly correlated, and therefore the OLS estimates are unbiased and consistent.

The second set of simultaneity issues has to do with whether the recursive model is the correct specification of the short-run relationship between growth and investment. It might be thought that the investment rate, considered as an important indicator of domestic demand shocks, should be included in the growth rate equation. This would essentially add a Keynesian "multiplier" effect in the (output) growth equation to the accelerator effect found in the investment function. To address this question, we consider a specification of the growth model in which InvRate is included as a regressor in equation (2′). Combined with the investment function (4), this gives us a truly simultaneous system, which we can use to test for whether InvRate is significant in the MexGrowth equation—in which case, the correct model would be simultaneous and not recursive.

In the presence of true simultaneity, OLS estimates are biased even if the residuals are uncorrelated. Therefore, we estimated various pairs of growth and investment equations, with the former modified to include InvRate, using two-stage least squares (2SLS). In all cases, the 2SLS residuals were not significantly correlated according to Breusch-Pagan LM tests (available on request). Therefore, the 2SLS results are unbiased and consistent, and it is not necessary to use three-stage least squares. Results of two typical pairs of 2SLS regressions are shown in Table 3. These estimates combine our preferred specification of the growth equation (column 1.4 in Table 1), with InvRate added as a regressor, along with two alternative investment functions, one excluding and one including the FDI-GDP ratio (essentially, equations analogous to columns 2.1 and 2.2 in Table 2). All the exogenous and lagged (predetermined) variables in each pair of equations were used as instruments for each set of estimates.

[Insert Table 3 about here]

In equations (3.1a) and (3.1b) in Table 3, the estimated coefficients on most variables are similar in magnitude compared to equations (1.4) and (2.1) in Tables 1 and 2, respectively, but DNAFTA*USGrowth and RealOil are insignificant in equation (3.1a) and ΔRealInterest is insignificant in (3.1b).[24] The coefficient on InvRate in (3.1a), while large and positive (nearly 0.5), is not statistically significant (*p*-value of 0.243). These results indicate that there is not true simultaneity, and the recursive model consisting of equations (1.4) and (2.1) is the correct model. Equations (3.2a) and (3.2b) in Table 3 repeat the same exercise, but including the FDI-GDP ratio as a regressor in the investment equation. The results show that the FDI-GDP ratio retains its positive coefficient, but it is still insignificant in the 2SLS estimates (*p*-value of 0.384). In this last set of estimates, InvRate is again insignificant in the growth equation (3.2a), although more marginally so (*p*-value of 0.118).[25]

Thus, the evidence suggests that investment in Mexico is a function of growth but not vice-versa, i.e., the relationship is one-way and not simultaneous, in the short run. Put another way, there is strong evidence for an accelerator effect of growth on investment, but no robust evidence for a multiplier effect of investment on growth. While this result may seem surprising, it suggests the persistent strength of external constraints on the Mexican economy. Given the strong accelerator effects on investment, it appears that investment has been heavily constrained by the same external factors that constrain growth.

Assuming that the recursive model is correct, we can use our earlier results from Tables 1 and 2 to simulate the quantitative impact of shocks to the main exogenous variables on domestic growth and investment.[26] The darker bars in Figure 3 show the effects of a one standard deviation increase in each exogenous variable on the growth rate, using equation (1.4). Shocks to net financial inflows have the largest positive impact, followed by the real oil price; the lagged real peso-dollar index has a large negative effect. The darker bars in Figure 4 show the effects of the same shocks on the investment rate, using equation (2.1) for investment and including indirect effects via the growth rate based on equation (1.4). For the investment rate, the largest impact factor is the real oil price, followed by net financial inflows. Shocks to the other exogenous variables have only small effects on the investment rate. Notably, for the real peso index, the negative indirect effect via growth approximately cancels out the positive direct effect, resulting in a negligible net impact of real peso appreciation on the investment rate.

