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TAX REVENUE IMPLICATIONS OF THE REAL EXCHANGE RATE: ECONOMETRIC EVIDENCE FROM KOREA AND MEXICO

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RÉSUMÉ

Les diverses voies par lesquelles la dévaluation du taux de change influe sur les recettes fiscales réelles demandent à être éclaircies au moyen de l'économétrie. Il convient de considérer le présent document comme une première tentative de démonstration économétrique. Il met en évidence les relations de causalité qui existent entre le taux de change réel et les recettes fiscales réelles. Un test de causalité conduit à rejeter l'hypothèse d'une relation unidirectionnelle traduisant une influence des impôts sur le taux de change. Les inférences causales du test de Sims autorisent à utiliser le taux de change réel comme déterminant exogène dans un modèle simple à équations simultanées. Le modèle endogénéise le produit et l'assiette de l'impôt de façon à permettre de tester la validité et le degré de signification d'une explication des variations des recettes fiscales réelles par le taux de change. La décomposition de l'effet des variations du taux de change réel sur les recettes fiscales en un effet direct (des prix) et un effet indirect (par le biais de la production) fait beaucoup progresser l'analyse. Quand on procède, pour la Corée et le Mexique, à l'estimation d'une version logarithmique du modèle au moyen de données trimestrielles (corrigées des variations saisonnières), on constate qu'une dévaluation réelle produit toute son incidence sur les recettes fiscales avec des retards de quatre et cinq trimestres et que, globalement, cette incidence a été faible et négative dans les deux pays dans les années 80. Ce résultat global masque toutefois des réactions très différentes pour chacune des quatre grandes catégories d'impôts : l'impôt sur le revenu des personnes physiques, l'impôt sur le revenu des sociétés, les impôts indirects intérieurs et les taxes à l'importation. Les calculs montrent également que le solde du budget de l'Etat mexicain se détériorerait probablement sous l'effet d'une dévaluation réelle, bien que les recettes pétrolières représentent une part importante des recettes publiques.

SUMMARY

The variety of channels through which devaluation of the exchange rate impacts on real tax receipts, calls for empirical clarification. This paper should be seen as a first attempt towards empirical evidence. It establishes the causal relationships between the real exchange rate and real tax receipts. A causality test rejects the hypothesis of unidirectional causality running from taxes to the exchange rate. The causal inferences from the Sims test allow to use the real exchange rate as an exogenous determinant in a simple simultaneous equation model. The model endogenises tax yields and tax bases to allow for a test of the significance and relevance of the exchange rate to explain variations in real tax receipts. An important insight results from the distinction of the direct (price) effect and indirect (output) effect of changes in the real exchange rate on tax receipts. A double-logarithmic version of the model with (seasonally adjusted) quarterly data is estimated for Korea and Mexico. We find that a real devaluation develops the strongest impact on tax receipts with a lag of four or five quarters, and that the overall impact was small and tax-reducing in both countries during the 1980s.

This overall result, however, hides very different responses for each of the four broad tax categories: personal income taxes, corporate income taxes, domestic indirect taxes, and international trade taxes. We also calculate that Mexico's government budget is likely to deteriorate as a result of real devaluation even though oil receipts contribute an important share to public revenues.

PREFACE

Macroeconomic stabilisation and structural adjustment programmes for debt-ridden developing countries generally centre on two major policies: reduction of the fiscal deficit to bring down expenditure and devaluation of the domestic currency to encourage shifts in expenditure and production patterns. Surprisingly enough, the consistency of the two policy instruments has hardly been explored, but if there is an important tradeoff between large devaluations and fiscal equilibrium, debtor countries face a difficult policy choice. Devaluation would improve the trade balance (necessary to service foreign debt), but also raise the local-currency value of foreign debt service. If taxes do not rise to the same amount, the budget deficit will widen and stimulate the government's recourse to inflationary finance.

The present paper confirms these concerns. It is the first attempt to arrive at serious econometric evidence on the tax revenue implications of devaluation. It is shown that devaluation slightly reduced real tax receipts in both Korea and Mexico during the 1980s because of implied shifts away from the tax base (Korea) and because of short-run contractionary output responses (Mexico). The results demand more caution in the use of exchange rate policy than is often implied by policy advice based on decades when most developing countries were still little indebted.

Louis Emmerij
President of the Development Centre
February 1990

1. INTRODUCTION*

It has been a long tradition in public finance to ignore the fiscal impact of changes in the foreign value of a currency. The literature has typically (see, as recent example, Frankel and Razin, 1987) assumed a unidirectional causality running from the government budget to the exchange rate. Exceptions to that tradition have been rare and most recent, spurred by the obvious fact that real devaluation of the exchange rate raises inflation-adjusted public spending when the government is indebted in a foreign currency. It also seems that no empirical evidence has been provided so far on the fiscal impact of the exchange rate**.

Behrman (1976) has discussed the short-run impact of devaluation in a simple Keynesian one-sector model where tax receipts are endogenous and where public spending as well as the foreign exchange rate are exogenous. Behrman finds the fiscal impact to depend on the response of total output, exports, and imports to devaluation and on the extent to which devaluation is accompanied by a reduction of export and other subsidies. But the one-sector model is not able to unveil the fiscal response to the shift between prices of tradables and non-tradables that underlies (and is often defined as) a sustained real devaluation of the exchange rate.

Reisen (1989) has integrated the distinction between tradables and non-tradables into the government budget identity to discuss the automatic price response to a rise in the prices of tradables relative to non-tradables. He finds that real devaluation raises the budget deficit when real interest payments on net external public debt exceed the initial non-interest budget surplus relating to tradables. Devaluation will enlarge the budget deficit to the extent that it is financed by domestic (local-currency) sources. Reisen has not provided a formal analysis with respect to the short-run output response on the tax base and on real spending because he considered the existing empirical and theoretical evidence as being inconclusive.

If real devaluation is contractionary in the short run, depressed output will narrow output-dependent tax bases such as consumption and imports. General equilibrium models applied to developing countries generally arrive at the conclusion that devaluation indeed is contractionary in the short-term, confirmed by empirical results (Edwards, 1987). Diaz-Alejandro (1965) and Krugman and Taylor (1978) stress demand effects of devaluation, which range from negative real balance effects to income-distributional effects favouring agents having a high marginal propensity to save. Other models embody supply-side effects, such as financing constraints on increased working-capital requirements, which cause devaluation to reduce output (Rojas-Suarez, 1987) even under the assumption of rational expectations and market-clearing prices. The contractionary effects of devaluation dominate in the short run, while expansionary neoclassical substitution effects take time to build up.

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*We would like to thank Beatriz Armendariz for valuable comments which helped to improve the paper. All remaining errors are ours.

**Note that what will follow is concerned with short-term effects, because the involved policy trade-offs are essentially of a short-term nature. The international debt saga has sufficiently proven that short-term effects are powerful enough to be highly relevant for political decision making.

