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A MACROECONOMETRIC MODEL OF MEXICO WITH RATIONAL EXPECTATIONS

SONG-SOO LIM*

I. Introduction

According to Uebe and Fischer (1992), the first linear programming model for Mexico appeared in 1963. Since then, many economic models have been constructed to study Mexico's macroeconomic performance. They include the DIEMEX Model (Beltran Del Rio, 1973), the Quarterly Econometric Model (Carrada-Bravo, 1982), the Multicountry Model (Fair, 1984), the Looney Model (Looney, 1985), the GLOBUS Model (Bremer, 1987), the DEMOD Model (Dittus and O'Brien, 1991), and the COLMEX Model (Romero, 1992).

Most common features of identified in the previous models for Mexico include: (1) demand-side components are prevalent over supply-side elements, (2) equation specifications focus on specific attributes of the economy such as government fiscal policies, external debt, international linkage in prices and exchange rates, and oil exports, (3) financial variables have generally weak implications in the models, and (4) markets are assumed in perfect competition or equilibrium.

The purpose of this study is to construct a macroeconometric model for Mexico and evaluate its economic performance under specific government policies. The modeling is guided by several principles. First, macroeconomics should be based on microeconomic foundations whenever applicable. Second, supply-side forces must be

* Research Associate, Korea Rural Economic Institute, Seoul, Korea.

considered along with demand-side forces. Third, markets are not necessarily in equilibrium or reflect perfect competition. Fourth, historical performance and unique characteristics of an economy should be adequately captured in the model.

II. The Model

For analytical purposes, the Mexican economy in this study is divided into five blocks. The five blocks are: (1) the consumption-saving block, (2) the investment block, (3) the supply block, (4) the financial block, and (5) the trade block.1)

1. Consumption-Saving Block

Private consumption function is derived by the Euler equation method (Pratten, 1990). It incorporates income, interest rates, and capital asset or a wealth term. Capital flight is proposed to have an adverse effect on the private consumption as domestic resources move abroad (Winters, 1993). Under the assumption of normal goods, petroleum consumption is specified by price and the total capital stock. The latter replaces income as a direct (physical) measure of market demand for petroleum products. Consumption by government depends largely on the credit supplied by banks. This features the Mexican government practice that have long been pursued in the financial market.

Formulating a "stripped-down" version of the life-cycle theory by Modigliani, savings behavior is postulated as a function of interest rates and either output or its growth (Rossi and Visco, 1994). The extended domestic saving equation included terms of trade, the expected exchange rate devaluation, and initial wealth. Two conditions appear to be relevant in foreign saving behavior–profitability and safety. The former can be influenced by output or economic growth, interest rates, and foreign investment while the

[1] See Lim (1995) for extended treatment of model specification and derivation.

latter may be influenced by the inflation rate, the exchange rate, and oil reserves.

2. Investment Block

Under the condition of an imperfectly competitive market, a firm facing a downward sloping demand curve seeks to maximize profits subject to a production function (Barrell et al., 1994). The private investment equation contains therefore the wage rate and rental cost. A capacity utilization term is included to incorporate investment incentives. Foreign investment is hy-pothexized to stimulate domestic investment and domestic credit to private represents the potential rationing effects of controlled interest rates (Shafik, 1992). The expected exchange rate devaluation is posited to stimulate investment by increasing potential opportunities in export markets. Government investment is specified with domestic credit to government, the cost of funds (real interest rates), output growth, and public debt.

3. Supply Block

Solution of cost minimization problem or Shephard's lema applied to a cost function enables one to derive the conditional demand function for labor. An income effect is represented by the real wage rate. The relative price of production inputs addresses the substitutability between labor and the capital stock. Output is added as a demand factor while the real oil price is included as an additional input cost in production. Labor supply is formulated by the real wage rate and the level and change in employment rate variables accounting for cyclical fluctuations in labor participation, which is the so called "discouraged-worker effect" (Pissarides, 1991).

The wage rate determination embodies the so-called "insider" and "outsider" factors developed by Lindbeck and Snower (1986). Insider factors include firm-specific elements such as productivity and well-being of workers. Outsider factors, on the other hand, refer to the general state of the labor market such as wage rates in other firms and the unemployment rate. In the aggregate economy, the wage rate

equation is, therefore, rewritten as a function of the unemployment rate, capacity utilization, and unemployment representing a demand pressure indicator.