[Insert Figures 3 and 4 about here]

To assess the importance of external shocks during the period since the recovery from the 1994-95 peso crisis, the lighter bars in Figures 3 and 4 show the simulated effects of the changes in the means of the exogenous variables between the five-year period 1996-2000 and the most recent five-year period 2003-7 (note that this periodization deliberately omits the growth slowdown of 2001-2). For this simulation, while we continue to use equation (2.1) for investment, we utilize equation (1.6) for growth in order not to exaggerate the importance of oil prices in the more recent period. According to these simulations, between 1996-2000 and 2003-7, Mexican growth was negatively impacted by reduced net financial inflows, the increased real value of the peso, and the lower U.S. growth rate, and these negative effects were only partly offset by the positive impact of increased world oil prices (Figure 3). The increase in world oil prices had a strongly positive effect on the investment rate between 1996-2000 and 2003-7, while reduced net financial inflows and slower U.S. growth had smaller negative effects (Figure 4). Changes in the other variables (the real dollar-peso index and real interest rate) had negligibly small net effects on the investment rate between those periods.

7. CONCLUSIONS

This article has found that most of the variation in Mexico's growth rate since 1979 can be explained, parsimoniously, by shocks to four external factors: net financial inflows, world oil prices, U.S. growth, and the lagged real exchange rate. Tests for structural breaks show (subject to some uncertainty about the validity of the hypothesis tests due to possible equation misspecification) that the post-1988 economic liberalization policies reduced, but did not eliminate, the constraining effects of net financial inflows and real oil prices on Mexican growth. The formation of NAFTA in 1994 created a statistically significant dependency of Mexico's growth on U.S. growth that is not found previously. We also found that there was a small but statistically significant increase in the negative effect of the value of the peso on the growth rate after liberalization and NAFTA (especially the latter).

Real oil prices and changes in real interest rates have the theoretically expected effects on the investment rate (positive and negative, respectively), but quantitatively shocks to oil prices have been much more important than interest rates in driving investment behavior. The real value of the peso has a positive direct effect on investment, but this effect is roughly cancelled out by the negative indirect effect via the growth rate. We also found that the real investment rate in Mexico is subject to a strong and significant accelerator (growth) effect, but there is no statistically significant reciprocal effect of the investment rate on the growth rate in the short run. In other words, the causality in the Mexican macroeconomy appears to go from external shocks to growth to investment, with no significant feedback (multiplier effect) of investment onto short-run growth. This suggests an economy that, after three decades of international opening and liberalization policies, has become chronically dependent on external forces as the motor of its expansion and remains highly vulnerable to adverse external shocks.

Of course, these results need to be heavily qualified to the extent that they explain only the variations in Mexico's short-run growth since the early 1980s, and not the long-run decrease in the average growth rate during this period. However, the results in this paper do suggest a new direction for future research on the causes of the long-term growth slowdown. Previous research (cited earlier) suggests that Mexico's economic opening of the 1980s and beyond may have made it more constrained by its balance of payments and other external conditions than it was in the preceding decades, and this paper verifies the strength of those external factors during the post-1980 period. Further research is needed to verify if the increased exposure to external constraints since 1980 has been one of the causes of the longer-term growth slowdown.

Although our results suggest that growth drives investment and not vice-versa in the short run, nothing in this paper denies that a low rate of capital accumulation could be a significant factor in the slow long-run (average) growth of the Mexican economy since the 1980s. However, if that is the case, our results imply that policies that could stimulate growth in the short run could also have a long-run payoff, insofar as encouraging more investment in the short run leads to a larger capital stock embodying new generations of technology in the long run. Finally, although there are many unique attributes of the Mexican case, as noted earlier, the findings of this paper should sound a cautionary note for other countries that are seeking to propel their development through similar types of export-promotion policies, trade liberalization measures, and preferential trade agreements. Whatever their other merits, such policies may be likely to tighten external constraints on the short-run growth of the countries that adopt them.

NOTES

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[1] According to the International Monetary Fund (IMF), *World Economic Outlook Database* (April 2008), the newly industrialized nations of Asia averaged 6.4% growth from 1981-2007 while the developing nations of Asia averaged 7.4% during the same period. The Mexican data for 1951-80 are from Urquidi (2003, p. 562, Table 15.1); the more recent Mexican growth rates are from our own data set described in section 3, below.