The redistributive effects arising from devaluation form a further channel by which the real exchange rate impacts on the government budget. Diaz-Alejandro (1965) has investigated the redistributive effects in a two-sector model with tradables and non-tradables which is augmented by the distinction of wage earners and non-wage earners with different propensities to save. Wage-earners are assumed to spend all their income on tradables and non-tradables, while 'capitalists' save a fraction of their income. He shows profits in the tradable sector to increase and real wages in both sectors to fall. The government will loose tax revenues when they are based more on wages and domestic consumption than on corporate income and export taxes. The assertion, however, that devaluation would depress real wages in the short-term, requires further qualifications, as Dornbusch (1980) has shown for the small open economy. A rise in the relative price of traded goods lowers the equilibrium relative wage in terms of traded goods and raises the real wage in terms of non-tradables. Real wages in terms of the prices of the two sectors would be depressed by devaluation with the wage elasticity of the labour demand and the share of the labour force in the non-tradable sector being high. They would rise if the wage elasticity of labour demand was low and the share of the labour force in tradables was high.

A further channel via which devaluation impacts on the government budget is inflation. A real devaluation raises local prices of imported materials and commodities, in particular in developing countries with unimportant local import-competing industries. Exporting and import-competing firms will also tend to raise prices in the face of rising import prices. Improved external competitiveness involved in real devaluation will lead to wage inflation in the tradable sectors and higher cost of living throughout the economy. The combined impact of real devaluation is to raise inflation beyond what it otherwise would be. In most developing countries, higher inflation erodes the real value of tax collections. Tax receipts do not keep up with inflation because progressive income taxes produce only a small share of total tax revenue and many other taxes are levied at specific rates, with long lags in collection (Tanzi, 1977).

While the two-sector model incorporating the tradable-nontradable divide helps to organise the thinking about tax effects of devaluation, it cannot be put to empirical test, being different from the conventional tax structures. The tax impact of devaluation will also very much depend on particular tax features encountered in practice, such as the definition of the tax base, multiple rates and special regimes, varying tax evasion ratios and the income, price and cross-price elasticities underlying the various tax bases. To the extent that income taxes rely on wages rather than corporate profits (with the wage elasticity of labour demand and the sector shares of the labour force held constant as parameters), personal income taxes (on wages) are likely to decline and corporate income taxes will rise (Seade, 1988). Much depends on the question if a shift to a country's comparative advantage means a shift into or away from its tax base. For example, if importers are rich and concentrated and exporters are poor and dispersed (like peasant farmers), devaluation is likely to reduce the tax base because it benefits small-scale exporters outside the tax base (Blejer/Cheasty 1988).

Domestic indirect taxes may be expected to rise as a consequence of devaluation (Tanzi, 1989), since a large share (often more than 50 per cent) of general sales taxes is collected from imports in developing countries. Devaluation raises the domestic value of these goods, but if the direct effect of devaluation outweighs the indirect effect on domestic indirect taxes, depends on the income elasticity of consumption, the substitutability of domestic goods for imports, and on the structure of tax rates. If devaluation is successful to shift consumption from imports towards domestic production which escapes taxations or is taxed at a lower rate, the net result on domestic indirect taxes may be negative in spite of the direct price effect.

Similar considerations apply to taxes on international trade which are prominently imposed on imports. Import duties are for the most part levied with *ad valorem* rates, their tax base being imports measured at the official exchange rates (Tanzi, 1989). Real devaluation will raise import tax revenues when the aggregate price elasticity of imports is below unity, so that the increased local-currency value of imports is not outweighed by the drop in the quantity of imports. The net outcome will be shaped by the import basket, with the price elasticity of food items or materials devoted to export production being low and the elasticity of luxury goods or imports for non-tradables being high.

The variety of channels through which devaluation of the exchange rate impacts on real tax receipts, calls for empirical clarification. This paper should be seen as a first attempt towards empirical evidence. Section 2 will establish the causal relationships between the real exchange rate and real tax receipts. The causality test à la Sims (1972) will reject the hypothesis of unidirectional causality running from taxes to the exchange rate. The causal inferences from the Sims test allow to use the real exchange rate as an exogenous determinant in a simple simultaneous equation model (Section 3). The model endogenises tax yields and tax bases to allow for a test of the significance and relevance of the exchange rate to explain variations in real tax receipts. An important insight results from the distinction of the direct (price) effect and indirect (output) effect of changes in the real exchange rate on tax receipts (Section 4). A double-logarithmic version of the model with (seasonally adjusted) quarterly data is estimated for Korea and Mexico (non-PEMEX). We find that a real devaluation develops the strongest impact on tax receipts with a lag of four, five quarters, and that the overall impact has been small and tax-reducing in both countries during the 1980s. This overall result, however, hides very different responses for each of the four broad tax categories, personal income taxes, corporate income taxes, domestic indirect taxes, and international trade taxes (Section 5). We also calculate that Mexico's government budget is likely to deteriorate as a result of real devaluation even though oil receipts (PEMEX) contribute an important share to public revenues (Section 6).

Korea and Mexico have been selected for two reasons. The first is data availability which allows to trace monthly (Sims test) and quarterly estimates (model). The second reason is that both countries undertook important trade reforms during the observation period which has side-effects for the tax response to devaluation. These two countries at least do not confirm, however, Tanzi's (1989) assertion that "A good case can be made that devaluation accompanied by trade liberalisation is likely to have a positive impact on tax revenue".

Yet the interpretation of our findings demand caution, too. First, more country experiences should be studied before general conclusions can be drawn. Data, however, are often a bottleneck to short-term tax analysis in developing countries. Second, we did not define the sources of exchange rate variation (tariff reform, exogenous shocks, monetary disturbances) nor did we endogenise the exchange rate in the model. Third, the different tax bases should be defined in more detail than we have done, and a careful modelling of the tax-base response to variations in the exchange rate would be needed. Fourth, our analysis excludes spending because discretionary changes (cuts, shifts, etc.) make it impossible to isolate the automatic response of public expenditures to changes in the real exchange rate. Finally, we did not care about the difficult definition of the base of comparison against which to analyse variations in the real exchange rate.

2. TAX REVENUES AND REAL EXCHANGE RATES: A TEST FOR CAUSALITY

Econometric studies involving distributed lags of the variables used should be preceded by tests for the direction of their causality. Sims (1972) has developed a practical technique of testing causality in a bivariate model. To applying his test for the purpose of this study, consider the following double-logarithmic equations with distributed monthly lags:

$$t_{i,t} = a_1 + b_1 e_1 + \sum_{j=1}^{n} c_1 e_{t-j} + u_t \tag{1}$$

$$t_{i,t} = a_2 + b_2 e_t + \sum_{j=1}^{n} c_2 e_{t-j} + \sum_{j=1}^{m} d_2 e_{t+j} + u_t \tag{2}$$

$$e_t = a_3 + b_3 t_{i,t} + \sum_{j=1}^{n} c_3 t_{i,t-j} + u_t \tag{3}$$

$$e_t = a_4 + b_4 t_{i,t} + \sum_{j=1}^{n} c_4 t_{i,t-j} + \sum_{j=1}^{m} d_4 t_{i,t+j} + u_t \tag{4}$$

where t stands for real tax revenues and e stands for the real exchange rate. Subscript t denotes the respective month, subscript j the monthly lags, resp. leads, and subscript i denotes the tax categories for which the analysis has been carried out: total taxes, income taxes, domestic indirect taxes, and trade taxes.