A simple Cobb-Douglas production function is adopted for output in which employment in man-hours is used for labor measure along with the capital stock. Following Fair (1994), this study estimates potential output Y* as follows:

$$Y^* = \lambda * JJP * WPOP,$$

where λ is a coefficient estimated by the peak to peak interpolation series of output per man-hour Y/N and JJP is the peak to peak interpolation series of the ratio of man-hour to working population Nh/WPOP. The potential output is then used to get a capacity utilization term.

4. Financial Block

Demand for money is explained by the nominal interest rate representing an opportunity cost for holding cash balances and output. Since money supply is no longer an exogenous policy instrument in an open economy like Mexico, it is specified as a function of net foreign assets and domestic credits. Given the equations of demand for money and the money supply, interest rates are determined by the expected inflation rate as shown in the Fisherian relationship, output, and money supply. The money supply has effect on interest rates via the "liquidity effect" and "income and price level effect" raised by Friedman (1968).

A proposed functional relationship for the domestic credit to private includes saving and the balance of payments which are hypothesized to be two possible sources of credit, terms of trade, and the relative proportion of domestic credit to government to domestic credit representing a credit rationing problem. Similarly, domestic credit to government is explained by government fiscal deficits, the expected inflation rate accounting for the change in government program costs and revenues from tax receipts and public enterprises, saving, and the level of public debt.

The balance of payments is represented by the change in net foreign assets. Taking into account of the Houthakker-Magee effect (Houthakker and Magee, 1969), the external shocks registered in international capital markets (Khan and Knight, 1983), the monetarization of government deficits (Berg and Sach, 1988), and the condition of capital market in Mexico, the balance of payments is specified with the changes in net foreign direct investment, domestic credit, output, the exchange rate, and international reserves.

Since the effective exchange rate is a trade-weighted index, it is regarded as an appropriate indicator for a country's competitiveness. Edwards (1989) proposed a formula to construct the real effective exchange rate, but it suffers from a systematic bias by taking an arithmetic averaging method. A preferred geometric formula (Board of Governors, 1978) is:

$$EX = 100 \exp \sum_{i=1}^{k} w_i \log_e \left\{ \frac{EX_i}{EX_{i,0}} \right\}$$

where w_i is the bilateral trade weight, EX_i is the real exchange rate with country i at time t, and $EX_{i,0}$ is a corresponding rate in the base period. The consequent exchange rate equation derived by the Euler equation approach consists of the output growth and inflation rates differences between Mexico and U.S. and the expected exchange rate.

Capital flight is proxied as the sum of "net errors and omissions" and "other short-term capital" from the balance of payments summary in the *International Financial Statistics*. To incorporate both the portfolio approach (Mikkelsen, 1991) and the risk differential approach (Eaton, 1987), the capital flight is specified with the interest rate difference, the exchange rate, the expected inflation rate, and government deficits.

The approach to inflation is different from most other approaches in a way that the level of price is specified by a behavioral equation and then the inflation rate is determined by an identity (Fair, 1994). In addition to the firm level of cost factors, supply-oriented cost and macroeconomic or policy factors are fully recognized in the specification of the general price level. A

consequent price equation consists of the wage rate, import price, and the expected price. Petroleum price is postulated under the presumption that causality runs from export price to domestic price. In addition, domestic production conditions are posited to influence domestic price.

5. Trade Block

As theory suggests, the level of exports depends upon international competitiveness or exchange rates and the level of world economic activity. In this study, total export of goods is divided into four categories: (1) agricultural goods, (2) petroleum products, (3) mineral goods, and (4) manufactural goods.

The level of imports is specified as a function of international competitiveness or exchange rates and domestic output. Import taxes and the degree of market openness are applied since the Mexican government has imposed a variety of import restrictions such as import licenses and quotas, prior import permits, import taxes, and import reference prices. Total import of goods is split into three categories: (1) consumer goods, (2) intermediate goods, and (3) capital goods.

6. Rational Expectations

In this study, two forward expectations variables— price and the exchange rate are considered. Following the error-in-variables method (EVM) suggested by Wickens (1982), the realized lead data is used as the expected variables by treating the former as additional endogenous variables in the model system. Then, estimating the system by the 3SLS or FIML method yields consistent and asymptotically efficient results.

III. Estimation Results

1. Data

The data used in this study consists of aggregate annual time series covering the 1960-1991 sample period. Table 1 in appendix

summaries the sources of data and definitions of variables in alphabetical order. The variables are categorized as either endogenous or exogenous, and their units are specified. Most variables are expressed in 1980 prices. Because of data inconsistencies and discrepancies as well as the lack of the data, substantial effort was devoted to collecting and constructing a reliable data set.