[2] See Moreno-Brid and Ros (2009) for a comprehensive survey and critical discussion.

[3] In a study of the so-called "decoupling" phenomenon, Akin and Kose (2008, p. 1) find that "the impact of Northern economic activity on the Emerging South has declined during the globalization period (1986-2005)" compared with earlier years. However, when the 23 nations in their Emerging South group are broken down by region, Akin and Kose find that while the growth of the Asia-Pacific region has become less dependent on the growth of the North since 1986, the growth of Latin America has become more so.

[4] For one effort at a long-run econometric approach, see Romero (2008).

[5] The data series in this paper were taken from IMF, *International Financial Statistics*, on-line database (IFS), September 2008, except as otherwise noted. The IFS data for Mexico's balance of payments start in 1979. Earlier balance of payments data available on the Banco de México website (www.banxico.gob.mx) are not fully consistent with the later data.

[6] IFS data on total unilateral current transfers received go back to 1979, while Mexican government data on "remesas familiares" (family remittances) go back only to 1995. Data for the overlapping years (1995-2007) show that more than 90% of the transfers are remittances.

[7] A Hausman exogeneity test (details available on request) confirms that the net financial inflows variable is exogenous with respect to the growth rate.

[8] As a sensitivity test, we estimated the growth model using oil revenue as a percentage of GDP instead of the real oil price index. The results are qualitatively similar, but the equation using oil revenue suffers from misspecification bias according to Ramsey RESET tests.

[9] Estimates using the multilateral real peso index show more evidence of serially correlated residuals and misspecification error than estimates using the bilateral real peso-dollar index.

[10] We use the term "long-run" in its standard sense in time-series econometrics, i.e., the sum of all lagged effects. This is not generally as long as the "long run" contemplated in growth theory, which is on the order of decades. Thus, our use of the term "long-run" here is not intended to deny the essentially short-run nature of the present analysis.

[11] Although the choice of any particular year as the beginning of the liberalization period is inevitably arbitrary, 1988 was chosen for several reasons. First, it was around the middle of the period 1986-1990 when many of the most drastic liberalization measures were taken, starting when Mexico joined the GATT in 1986 and culminating with the privatization of state-owned banks in 1990. According to Lustig (1998, pp. 51, 108, 117), 1988 was the year in which the government began to have success in reducing inflation, adopted a series of important banking reform measures, and "consolidated" its efforts at trade liberalization.

[12] In all the regressions in Table 1, the coefficient on the plain variable is an estimate of the effect before the structural break, while the coefficient on the interactive variable is an estimate of the change in the coefficient after the break.

[13] Due to the small sample size, each interactive dummy term was tested separately (in addition to DNAFTA*USGrowth). Equations using more interactive dummies at once had autocorrelated residuals and other specification problems.

[14] The coefficient for FinInflows for 1988-2007 in equation (1.5) is 0.617 (p-value 0.000); the coefficient for RealOil for 1988-2007 in equation (1.6) is 0.026 (p-value 0.010).

[15] Similar results are obtained using DNAFTA instead of DLiberal, except that the structural break in FinInflows is not statistically significant.

[16] For an alternative investment function emphasizing the profit share, see Ibarra (2008a).

[17] The Mexican government has not published a capital stock series in several years. Loría and de Jesus (2007) cite a Banco de México series that was discontinued after 2003, as well as previously published critiques of the methodology used for that series. Loría and de Jesus's own estimates of quarterly capital stocks from 1980:1 to 2004:4 imply, rather implausibly, that the decline in the capital stock during the debt crisis of the 1980s was not reversed until after 2000, and their estimated capital stock seems too highly correlated with the current flow of investment.

[18] The Hodrick-Prescott filter was applied using a power value of 4, as suggested by Ravn and Uhlig (2002). This results in a trend that better approximates the medium-run cycles in Mexican output compared with a power value of 2, as originally suggested by Hodrick and Prescott (1997), which results in a smoother, more long-run trend.

[19] The FDI-GDP ratio averaged 3.0% in 1994-2007, compared with 1.2% in 1979-1993.