The direction of causality runs from e to t, if all $d_2 = 0$ and some $d_4 \neq 0$; it runs from t to e, if some $d_2 \neq 0$ while all $d_4 = 0$. If some $d_2 \neq 0$, and some $d_4 \neq 0$, then a bidirectional causality between exchange rates and tax revenues can be presumed. In order to test the hypothesis that coefficients for future values of the independent variable, d_2 resp. d_4, are jointly equal to zero, F-statistics are calculated. Sims (1972) points also to the fact, that the direction of causality can be detected even with inconclusive F-statistics. If the regression coefficients are 'large' from an economic point of view, they should not be assumed to be zero.

Since regression analysis on time-series data is very likely to exhibit autocorrelation among residuals, a pre-filtered treatment of all variables was conducted. Serially uncorrelated residual series were obtained by using an autoregressive integrated moving average (ARIMA) model for each variable (Maddala, 1977). The analysis was carried out on the basis of monthly data, covering the period January 1979 to December 1987 in the case of Mexico, and January 1980 to March 1988 in the case of Korea.

The Sims test as given in equations (1) to (4) was applied to four tax categories in two countries, hence giving rise to 32 regression equations. All of these regressions had a low R^2 and insignificant F-statistics and thus did not indicate a definite causality between tax revenues and the real exchange rate in both countries. All quarterly lags and leads of the independent variables were insignificant *as a group.*

Tables 1 and 2 -- which show a selection of individual regression coefficients significant at the 90 per cent confidence level at least -- indicate nevertheless some causal relationships between tax revenues and real exchange rates, in view of the absolute size and the statistical significance of the coefficients presented therein.

In Korea, causality seems to run from the real exchange rate to (real) total tax revenues, implying that a devaluation (or appreciation) of the Won affects tax receipts but not the other way around. In fact, the future value of taxes $t_{1,t+3}$ explains significantly the real exchange rate with a regression coefficient as large as the past value of tax revenues, while none of the future values of the real exchange rate can significantly explain the current value of the real exchange rate. There seems to be no causality between domestic indirect taxes and the exchange rate in Korea as none of the future values of these variables are statistically significant or as large as their lagged values. Finally, bidirectional causality with the real exchange rate is indicated for income taxes, and import taxes, respectively, by the significance and parameter values of their future values.

In Mexico, total tax revenues and the real exchange rate seem to display a bidirectional causality, since the future independent variables e_{t+2} and $t_{1,t+5}$, respectively, are found to be statistically significant. The same observation applies for the causal relationship between the real exchange rate and import tax receipts. A unidirectional causation seems to run from the exchange rate to income tax revenues, whereas, like in Korea, no causal relationship could be identified for the exchange rate and domestic indirect taxes.

Even if these results should be treated with caution in view of the low R^2 and F-values in the underlying regressions, they allow to reject the hypothesis that tax revenues determine the real exchange rate. Since there is no unidirectional causality running from taxes to the exchange rate, the real exchange rate can be used as an exogenous determinant in multiple regressions to explain variation in tax revenues.

Table 1

SIMS' TEST OF CAUSALITY BETWEEN TAX REVENUES AND THE REAL EXCHANGE RATE: KOREA JANUARY 1980 TO MARCH 1988

	Equation/ Coefficient	(1)	(2)	(3)	(4)	Causal Inference
1. Total Tax Revenues $t_{1,t}$	c	$5.08e_{t-8}$ (2.64)	$4.37e_{t-8}$ (2.10)		$-0.02t_{1,t-3}$ (-1.88)	e_t causes $t_{1,t}$
	d	$-4.64e_{t-10}$ (-2.45)	$-4.25e_{t-10}$ (-2.06)		$0.02t_{1,t-4}$ (1.94) $0.02t_{1,t+3}$ (2.01)	
2. Income Tax Revenues $t_{2,t}$	c	$-7.66e_{t-6}$ (-2.48)	$-6.23e_{t-6}$ (-1.85)		$0.01t_{2,t-1}$ (1.99)	$t_{2,t}$ and e_t bidirectional
	d	$-7.41e_{t-10}$ (-2.38)	$-7.79e_{t-10}$ (-2.39) $7.39e_{t+6}$ (2.32)			
3. Domestic Indirect Tax Revenues $t_{3,t}$	c					No causality
	d					
4. Import Tax Revenues $t_{4,t}$	c	$3.70e_{t-5}$ (2.14)				$t_{4,t}$ and e_t birdirectional
			$-3.55e_{t+6}$ (-2.03)		$0.02t_{4,t+5}$ (1.99) $0.03t_{4,t+6}$ (3.14)	

Note: The variables used in the underlying regressions are logarithms of index numbers (1980 = 100) of real values pre-filtered by the ARIMA model (see text). The real exchange rate index is based on the monthly average exchange rate index is based on the monthly average exchange rate of the US dollar per domestic currency weighted for changes in the domestic versus the US consumer price index. A decrease of the real exchange rate variable denotes devaluation.

Equations (1) to (4) have for each tax category been tested using 12 monthly lags and 6 monthly leads. The results selected for this table indicate the double-log regression coefficient, the respective variable and the significant lag, and the t-value (in brackets).

Table 2

SIMS' TEST OF CAUSALITY BETWEEN TAX REVENUES AND THE REAL EXCHANGE RATE: MEXICO JANUARY 1979 TO DECEMBER 1987

	Equation/ Coefficient	(1)	(2)	(3)	(4)	Causal Inference
1. Total Tax Revenues $t_{1,t}$	c	$-0.39e_{t-5}$ (-2.04)	$-0.42e_{t-5}$ (-2.14)	$-0.14t_{1,t-2}$ (-1.83)	$-0.17t_{1,t-2}$ (-2.09)	$t_{1,t}$ and e_t bidirectional
	d		$0.40e_{t+2}$ (-2.03)		$-0.15t_{1,t-5}$ (-1.97)	
2. Income Tax Revenues $t_{2,t}$	c	$0.733e_{t-6}$ (2.55)	$0.75e_{t-6}$ (2.59)			e_t causes $t_{2,t}$
	d				$0.11t_{2,t+6}$ (2.41)	
3. Domestic Indirect Tax Revenues $t_{3,t}$	c					No causality
	d					
4. Import Tax Revenues $t_{4,t}$	c	$0.91e_{t-6}$ (2.67)	$0.88e_{t-6}$ (2.57)	$-0.06t_{4,t-5}$ (-1.64)	$-0.06t_{4,t-5}$ (-1.71)	$t_{4,t}$ and e_t birdirectional
			$-0.69e_{t+5}$ (-2.02)		$0.10t_{4,t+5}$ (2.53)	

Note: The variables used in the underlying regressions are logarithms of index numbers (1980 = 100) of real values pre-filtered by the ARIMA model (see text). The real exchange rate index is based on the monthly average exchange rate index is based on the monthly average exchange rate of the US dollar per domestic currency weighted for changes in the domestic versus the US consumer price index. A decrease of the real exchange rate variable denotes devaluation.

Equations (1) to (4) have for each tax category been tested using 12 monthly lags and 6 monthly leads. The results selected for this table indicate the double-log regression coefficient, the respective variable and the significant lag, and the t-value (in brackets).