2. Estimation Procedure

If the regressors vary systematically with the errors, the OLS method gives inconsistent and biased coefficient estimates. The stochastic equations in this study are simultaneous equations whose regressors include a large number of dependent variables. In this regard, the system is estimated by the non-linear 3SLS method available under SAS 6.08 PC version.

The 3SLS method was chosen over the 2SLS for three reasons. First, no macroeconomic model of Mexico has ever been estimated using the 3SLS method. Second, the 3SLS method produces more efficient coefficient estimates than the 2SLS method because it incorporates cross-equation correlation. Third, the 3SLS method allows one to estimate a simultaneous equations system in a context of the rational expectations formulation.

The first stage regressors were chosen by following the rules of thumb suggested by Fair (1984). To determine the optimal transformation of dependent variables, the Box-Cox transformation method was employed unless their functional forms were predetermined by theories. In most cases, the results supported the use of logarithmic transformation. Finally, autoregressive errors were detected by the Durbin-Watson and Durbin h tests and then corrected by the conditional least squares method.

3. Estimation Results

Table 2 in appendix presents the estimation results. Note that those variables with carrying wrong signs were deleted from the equations. The final model is comprised of 87 variables with 52 endogenous, 35 exogenous variables, including 6 dummy indicators.

There are 30 stochastic equations and 22 identities. The coefficient estimates total 174, including constant terms and the first-order autocorrelation coefficients. The figures in parenthesis are t-statistics. The coefficient on ROH1 indicates the estimate of autoregressive error.

Both the short run and long run elasticities of wage income in private consumption turned out to be relatively small while the wealth effect is highly significant. The negative coefficient of the interest rate suggests that the substitution effect overwhelms the income effect. The positive effect of interest rates on domestic saving is a noticeable result since previous empirical studies failed to yield such a positive correlation (Warman and Thirlwall, 1994). However, this relationship did not hold for foreign saving.

In contrast with theory, the interest rate in private gross fixed investment had a positive coefficient, which indirectly reflects the weak structure of financial markets in Mexico. A strong positive correlation between domestic credit and investment is found with a time gap, meaning credit precedes investment expenditures in the private sector. The complementary nature of net foreign direct investment is also found. With respect to future export opportunities, the expected exchange rate devaluation seems to accelerate private investment.

A negative correlation between employment and the hourly wage rate was confirmed. Output is shown to have a stimulating impact on employment while the oil price shock restrains demand for labor. The negative coefficient of the wage rate in labor supply implies that the income effect of the wage rate overcomes the substitution effect. This "backward-bending" labor supply curve represents a long run relationship. The suggested discouraged-worker effect turned out to be significant in labor force determination. The unemployment variable demonstrates an elastic and significant effect on the wage rate. A higher level of capacity utilization is shown to raise the wage rate and so does the minimum wage rate. In fact, the minimum wage rate has often served as a measuring stick in collective bargaining in Mexico.

In the demand for money, as the income elasticity seems low in the short run, it becomes elastic in the long run at 1.05. For the nominal interest rate, the coefficient on the expected inflation variable

implies that 1% change in the expected inflation rate brings about approximately the same magnitude of change in the nominal interest rate at *ceteris paribus*.

In the forces driving a monetary expansion via domestic credit, saving appears to play a significant role. As Fry (1988) pointed out, a deterioration of the terms of trade seems to elicit expansionary domestic credit to financing the inventory accumulation of export goods or higher import costs. The negative coefficient on the relative domestic credit to government variable shows the existence of a credit rationing problem in Mexico. The rest variables clearly signify that monetary authorities have expedited monetary expansion to finance macroeconomic unbalance.

As postulated by monetarists, the balance of payments is negatively related to domestic credit. The estimated short run and long run offset coefficients are -.241 and -.258, respectively. These small values implies that there is no evidence of offsetting capital inflows by the change in domestic monetary policy (no loss of monetary control). In the determinants of the exchange rate, the coefficient on the expected exchange rate displays the correct sign, but is not statistically significant.

The negative coefficient on the interest rate differential in capital flight confirms the proposition that economic agents seek to maximize their returns on portfolios by allocating wealth (Mikkelsen, 1991). Various risk factors associated with holding domestic or foreign assets are shown to expedite capital flight to a great extent. All three (supply-oriented) cost factors including the wage rate, petroleum price, and import price are highly correlated with the GDP deflator. The highly significant coefficient estimate for the expected price variable provides a strong support for the rational expectations hy-pothesis.