[20] The same result is obtained if we use the lagged FDI-GDP ratio or its first difference. This result could be explained by the fact that some of the largest FDI inflows in Mexico have been for corporate acquisitions rather than greenfield investment.

[21] I am indebted to an anonymous referee for suggesting this test.

[22] Since DOLS is a special application of OLS, this discussion also applies to the DOLS estimates of the growth equation.

[23] The Breusch-Pagan LM test statistic is $\lambda = n\sum_{i=2}^{m}\sum_{j=1}^{i-1}\rho_{ij}^2$, where n is the number of observations, m is the number of equations, ρ_{ij} is the correlation coefficient between the residuals of the i^{th} and j^{th} equations, and (under the null hypothesis of no cross-equation correlation) λ is distributed as

$\chi^2[0.5m(m-1)]$. With two equations ($m = 2$), this reduces to $\lambda = n\rho^2$, where ρ is the correlation of their residuals and $\lambda \sim \chi^2(1)$. We computed these statistics for all possible pairs of equations (1.1), (1.2), (1.3), (1.4), and (1.8) from Table 1 with all four equations from Table 2.

[24] We suspect that the insignificance of the real oil price results from the high correlation of this variable with the investment rate; the simple correlation coefficient between these two variables from 1979-2007 is 0.59, and RealOil is positive and significant in all the estimated InvRate equations. Given the multicollinearity of these two variables, it may be impossible to definitively tease out their respective effects on growth. However, since the world oil price is exogenous to the Mexican economy, it is likely that investment is driven by oil prices and not vice-versa.

[25] Several other permutations of the 2SLS models were tried as sensitivity tests. In one variant, ΔInvRate was included in the growth equation along with the level of InvRate, but the latter was still not significant. In another model, the FDI-GDP ratio was treated as endogenous in the investment equation (with the lagged ratio and DNAFTA used as instruments), but the FDI-GDP ratio was still not statistically significant. Details are available on request.

[26] Details on these simulations are available on request.

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Table 1. *Estimates of growth equations with tests for structural breaks*
Dependent variable: MexGrowth(t); Sample period: 1979-2007 (29 annual observations)

Equation:	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)
FinInflows(t)	0.758	0.738	0.722	0.717	1.012	0.727	0.741	0.649
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DLiberal(t)*FinInflows(t)					-0.395			
					(0.017)			
USGrowth(t)	0.322	0.161	0.082					
	(0.181)	(0.517)	(0.732)					
DLiberal(t)*USGrowth(t)		0.425						
		(0.109)						
DNAFTA(t)*USGrowth(t)			0.536	0.570	0.662	0.791	0.751	1.195
			(0.029)	(0.010)	(0.002)	(0.001)	(0.002)	(0.002)
RealOil(t)	0.030	0.040	0.039	0.039	0.027	0.041	0.029	0.037
	(0.002)	(0.001)	(0.000)	(0.000)	(0.008)	(0.000)	(0.006)	(0.000)
ΔRealOil(t)	0.048	0.038	0.037	0.037	0.046	0.041	0.045	0.039
	(0.002)	(0.014)	(0.012)	(0.010)	(0.001)	(0.003)	(0.002)	(0.004)
DLiberal(t)*RealOil(t)						-0.014		
						(0.021)		
RealPeso(t-1)	-0.116	-0.131	-0.155	-0.162	-0.160	-0.159	-0.142	-0.123
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ΔRealPeso(t-1)	0.087	0.084	0.106	0.107	0.094	0.113	0.110	0.101
	(0.012)	(0.013)	(0.002)	(0.002)	(0.002)	(0.000)	(0.001)	(0.001)
DLiberal(t)*RealPeso(t-1)							-0.020	
							(0.056)	
DNAFTA(t)*RealPeso(t-1)								-0.030
								(0.038)
Adjusted R^2	0.753	0.772	0.795	0.803	0.844	0.841	0.828	0.833
SE	1.747	1.679	1.592	1.560	1.390	1.403	1.460	1.438
Durbin-Watson	2.281	2.273	2.128	2.131	2.802	2.412	2.361	2.491
Diagnostic tests (*p*-values)								
Jarque-Bera Normality	0.627	0.849	0.832	0.791	0.625	0.809	0.880	0.927
Breusch-Godfrey LM (2 lags)	0.401	0.330	0.197	0.211	0.042	0.263	0.392	0.268
RESET (squared fitted values)	0.303	0.428	0.402	0.378	0.045	0.031	0.124	0.129