3. THE MODEL

The model presented in Table 3 is able to determine the short-term price and output response of tax revenues following an (exogenous) change in the real exchange rate. It features simultaneous equations for the main tax categories and their major tax bases. The structural equations (3.1) to (3.4) model tax receipts for the major tax items. The real exchange rate takes a lagged value and its estimated coefficient will denote the 'direct' impact of the exchange rate on taxes. We do not predict the expected signs here, but refer to the introductory discussion which has demonstrated the variety of possible outcomes. The (lagged) variable denoting the consumer price index is expected to exert a negative impact on tax receipts, taking account of the Tanzi effect (Tanzi, 1977). Because tax collections depend also on structural factors, a lagged independent tax revenue variable is included in each of the tax equations.

Each tax equation incorporates a proxy of the tax base, Y_t for personal and corporate income taxes, $c_t^p r$ for domestic indirect taxes, and m_t for import taxes. Since export taxes are non-existent in Korea and account for only 0.2 per cent of total non-PEMEX tax revenues in Mexico, exports have been dropped as a tax base. The estimated coefficients of the tax bases in structural equations (3.1) to (3.4) indicate the relationship between a given change in the tax base and the resultant change in the tax yield, i.e. the marginal effective tax rate. Additive dummies AD_i and multiplicative dummies MD_i allow for discretionary changes of tax rates during the observation period. The additive dummy is defined 1 for the sub-period after tax reform and 0 before. The multiplicative dummy is defined Y_t for the sub-period after tax reforms and 0 before. Hence, the additive dummy is thought to account for the impact of tax legislation on the tax yield, while the multiplicative dummy accounts for the impact on the tax base.

The further structural equations (3.5) to (3.9) determine the elements of the different tax bases, namely private savings, domestic investment, government final consumption, as well as exports and imports. The definitions given in (3.10) to (3.17) complete the model which is closed by the national account identity (3.18).

Private savings depend on current private disposable income, the nominal three-month treasury bill rate, expected inflation proxied by a lagged consumer price index, and past savings (habit persistence). Domestic investment is governed by the availability of domestic funds (savings), as well as by nominal rates of interest, lagged inflation and lagged investment. The expected signs for nominal interest rates and inflation are ambiguous for both the savings and investment function. Higher interest rates exert (negative) income and (positive) substitution effects on private savings. Investments should be negatively determined by interest rates according to standard theory. But with complementarity between domestic savings and investment (for reasons of financial 'repression' and external credit constraints), the relationship between interest rates and domestic investment can also be positive.

Government final consumption is determined by lagged values of government consumption and by total government revenues. The latter consist of total tax receipts and other government revenues $t_{5,t}$.

Imports are explained by GDP and lagged imports, not however by real exchange rates. The direct impact of the real exchange rate on import taxes has been taken into account in tax equation (3.4). It will be shown later that a change in imports taxes brought about by the direct change in imports following an adjustment of the real exchange rate passes through the GDP. This passthrough does not hold for exports which we assume not to be taxed. Hence, exports are determined directly by the real exchange rate.

Table 3

MODEL EQUATIONS

Personal Income Taxes	$t^{P}_{2,t} = f(\underset{(+)}{Y_t},\ \underset{(+/-)}{e_{t-n}},\ \underset{(-)}{P_{t-n}},\ \underset{(+)}{t^{P}_{2,t-n}},\ \underset{(+/-)}{AD^{P}_{2}},\ \underset{(+/-)}{MD^{P}_{2}})$	(3.1)
Corporate Income Taxes	$t^{C}_{2,t} = f(\underset{(+)}{Y_t},\ \underset{(+/-)}{e_{t-n}},\ \underset{(-)}{P_{t-n}},\ \underset{(+)}{t^{C}_{2,t-n}},\ \underset{(+/-)}{AD^{C}_{2}},\ \underset{(+/-)}{MD^{C}_{2}})$	(3.2)
Domestic Indirect Taxes	$t_{3,t} = f(\underset{(+)}{c^{Pr}_t},\ \underset{(+/-)}{e_{t-n}},\ \underset{(-)}{P_{t-n}},\ \underset{(+)}{t_{3,t-n}},\ \underset{(+/-)}{AD_3},\ \underset{(+/-)}{MD_3})$	(3.3)
Import taxes	$t_{4,t} = f(\underset{(+)}{m_t},\ \underset{(+/-)}{e_{t-n}},\ \underset{(-)}{P_{t-n}},\ \underset{(+)}{t_{4,t-n}},\ \underset{(+/-)}{AD_4},\ \underset{(+/-)}{MD_4})$	(3.4)
Private Domestic Savings	$S^{Pr}_t = f(\underset{(+)}{Y^{Pr}_t},\ \underset{(+/-)}{R_t},\ \underset{(+/-)}{P_{t-n}},\ \underset{(+)}{S^{Pr}_{t-n}})$	(3.5)
Domestic Investment (Private and Public)	$i_t = f(\underset{(+)}{S_t},\ \underset{(+/-)}{R_t},\ \underset{(+/-)}{P_{t-n}},\ \underset{(+)}{i_{t-n}})$	(3.6)
Government Final Consumption	$c^{g}_t = f(\underset{(+)}{t_{0,t}},\ \underset{(+)}{c^{g}_{t-n}})$	(3.7)
Imports	$m_t = f(\underset{(+)}{Y_t},\ \underset{(+)}{m_{t-n}})$	(3.8)
Exports	$x_t = f(e_{t-n},\ x_{t-n})$	(3.9)
	II. Definitions	
Income Taxes	$t_{2,t} = t^{P}_{2,t} + t^{C}_{2,t}$	(3.10)
Total Tax Revenues	$t_{1,t} = t_{2,t} + t_{3,t} + t_{4,t}$	(3.11)
Total Government Revenues	$t_{0,t} = t_{1,t} + t_{5,t}$	(3.12)
Private Disposable Income	$Y_t = Y_t - t_{1,t}$	(3.13)

Table 3 (continued)

Private Final Consumption	$c_t^{Pr} = Y_t^{Pr} - S_t^{Pr}$	(3.14)
Total Final Consumption	$c_t = c_t^{Pr} + c_t^{G}$	(3.15)
Public Domestic Savings	$s_t^{G} = t_{0,t} - c_t^{G}$	(3.16)
Total Domestic Savings	$s_t = s_t^{Pr} + s_t^{G}$	(3.17)
	III. Equilibrium	
Gross Domestic Product	$Y_t = c_t + i_t + X_t - m_t$	(3.18)

Note: Small letters denote real variables. The real exchange rate is the period average exchange rate of the US dollar per domestic currency weighted for changes in the domestic versus the US consumer price index. All endogenous variables are in domestic currency at 1980 constant market prices.

Capital letters denote nominal variables. R_t denotes the period average nominal treasury bill rates (three month); P_{t-n} is the (lagged) domestic consumer price index (1980 = 100); Ad_i is the additive dummy and MD_i the multiplicative dummy for tax category i.

The expected signs of the coefficients are shown in parenthesis.

4. INTERPRETING PARAMETERS

The total effect on tax revenues of changes in the real exchange rate is the sum of the direct effect and the indirect effect. The fact that the respective tax bases have not been regressed on the real exchange rate allows to associate the direct and indirect effect to the price and output effect, respectively, which changes of the real exchange rate exert on tax revenues.