In export equations, the exchange rate devaluation is shown to help stimulate Mexico's export for agricultural goods by enhancing international competitiveness. As a proxy for world demand, the U.S. income is proposed to be a key determinant of export in this model. The export tax rate has an adverse impact on export for agricultural goods.

In import equations, the exchange rate elasticity seems smaller

than those in export equations. This indicates that the importing sector is relatively less vulnerable to the exchange rate risk than the exporting sector. Not significant coefficients of exchange rates in imports of intermediate and capital goods were disappointing results. However, as a key demand force, domestic income bears highly significant coefficients. The import tax rate incorporated as a direct measure of import constraint plays significant role in import equations.

IV. Counterfactual Simulation

A few scenarios have been selected to test the model dynamics and give further insight to the sensitivity of the Mexican economy to policy shocks. An ex post simulation period of 1986 to 1991 was chosen. Alternative paths for selected exogenous variables are set closely to the actual values so that their period average growth rates deviate from the period average growth rates of actual values by 5% either to positive or to negative direction.

1. Fiscal Policy Scenarios

The first set of scenarios focuses on fiscal activities of the Mexican government. Given the model structure, it can be categorized as either "inflationary" or "anti-inflationary" policy. The key variables consist of (1) internal and external government debt, (2) government total expenditure, (3) total income tax receipts, (4) petroleum production, and (5) the minimum wage rate which are basically subject to fiscal policy decisions in Mexico.

2. Import Policy Scenarios

The second set of scenarios concentrates on the import policies of the Mexican government. Import tax receipts by the government are the only feasible explicit factor in the model. A "restrictive" import policy indicates a higher import tax rate than historical values while a "non-restrictive" import policy represents a lower import tax rate.

3. Simulation Results

The results from simulating the five scenarios on selective endogenous variables are shown graphically in figures 1 to 13 in appendix. Scenario A on the graphs indicates the results of stochastic simulation with actual historical values, serving as a baseline. Scenarios B and C represent the "anti-inflationary" and "inflationary" fiscal policies, respectively. Scenarios D and E symbolize the "restrictive" and "non-restrictive" import policies, respectively. The vertical scale varies from one graph to the next as the variable examined changes. Finally, "MNP" on the vertical axis of selected graphs represents million new pesos in real value and "NP/hr" indicates new pesos per hour.

The anti-inflationtionary policy B appears to discourage private consumption (Figure 1). It is affected directly by the reduced disposable wage income and indirectly by higher capital flight. The private investment responds positively to sound fiscal policies B (Figure 2). This result sheds light on the importance of fiscal policies in establishing economic confidence and reducing economic uncertainty or risks.

Scenario B depicts a somewhat explosive movement in the wage rate while scenario C shows a downward trend of the wage rate since 1988 (Figure 3). In contrast, the historical simulation value in scenario A displays that the wage rate stabilizes at .045 NP/hr after 1988. The underlying core factor in determining the wage rate is the minimum wage rate. GDP shows relatively weak deviations in response to scenarios B and C where the input cost effects on employment become the key transmission mechanism (Figure 4). Output appears to have steady positive slopes over the simulation period.

The impact of inflationary fiscal policies on the peso devaluation by scenario C is obvious (Figure 5). Note that in all three scenarios, the tendency of peso appreciation is apparent over the simulation period. In the GDP deflator, a greater upward pressure on prices in scenario C apparently supports the notion of price inertia (Figure 6). By contrast, tight fiscal measures seem not very successful in subduing the price level until the last two periods.

In the export for goods, scenario C displays an improvement in the export, implying a positive transmission mechanism through a devalued exchange rate (Figures 7, 8, 9, and 10). However, all scenarios indicate downward trends along with the baseline. As for the import of goods, a higher import tax in scenario D tends to depress the import demand while a lower import tax in scenario E enhances the import of goods (Figures 11, 12, and 13). Not much change is found in the import demand for intermediate and capital goods under scenarios A, B, and C, which underscores the failure of incorporating exchange rates in their specifications.

V. Conclusions

Two key features of the model are the proposition of imperfectly competitive market conditions and the emphasis on the role of supply factors in modeling the Mexican economy. Suggestions for future research include the following. First, this model can be further segregated into multi-sectors within the blocks to investigate the sector-specific effect of economic policies and phenomena. Second, in a context of NAFTA, this model may be linked with the U.S. and Canada models so that it is capable of addressing economic inter-dependency and inter-linkage between these countries. Furthermore, it can help project trade flows between them and evaluate economic impact of the change in international economic environment.