Notes to Table 1:

Notes: Numbers in parentheses are *p*-values (significance levels). Equations were estimated by dynamic ordinary least squares (DOLS) as explained in the text. Constants were included in each equation but are not reported here for reasons of space.

Table 2. *Estimated investment functions*

Dependent variable: InvRate(t); Sample period: 1980-2007 (28 annual observations)

Equation:	(2.1)	(2.2)	(2.3)	(2.4)
Constant	6.643	6.836	6.681	6.256
	(0.000)	(0.000)	(0.000)	(0.000)
MexGrowth[a]	0.557	0.589	0.560	0.527
	(0.000)	(0.000)	(0.000)	(0.000)
ΔRealInterest[b]	-0.024	-0.021	-0.024	-0.029
	(0.047)	(0.101)	(0.055)	(0.064)
RealPeso (t)	0.094	0.084	0.093	0.110
	(0.000)	(0.000)	(0.000)	(0.000)
RealOil (t)	0.018	0.020	0.018	
	(0.001)	(0.000)	(0.001)	
FDI-GDP Ratio (t)		0.187		
		(0.190)		
PubInvRate (t)			-0.007	0.199
			(0.947)	(0.034)
Adjusted R^2	0.913	0.913	0.909	0.854
SE	0.866	0.869	0.888	1.125
Durbin-Watson	1.765	1.881	1.776	0.955
Diagnostic tests (*p*-values):				
Jarque-Bera Normality	0.746	0.883	0.762	0.428
Breusch-Godfrey LM test (2 lags)	0.251	0.029	0.232	0.041
RESET (squared fitted values)	0.397	0.522	0.345	0.250
RESET (cubed fitted values)	0.170	0.151	0.009	0.505

Notes: Numbers in parentheses are *p*-values (significance levels) using OLS with White heteroskedasticity-consistent standard errors and covariances (used because these equations show significant heteroskedasticity according to Breusch-Pagan-Godfrey and White tests).

[a]Sum of 0 to 2 lags; *p*-values are based on *F*-tests.

[b]Sum of 0 to 1 lags; *p*-values are based on *F*-tests.

Table 3. *Two-stage least squares (2SLS) estimates of simultaneous equations models*
Sample period: 1980-2007 (28 annual observations)

Equation:	(3.1a)	(3.1b)	(3.2a)	(3.2b)
Dependent Variable:	MexGrowth	InvRate	MexGrowth	InvRate
Constant	4.575	6.492	3.272	6.769
	(0.289)	(0.000)	(0.430)	(0.000)
FinInflows(t)	0.518		0.460	
	(0.011)		(0.019)	
DNAFTA(t)*USGrowth(t)	0.412		0.362	
	(0.111)		(0.152)	
RealOil(t)	0.019	0.018	0.013	0.020
	(0.312)	(0.000)	(0.462)	(0.000)
RealPeso(t)		0.096		0.086
		(0.000)		(0.000)
RealPeso(t-1)	-0.178		-0.183	
	(0.000)		(0.000)	
InvRate(t)	0.497		0.640	
	(0.243)		(0.118)	
MexGrowth[a]		0.537		0.580
		(0.000)		(0.000)
ΔRealInterest[b]		-0.024		-0.021
		(0.102)		(0.151)
FDI-GDP Ratio(t)				0.180
				(0.384)
Adjusted R^2	0.811	0.913	0.814	0.913
SE	1.469	0.868	1.456	0.869
System Residual Normality[c]	0.901	0.660	0.911	0.840

Notes: Numbers in parentheses are *p*-values (significance levels). Each pair of equations (3.1 and 3.2) was estimated using 2SLS; all exogenous and predetermined variables in both equations were used as instruments (i.e., all variables except InvRate(t) and MexGrowth(t). Equations (3.1a) and (3.2a) include first differences of RealOil and RealPeso(t-1), which are not shown for reasons of space.