Consider as an example import taxes. To simplify the exposition, we reduce the structural model equation (3.4) for import taxes to

$$t_{4,t} = a_1 m_t + b_1 e_t \tag{4.1}$$

and the structural equation (3.8) for imports to

$$m_t = a_2 y_t \tag{4.2}$$

The direct and indirect effect are then found by differentiating (4.1) with respect to the real exchange rate e_t:

$$\frac{\partial t_{4,t}}{\partial e_t} = a_1 \frac{\partial m_t}{\partial e_t} + b_1 \tag{4.3}$$

where b_1 reveals the direct impact of the real exchange rate on import taxes and where a_1 $(\partial m_t/\partial e_t)$ reveals the indirect effect which the real exchange rate exerts on import taxes through its impact on imports, the tax base.

The total impact, which consists of the price and output effect, is found by substituting (4.2) into (4.1) and differentiating with respect to the real exchange rate e_t:

$$\frac{\partial t_{4,t}}{\partial e_t} = a_1 a_2 \frac{\partial y_t}{\partial e_t} + b_1 \tag{4.4}$$

where $a_1 a_2$ $(\partial y_t/\partial e_t)$ denotes the output effect of the real exchange rate on import taxes and where b_1 denotes its price effect. The output effect results from the product of the marginal effective tax rate *times* the marginal propensity to import out of current income.

5. FINDINGS

A double-logarithmic version of the model with quarterly data was estimated for Korea and Mexico, using two-stages least squares regressions. Estimates of structural equations (3.1) to (3.9), calculations for definitions and the equilibrium equation, and more about the estimations procedures are reported in the appendix. Here, we will focus instead on interpretations with respect to the estimated coefficients of the real exchange rate, summarised in Table 4.

Table 4 reports the impact of the real exchange rate on GDP and on the different tax categories, breaking the latter down into the price and output effect. The total effect for each tax item is given by the model's solution, found from the matrix of reduced-form coefficients. The price effect of each tax item is directly given by the estimated coefficients of the structural equations (3.1) to (3.4), the output effect has been calculated as indicated in the preceding section. The total price and output impact on total tax revenues has been computed as the tax-share-weighted sum of all tax items. Note, however, that the impact on total tax revenues excludes the impact of the real exchange on the Korean Defense and Education Surtaxes and Monopoly Profit for which quarterly data were unavailable. Note also that Mexican data exclude revenue from Petroleos Mexicanos (PEMEX). Finally, the impact of the real exchange rate on GDP has been calculated as the weighted sum of the former's impact on consumption, investment, exports and imports.

A real devaluation develops the strongest impact on tax receipts with a lag of four quarters in Korea, and five quarters in Mexico. The overall impact was found to be slightly negative in both Korea and Mexico (non-PEMEX) during the observation period. The elasticities reported in Table 4, O.O5 for Korea and 0.14 for Mexico, are small enough to warrant the usual treatment of real tax receipts in the government budget constraint as independent from changes in the real exchange rate. This overall result, however, hides very different responses for each of the broad tax categories.

The small negative link between total tax receipts and devaluation in Korea is exclusively due to the devaluation-induced fall in indirect taxes. The direct (price) elasticity exceeds unity, i.e. a real devaluation lowers real revenues from indirect taxes by more (1.18) than one to one. This may be explained by widespread zero rates for the Value Added Tax (VAT) on foreign-exchange earning activities such as merchandise exports and international services, so that the bulk of the VAT in Korea falls on non-tradables. A second reason for the elastic price response of indirect taxes is the fact that they only fall to a small part on excises in cigarettes, alcohol, etc., unlike in poorer countries with rudimentary tax administrations where excises still play a significant role. Thirdly, the small price effect which a devaluation exerts on Korea's import tax revenues suggest a low substitutability between imports and non-traded goods. Consequently, a devaluation of the Korean Won does not feed the specific (non-tradable) tax base for indirect taxes.

Income taxes and import taxes, on the other hand, are found to rise in response to a real devaluation in Korea. While the price effect has only a small impact on tax revenues, the output effect of a devaluation is positive for all tax items in Korea, although it is very low for imports. The positive output response to devaluation confirms the suggestion that a devaluation acts as a growth machine in an outward oriented economy such as Korea, while it is contractionary in the short-term in most of Latin America. Note, however, that much depends on the source of real devaluation for its impact on output growth. Important sources are exogenous shocks (leading to a deterioration in the income terms of trade), trade liberalisation, or monetary policy. To the extent that exogenous shocks predominate as a source of real devaluation, as has been the case in Mexico during the observation period, they are likely to depress output, consumption, imports (with external liquidity constraints), and thus the respective tax base.

Whatever the source of real devaluation, it is only sustained if it shifts demand towards non-tradables relative to tradables. If wages are defined as non-tradables, and if wage income forms a significant share of revenues from the personal income tax, a devaluation can be expected to lower personal income taxes relative to corporate taxes which rise as a result of improved external competitiveness (Diaz-Alejandro, 1965; Seade, 1988). This hypothesis is strongly confirmed for Mexico, and weakly also for Korea. The elasticity of Mexico's personal income tax with respect to the real exchange rate is found to exceed unity, both as a result of strong output and price effect. While a real devaluation in Mexico lowers personal income tax receipts (by 1.11 per cent), it raises the corporate income tax yield (by only 0.38 per cent, however). Overall, direct taxes fall in Mexico as a consequence of real devaluation (by 0.36 per cent), while they rise in Korea (by 0.52 per cent).

Table 4 shows equally a steep fall in Mexico's import taxes (0.83 per cent) after real devaluation of the currency. This finding contrasts with Tanzi's (1989) presumption that a devaluation would be likely to increase the real (local currency) value of import taxes (tariffs). In Mexico, the price elasticity of real import taxes is very high (and supplemented by a contractionary output effect). This may be explained by a high content of price elastic consumption goods in the import mix, the demand of which is shifted toward non-traded goods which prevail in the tax base for domestic indirect taxes. Indeed, contrary to Korea, where a higher share of imports is devoted as inputs for export production, the price effect of domestic indirect taxes is significantly high in Mexico, suggesting a high substitutability between imports and non-traded goods. Note that, domestic indirect taxes in Mexico were the only tax item in the sample to show a significant (multiplicative) dummy for tax reform. The dummy is supposed to account for the switch from income -to consumption-based taxation which took place in Mexico in 1985.

Table 4

TAX REVENUE IMPLICATIONS OF REAL EXCHANGE RATE ADJUSTMENT

	I. Korea			II. Mexico (without PEMEX		
	Total Effect	Price Effect	Output Effect	Total Effect	Price Effect	Output Effect
Personal Income Tax	-0.44	-0.16	-0.28	+1.11	+0.40	+0.71
Corporate Income Tax	-0.66	-0.26	-0.40	-0.38	-0.47	+0.09
Domestic Income Tax	+0.50	+1.18	-0.68	-0.16	-0.41	+0.25
Import Tax	-0.15	-0.10	-0.05	+0.83	+0.72	+0.11
Total Tax Revenues	+0.05	+0.38	-0.33	+0.14	-0.17	+0.31
memo: GDP	-0.32			+0.16		

Note: The real exchange rate is the period average exchange rate of the US dollar per domestic currency weighted for changes in the domestic versus the US consumer price index. The estimated coefficients are based on double-logarithmic regressions. A positive sign denotes a fall in tax revenues as a result of real devaluation. For example, a 10 per cent devaluation of the Mexican Peso against the US dollar adjusted for the bilateral inflation differential lowers inflation-adjusted tax revenues (non-PEMEX) by 1.4 per cent, resulting from a tax-raising price effect (1.7 per cent) and a tax-lowering output effect (3.1 per cent).