[a]Sum of 0 to 2 lags; *p*-values are based on chi-square statistics.

[b]Sum of 0 to 1 lags; *p*-values are based on chi-square statistics.

[c]Numbers are *p*-values for Jarque-Bera statistics for the null hypothesis of multivariate normality for each component, using Lutkepohl orthogonalization (Cholesky of covariance).

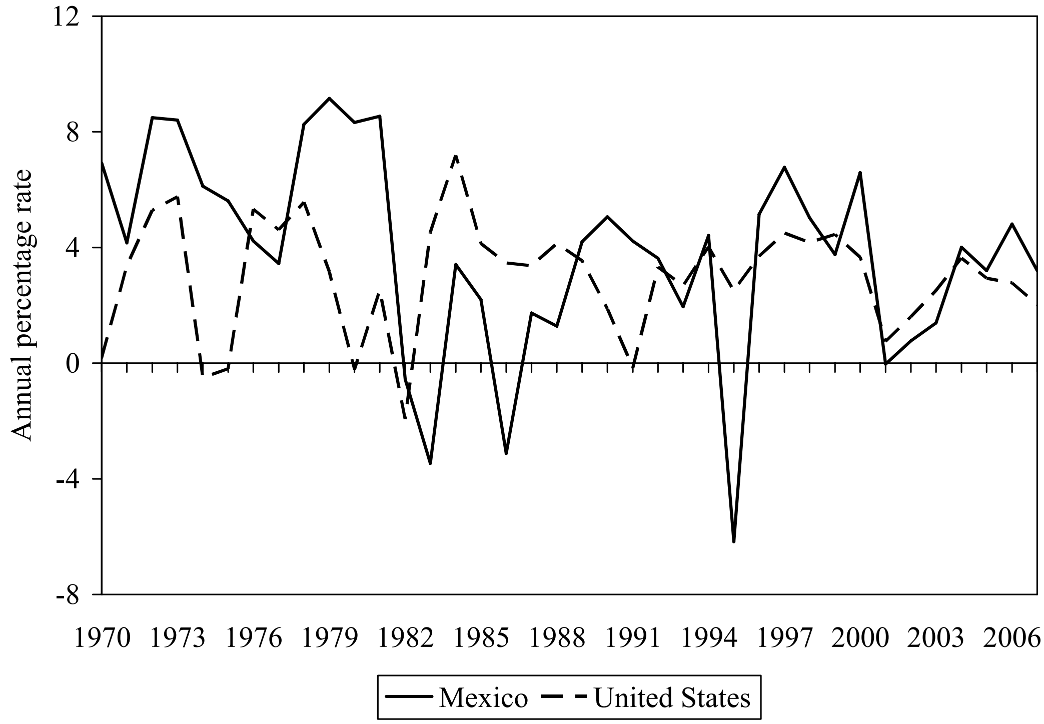

Figure 1. *Mexican and U.S. growth rates of real GDP, 1970-2007. Source: IMF, International Financial Statistics (IFS), and author's calculations.*