6. CONCLUSIONS

The empirical evidence presented above has shown for two countries with very different structures that the overall real tax response to changes in their real exchange rate has been small. This result is essentially shaped by the crowding in (or out) of the various tax bases, by the general output effect, and by the (direct) price elasticities of tax yields. Rather than to review the various channels on which exchange rates impact on taxes, it may be useful to present a back-of-the-envelope calculation for the total government budget implications of the real exchange rate for Mexico. Perhaps surprisingly, also the total Mexican budget (including PEMEX) would be likely to be negatively affected by a real devaluation (Table 5).

Table 5 simulates the budgetary impact of a 10 per cent real devaluation. The first column in Table 5 presents the major items of Mexico's 1988 government budget, expressed as percentages of GDP. Oil Receipts contributed 7.5 per cent of GDP to public revenues, i.e. roughly a fourth, while parastatal receipts added almost a third to public revenues.

The price effect, given in the second column, is shown to reduce slightly Mexico's government budget deficit. Under the small-country assumption, oil receipts in local currency would rise in proportion to the rate of devaluation, since no effects on export volumes would be implied. Tax receipts would rise by 1.7 per cent in local currency (recall Table 4), which by multiplication with the initial tax ratio (13.1 per cent of GDP) would add 0.22 per cent of GDP to public revenues. Nothing can be said without further inquiry on the impact on parastatal receipts. Assuming the latter was zero, the direct price effect of a 10 per cent devaluation would be to raise total revenues by 0.97 per cent of GDP. But public expenditures would rise, too. Foreign-currency interest service would rise by the amount of devaluation, and the same would happen for capital expenditures assuming that they consist of imported capital goods only and that there was no reduction of imported volumes. Other government consumption would not rise with the assumption that they fall on non-traded goods only. The heaviest price impact of devaluation on government spending is clearly dependent on the reaction of domestic interest rates at which domestic bonds can be sold to the public. With rational expectations and financial openness, the domestic interest burden would also rise by the amount of devaluation, while initial overshooting of the real exchange rate could lower the costs of servicing domestic debt (see Reisen, 1989). Excluding the reaction of domestic interest rates, the price effect on the government budget would then slightly reduce the economic deficit, by 0.17 per cent of GDP.

The third column reports the output effect on taxes and, in the absence of further research, is silent on the residual items in the government budget. The output effect is assumed to be zero for oil receipts and calculated for non-oil taxes by multiplication of the tax ratio with minus 3.1 per cent, the effect of the contractionary output effect of devaluation on total tax receipts.

Since a 10 per cent devaluation would depress Mexico's GDP by 1.6 per cent (recall Table 4), taxes and spending after devaluation have to be related to the lower GDP. This raises the tax ratio, but also spending as a fraction of GDP, hence widening the deficit in terms of GDP by 0.14 per cent. The last column reports the post-devaluation budget, showing that the deficit has widened from 9.2 to 9.58 per cent of GDP.

Table 5

SIMULATION; THE IMPACT OF A 10 PER CENT DEVALUATION OF THE REAL EXCHANGE RATE ON THE GOVERNMENT BUDGET: MEXICO
(in per cent of GDP)

Government Budget 1988		Price Effect	Output Effect	GDP Ratio	Result
Public Sector Receipts	29.8	+0.97	-0.41	+0.49	30.85
- Oil	7.5	+0.75	0	+0.13	8.38
- Non-Oil	22.3	+0.22	-0.41	+0.36	22.47
(Taxes)	13.1	+0.22	-0.41	+0.21	13.12
(Parastatal)	9.2	?	?	+0.15	9.35
Public Sector Expenditure	39.0	+0.80	?	+0.63	40.43
- Foreign Interest	3.6	+0.36	0	+0.06	4.02
- Domestic Interest	13.1	?	0	+0.21	13.31
- Other Gov. Cons.	17.9	0	?	+0.29	18.19
- Capital Exp.	4.4	+0.44	?	+0.07	4.91
Economic Deficit	9.2	-0.17	+0.41	+0.14	9.58

Note: The Price Effect results from the multiplication of 1988 government budget ratios with 10 per cent (devaluation of the real exchange rate) in the case of oil receipts, foreign interest payments, and capital expenditures.

The Output Effect was assumed to be zero for oil receipts and calculated for non-oil taxes by multiplication of the tax ratio with 3.1 per cent (elasticity from table 4).

The GDP ratio denotes the impact on tax and spending ratios of the devaluation-induced fall in GDP (-1.6 per cent for 10 per cent devaluation).

APPENDIX

A. Data Sources and Processing

Data on tax receipts and on national account items are from *Bank of Korea, Monthly Bulletin* and *Banco De Mexico, Indicadores Economicos,* financial data (exchange rates, interest rates, consumer prices) are from *International Monetary Fund, International Financial Statistics.* Government revenues refer to the central government level. Interest rates are 12-months Treasury Bill rates.

The *causality test* is based on monthly data covering the period January 1980 - March 1988 in Korea, and January 1979 - December 1987 in Mexico. The real exchange rate index (1980 = 100) was computed as defined in Tables 1 and 2. Data on tax receipts were converted into 1980 constant market prices and then transformed into monthly indices (1980 = 100). Serially uncorrelated residual series were then obtained by an ARIMA (p,d,q) model (autoregressive integrated moving average) for each variable. First, the series trend and seasonality was eliminated by successive first or higher order differences, to give the 'integration' degree, d. Second, the approximate structure of the model was identified, i.e., the p degrees of autoregressive parameters and q degrees of moving average parameters by studying the partial autocorrelation and the autocorrelation functions, respectively. The third step was the estimation of the preliminary structure of the ARIMA model by the ordinary least-squares method. Fourth, the residuals of the ARIMA model were checked for remaining autocorrelation and for systematic patterns, in which case the specification of the model was modified. The residuals which did not change were used to conduct the Sims test. The underlying time series, the prewhitening steps for each variable, the serially uncorrelated residuals, and the results from the thirty-two regressions that constitute the Sims Test are available on request from the authors.

The *simultaneous equation model* was estimated in double-logarithmic version based on quarterly data, covering the first quarter 1980 to the first quarter 1988 for Korea, and to the second quarter 1988 for Mexico. Data on tax receipts and other government revenues were deflated by a quarterly consumer price index (average 1980 = 100) to obtain quarterly series in 1980 constant market prices, and were then transformed into quarterly indices (1980 = 100). The indices were in turn seasonally adjusted by the ratio to moving average method, and finally converted into natural logarithms. Exchange rates, interest rates, and consumer prices were not seasonally adjusted, because no systematic intrayear movements were observed.