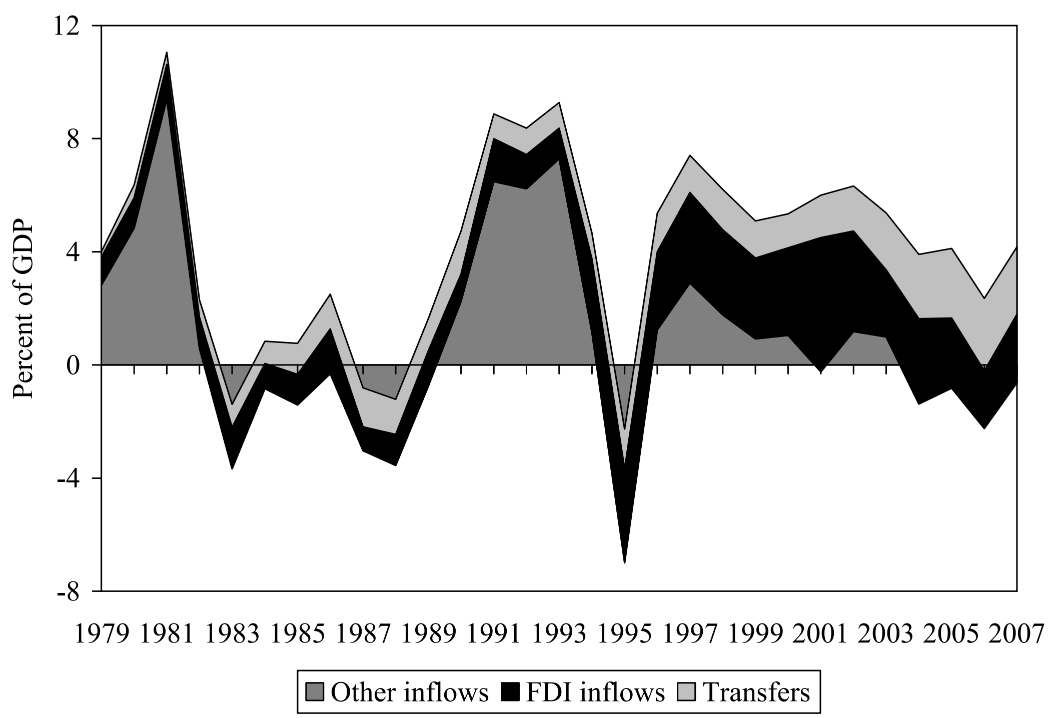

Figure 2. *Net financial inflows and their composition, as percentages of GDP, 1979-2007. Sources: IMF, IFS, and author's calculations.*

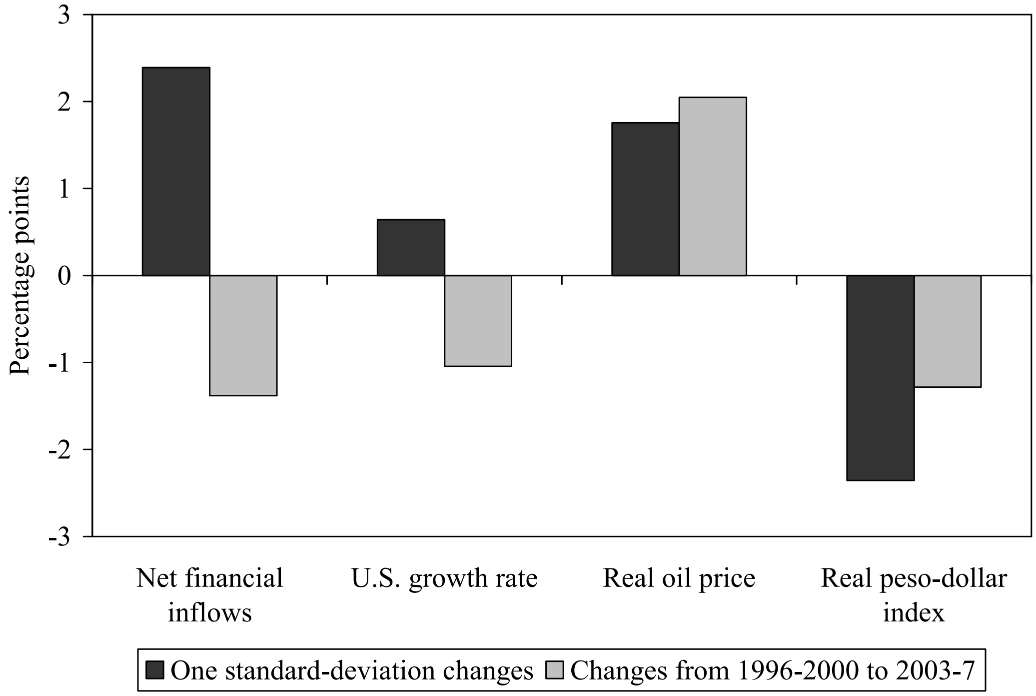

Figure 3. *Simulated long-run effects of shocks to exogenous variables on the Mexican growth rate. Source: Author's calculations.*