B. Model Solution

The total (direct and indirect) impact of the exogenous variables on the endogenous variables is found from the matrix of reduced form coefficients, obtained by solving the estimated model. In matrix form, we write the model as

$$AY_t = BX_t + CY_{t-n} \tag{A.1}$$

where A, B, and C are the matrices of the estimated coefficients of the current endogenous, the current exogenous, and the lagged endogenous variables, respectively. Y_t, X_t and Y_{t-n} denote the respective column vectors. The dimensions of A are G times G (the number of endogenous variables), for B they are G times K (the number of exogenous variables), for C they are G times Z (the number of lagged endogenous variables), while Y_t, X_t, and Y_{t-n} have the dimension G, K, and Z, respectively.

Assuming that A is non-singular, equation (A.1) can be solved for Y to give:

$$Y_t = \Pi_1 X + \Pi_2 Y_{t-n} \qquad \text{(A.2)}$$

where $\Pi_1 = A^{-1}.B$, a G times K matrix of reduced-form coefficients, and where $\Pi_2 = A^{-1}.C$, a B times Z matrix of reduced-form coefficients. The system given in (A.2) is the reduced form of the model which constitutes a set of reduced-form equations, where each of the endogenous variables is expressed as a function of the exogenous and the lagged dependent variable. The total (direct and indirect) impact of the exogenous variables on the endogenous variables is given by the elements of matrix Π_1 (Table A.1).

C. Estimates

Running regressions to estimate equations (3.1) to (3.9) of the model followed a common pattern. Partial correlation matrices were studied and "stepwise" procedures were applied until obtaining good fit and removing auto-correlation problems of regressions.

Changes in real exchange rate revealed to be highly correlated (negatively) with changes in prices so that their simultaneous inclusion would have introduced multi-collinearity problems. In general, when strong correlation was detected among the explanatory variables, a "stepwise" regression procedure was undertaken to prove the true coefficient and significance of the variables. In those cases where the latter changed markedly, we dropped out one of the variables from the regression. This was specially the case with exchange rates and prices where prices were dropped out of the tax revenue categories equations.

Regarding the lagged variables (exogenous as well as endogenous) the number of lags were selected according to both their correlation degree with the dependent variable and their correlation degree with other explanatory variables in the regression. In the case of the lagged endogenous variables, the auto-correlation identification procedure undertaken in the causality section of this work was of help.

The estimation of the reduced-form equations generally yielded a good fit with respect to R^2 and Durbin-Watson coefficients, the parameter signs confirming standard hypotheses and being statistically significant (Tables A.2 and A.3).

In Korea, e_{t-4} was found to be a significant explanatory variable at a 95 per cent confidence level for personal income and domestic indirect taxes, and at a 90 per cent confidence level for corporate income and import taxes. In Mexico, the most significant lag was five quarters for the real exchange rate in determining income and import taxes. But e_{t-5} determined domestic indirect taxes only at the 80 per cent confidence level, still better however than any other lag and with a coefficient exceeding the standard error. The elasticity of the tax yield with respect to changes in the tax base clearly exceeds unity for domestic indirect taxes, and is well below unity for import taxes in both countries. Tax buoyancy of personal and corporate income taxes was around one in Korea, while corporate taxes were inelastic to changes in income in Mexico. Since inflation (consumer prices) had to be dropped from the tax equations to avoid multi-collinearity with the exchange rate variable, the latter's impact on tax receipts has to be interpreted to incorporate varying inflation levels. A real devaluation would go along with higher inflation and thus impact on tax receipts jointly with the inflationary impact on real tax receipts (fiscal drag, Tanzi effect).

The tax equations were quite stable, and hence insensitive to the introduction of dummies denoting discretionary changes in tax parameters (rates, bases, shift from income to indirect taxes). In Korea, in spite of reduction of import tariffs (1984 and 1986), reduction of income taxes and simplification of brackets (1984), and in spite of changes in the Value Added Tax, neither additive nor multiplicative dummies to account for these changes in tax legislation were significant in explaining tax receipts. In Mexico, changes in income legislation (1987) and the major harmonisation and reduction of import tariffs when the country entered the GATT (1986), were both not reflected in significant dummies. Only the multiplicative dummy in Mexico's domestic indirect taxes significantly reflected the increase in VAT rates from 10 to 15 per cent introduced in 1985. Hence, MD_3 was defined as zero for the period 1980.1 to 1984.IV and as equal to private consumption from 1985.I to 1988.II. The estimated sign of MD_3 was negative, reducing the elasticity of domestic indirect taxes with respect to private consumption from 1.313 before 1985 to 1.239 since then. Higher VAT rates joint with lower tax elasticity may indicate increased tax avoidance in Mexico.

In Korea, where nominal interest rates have been fixed by the authorities, savings and investment functions show as a rough proxy lagged inflation, P_{t-4}, the signs being negative for savings and positive for investment, hence confirming the standard hypotheses. The savings elasticity with respect to changes in private disposable income exceeds unity, while investments are quite inelastic with respect to domestic savings. Mexico in contrast, subject to a heavy constraint on external finance, showed a very high investment elasticity with respect to domestic savings. Lagged interest rates, R_{t-4}, explain significantly savings and investment in Mexico, again with signs as expected.

The income elasticity was low in Korea and high in Mexico, with a lagged endogenous variable, m_{t-1}, highly significant in Korea which was not the case in Mexico. This result is not surprising, since foreign exchange constraints introduced discontinuity into Mexican imports. The real exchange rate, with a lag of four quarters in Korea and five quarters in Mexico, determines exports significantly with expected signs, with a rise following real devaluation. Note, however, that Mexican exports are not well explained by the estimate, probably for the lack of a (oil) demand factor, the absence of which did not generate specification problems in the case of Korea.

Table A.1

Matrix of Reduced-Form Coefficients, $\Pi^1 = A^{-1}.B$

1. <u>Korea</u>

Constant	e_{t-4}	P_{t-4}	$t_{5,t}$	
1.724	-0.437	0.428	0.052	$t^P_{2,t}$
2.455	-0.654	0.610	0.074	$t^C_{2,t}$
3.451	0.504	1.376	0.104	$t_{3,t}$
0.171	-0.153	0.080	0.009	$t_{4,t}$
2.707	-0.527	-0.154	0.081	s^{Pr}_t
1.189	-0.145	0.350	0.087	i_t
0.507	0.015	0.184	0.083	c^G_t
0.356	-0.109	0.168	0.020	m_t
1.539	-0.277	0.000	0.000	x_t
2.003	-0.520	0.497	0.060	$t_{2,t}$
1.753	0.053	0.636	0.053	$t_{1,t}$
1.430	0.043	0.519	0.233	$t_{0,t}$
2.019	-0.393	0.462	0.061	Y^{Pr}_t
1.754	-0.341	0.699	0.053	c^{Pr}_t
1.576	-0.290	0.626	0.057	c_t
2.471	0.075	0.896	0.404	s^G_t
2.626	-0.320	0.206	0.192	s_t
1.975	-0.320	0.490	0.059	Y_t

Table A.1 (continued)

2. <u>Mexico</u>

Constant	e_{t-5}	R_{t-4}	$t_{5,t}$	MD_3	
-6.758	1.109	-3.428	0.379	0.030	$t^P_{2,t}$
1.794	-0.380	-0.407	0.045	0.003	$t^C_{2,t}$
5.582	-0.160	-1.151	0.120	-0.058	$t_{3,t}$
-0.055	0.833	-0.540	0.059	0.004	$t_{4,t}$
1.976	0.089	-0.272	0.042	0.005	s^{Pr}_t
5.598	0.271	-2.924	0.315	0.008	i_t
0.113	0.009	-0.095	0.046	-0.001	c^G_t
-0.237	0.482	-2.331	0.258	0.020	m_t
0.000	0.173	0.000	0.000	0.000	x_t
-2.456	0.359	-1.908	0.211	0.017	$t_{2,t}$
1.692	0.138	-1.433	0.155	0.021	$t_{1,t}$
1.099	0.089	-0.931	0.450	-0.013	$t_{0,t}$
3.498	0.157	-0.676	0.075	0.009	Y^{Pr}_t
4.251	0.191	-0.876	0.091	0.011	c^{Pr}_t
3.560	0.161	-0.746	0.084	0.009	c_t
3.288	0.268	-0.2785	1.347	-0.040	s^G_t
2.049	0.099	-0.412	0.155	0.002	s_t
3.316	0.155	-0.752	0.083	0.006	Y_t

Table A.2

Korea: Estimates for Reduced Form Equations

I. Structural Equations

	R^2	DW	Equation
$t^{P}_{2,t} = 0.873\ Y_t - 0.158\ e_{t-4} + 0.283\ t^{P}_{2,t-2}$ (3.849) (-3.090) (1.449)	0.94	1.90	(3.1)
$t^{c}_{2,t} = 1.243\ Y_t - 0.256\ e_{t-4}$ (9.968) (-1.845)	0.66	1.80	(3.2)
$t_{3,t} = -12.119 + 1.967\ c^{Pr}_t + 1.117\ e_{t-4} + 0.476\ t_{3,t-4}$ (-3.59) (5.017) (2.991) (2.339)	0.93	1.90	(3.3)
$t_{4,t} = 0.48\ m_t - 0.101\ e_{t-4} + 0.623\ m_{t-1}$ (2.967) (-1.906) (4.818)	0.95	1.68	(3.4)
$S^{Pr}_t = 1.341\ Y^{Pr}_t - 0.775\ P_{t-4} + 0.473\ S^{Pr}_{t-4}$ (3.149) (-2.585) (3.576)	0.98	1.67	(3.5)
$i_t = 0.453\ S_t + 0.257\ P_{t-4} + 0.226\ i_{t-2}$ (5.69) (3.867) (2.112)	0.96	1.77	(3.6)
$c^{G}_t = 0.355\ t_{0,t} + 0.643\ c^{G}_{t-2}$ (3.18) (5.633)	0.88	1.72	(3.7)
$m_t = 0.321 + 0.343\ Y_t + 0.724\ m_{t-1}$ (-1.443) (1.995) (4.3)	0.96	2.18	(3.8)
$x_t = 1.539 - 0.277\ c_{t-4} + 0.945\ x_{t-1}$ (1.503) (-1.758) (13.91)	0.98	1.47	(3.9)

Table A.2. (continued)

II. Definitions

$$t_{2,t} = 0.619\ t^{P}_{2,t} + 0.381\ t^{C}_{c,t} \tag{3.10}$$

$$t_{1,t} = 0.216\ t_{2,t} + 0.375\ t_{3,t} + 0.152\ t_{4,t} + 0.257\ Def \tag{3.11}$$

$$t_{0,t} = 0.816\ t_{1,t} + 0.184\ t_{s,t} \tag{3.12}$$

$$Y^{Pr}_{t} = 1.194\ Y_{t} - 0.194\ t_{n,t} \tag{3.13}$$

$$C^{Pr}_{t} = 1.384\ Y^{Pr}_{t} - 0.384\ S^{Pr}_{t} \tag{3.14}$$

$$C_{t} = 0.857\ C^{Pr}_{t} + 0.143\ C^{G}_{t} \tag{3.15}$$

$$S^{G}_{t} = 2.128\ t_{0,t} - 1.128\ C^{G}_{t} \tag{3.16}$$

$$S_{t} = 0.657\ S^{Pr}_{t} + 0.343\ S^{G}_{t} \tag{3.17}$$

III. Equilibrium

$$Y_{t} = 0.721\ C_{t} + 0.309\ i_{t} + 0.401\ x_{t} - 0.408\ m_{t} \tag{3.18}$$

Table A.3

Mexico: Estimates for Reduced Form Equations

I. Structural Equations

	R^2	DW	Equation
$t^{P}_{2,t} = -21.864 + 4.555\ Y_t + 0.399\ e_{t-5} + 0.722\ t^{P}_{2,t-4}$ (2.677) (2.879) (2.572) (2.583)	0.705	1.190	(3.1)
$t^{C}_{2,t} = 0.541\ Y_t - 0.465\ e_{t-5} - 0.836\ t^{C}_{4,t-4}$ (4.308) (2.397) (5.045)	1.547	1.531	(3.2)
$t_{3,t} = 1.313\ C^{Pr}_t - 0.412\ e_{t-5} - 0.074\ MD_3$ (4.718) (1.374) (2.746)	0.488	2.393	(3.3)
$t_{4,t} = 0.232\ m_t + 0.721\ e_{t-5}$ (1.266) (4.061)	0.807	1.360	(3.4)
$S^{Pr}_t = 0.565\ Y^{Pr}_t - 0.110\ R_{t-4} + 0.336\ S^{Pr}_{t-1}$ (4.050) (4.000) (2.168)	0.849	2.006	(3.5)
$i_t = 2.731\ S_t - 1.797\ R_{t-4}$ (9.330) (7.038)	0.678	1.330	(3.6)
$C^{G}_t = 0.103\ t_{0,t} + 0.901\ C^{G}_{t-2}$ (1.859) (16.725)	0.642	2.111	(3.7)
$m_t = -10.508 + 3.097\ Y_t$ (1.967) (2.722)	0.899	1.332	(3.8)
$x_t = 0.173\ e_{t-5} + 0.865\ x_{t-4}$	0.508	1.273	(3.9)

Table A.3. (continued)

II. Definitions

$$t_{2,t} = 0.619\ t^{P}_{2,t} + 0.381\ t^{C}_{c,t} \tag{3.10}$$

$$t_{1,t} = 0.216\ t_{2,t} + 0.375\ t_{3,t} + 0.152\ t_{4,t} + 0.257\ \mathrm{Def} \tag{3.11}$$

$$t_{0,t} = 0.816\ t_{1,t} + 0.184\ t_{s,t} \tag{3.12}$$

$$Y^{Pr}_{t} = 1.194\ Y_{t} - 0.194\ t_{n,t} \tag{3.13}$$

$$C^{Pr}_{t} = 1.384\ Y^{Pr}_{t} - 0.384\ S^{Pr}_{t} \tag{3.14}$$

$$C_{t} = 0.857\ C^{Pr}_{t} + 0.143\ C^{G}_{t} \tag{3.15}$$

$$S^{G}_{t} = 2.128\ t_{0,t} - 1.128\ C^{G}_{t} \tag{3.16}$$

$$S_{t} = 0.657\ S^{Pr}_{t} + 0.343\ S^{G}_{t} \tag{3.17}$$

III. Equilibrium

$$Y_{t} = 0.721\ C_{t} + 0.309\ i_{t} + 0.401\ x_{t} - 0.408\ m_{t} \tag{3.18}$$

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