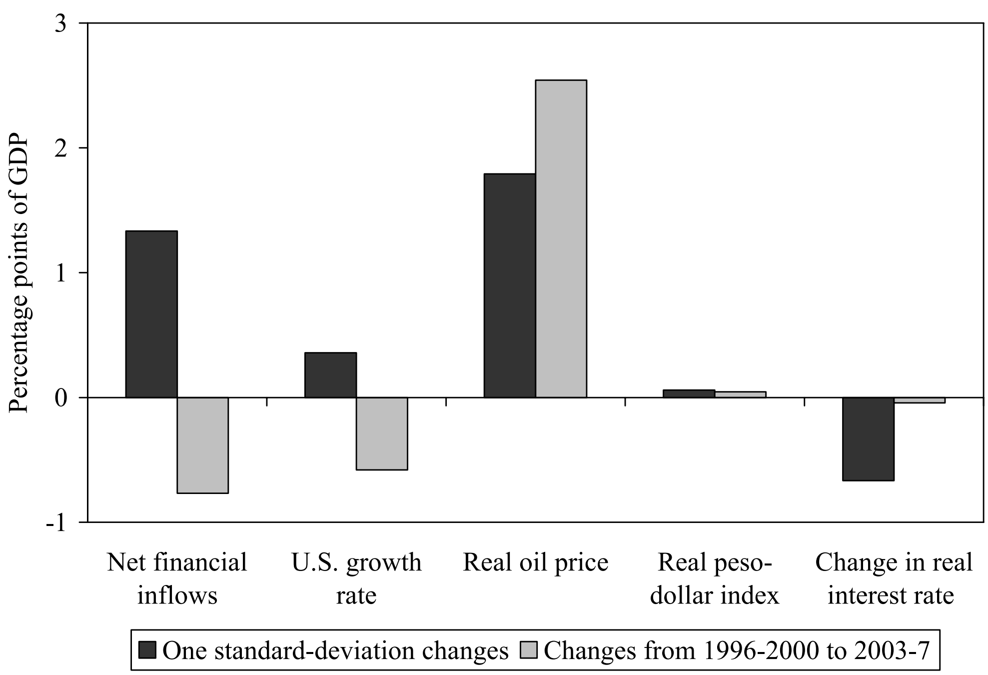

Figure 4. *Simulated long-run effects of shocks to exogenous variables on the Mexican real investment rate (including direct and indirect effects of the real oil price and real peso-dollar index). Source: Author's calculations.*

APPENDIX A. SUMMARY OF UNIT ROOT TESTS

The time-series properties of the variables were tested using four alternative unit root tests: augmented Dickey-Fuller (ADF) with the Schwartz information criterion for lag selection, ADF with the Akaike information criterion, Phillips-Perron, and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Although ADF tests are more commonly used, the other tests (especially KPSS) are less prone to be biased toward finding unit roots in small samples (see Kwiatkowski, et al., 1992). The results may be summarized as follows (details are available on request):

- MexGrowth and USGrowth are both stationary at the 1% level according to all four tests.
- FinInflows is stationary at the 10% level using Phillips-Perron and at 5% using the other three tests.
- RealPeso (the bilateral peso-dollar index) is stationary at the 5% level using KPSS and ADF/Akaike and at 10% using ADF/Schwartz (it is borderline using Phillips-Perron with a *p*-value of 0.102).
- RealOil is stationary at the 5% level according to KPSS, but has a unit root according to the other three tests.
- InvRate is stationary at the 5% level according to KPSS and ADF/Akaike, but has a unit root according to Phillips-Perron and ADF/Schwartz.
- ΔRealInterest is stationary according to three of four tests (the exception is ADF/Akaike).
- FDI-GDP ratio has a unit root according to three of the four tests, but is stationary at the 1% level using KPSS.
- PubInvRate has a unit root according to both ADF tests, but is stationary at the 1% level using Phillips-Perron and KPSS.