APPENDIX

TABLE 1 Data and Variable Definitions

Variable		Definition	
B	Exog	Government outstanding bonds in mnp	1960-61:LEMC 1962-91:IE
C	Endo	Private consumption in mnp.	1960-84:LEMC 1985-91:IE
C_{OIL}	Endo	Petroleum conumption in mnp.	QIG, ESY, LEMC
CA	Endo	Current account.	
CU	Endo	Capacity utilizatioin.	
D	Endo	Total government debts in mnp.	
D_D	Exog	Domestic government debt in mnp.	1960-61:AE 1962-91:QIG
D_F	Exog	External government debt in mnp.	1960-63:SY 1964-91:LEMC
DC	Endo	Total domestic credit by the Bank of Mexico in mnp.	
DC_G	Endo	Domestic credit to government in mnp.	IFS
DC_P	Endo	Domestic credit to private in mnp.	IFS
DEF	Endo	Government deficits in mnp.	
EX	Endo	Effective exchange rate, 1980=1.0	IFS
EX_{+1}^e	Endo	Expected EX.	IFS
EXn	Exog	Nominal exchange rate in np per U.S. dollar.	IE
EXD	Endo	Expected EX devaluation.	
EXP_G	Exog	Government expenditures in mnp.	1960-64:AE 1965-91:QIG
G	Endo	Government consumption in mnp.	1960-84:LEMC 1985-91:IE
I	Endo	Total gross investment in mnp.	
I_G	Endo	Government gross fixed investment in mnp.	1960-76:LEMC 1977-91:IE
I_P	Endo	Private gross fixed investment in mnp.	1960-76:LEMC 1977-91:IE
I_V	Exog	Change in inventory in mnp.	LEMC, IE
INC_G	Exog	Government revenues in mnp.	1960-64:LEMC 1965-91:QIG
K	Endo	Total capital stock in mnp.	
K_{NR}	Exog	Non-residential capital stock in mnp.	Hofman
K_R	Exog	Residential capital stock in mnp.	Hofman
KFL	Endo	Capital flight in mnp.	IFS

TABLE 1 Continued

Variable		Definition	Source
LF	Endo	Labor force in millions of people.	LEMC
M	Endo	M2 money in mnp.	QIG
M_{US}	Exog	U.S. M2 money in billions of dollars.	IFS
Mn	Endo	Nominal M2 money in mnp.	QIG
N	Exog	Employment in millions of people.	LEMC
Nh	Endo	Empolyment in man-hours in millions	YLS, LEMC
NFA	Endo	Net foreign assets held by the Bank of Mexico in mnp.	IFS
NFDI	Exog	Net foreign direct investment in millions of dollars.	IFS
OPEN	Endo	Market openness.	
P	Endo	GDP deflator, 1980=1.0.	LEMC, QIG
P_{+1}^{e}	Endo	Expected P.	LEMC, QIG
P_{OIL}	Endo	Domestic petroleum price, 1980=1.0.	QIG
P_Q	Exog	Import price, 1980=1.0.	1960-67:EHM 1968-91:WT
P_{US}	Exog	U.S. GDP deflator, 1980=1.0.	IFS
P_X	Exog	Export price, 1980=1.0.	1960-67:EHM 1968-91:WT
P_{XOIL}	Exog	Export crude oil price in np per barrel.	QIG
Q	Endo	Total imports in mnp.	
Q_{CA}	Endo	Import of capital goods in mnp.	1960-87:LEMC 1988-91:IE
Q_{CO}	Endo	Import of consumer goods in mnp.	1960-87:LEMC 1988-91:IE
Q_{IN}	Endo	Import of intemediate goods in mnp.	1960-87:LEMC 1988-91:LE
Q_{SVC}	Exog	Import of services in mnp.	1960-87:LEMC 1988-91:IE
QG	Endo	Total imports of goods in mnp.	
R	Endo	Interest rate in pc.	
R_{US}	Exog	U.S. interest rate in pc (3-year government bond rate for 1960-77 and 3-month T-bill rate for 1978-91).	IFS
Rn	Endo	Nominal interest rate in pc (average of short- and long-term deposit rates for 1960-77 and 3-month Mexican peso-denominated treasury bill(CETES) rate for 1978-91).	1960-77:Warman 1978-91:QIG

TABLE 1 Continued

Variable		Definition	Source
RSV	Exog	International reserves in mnp.	IFS
RSV_{OIL}	Exog	Crude oil reserves in millions of barrels.	QIG
S	Endo	Total savings in mnp.	
S_P	Endo	Domestic saving in mnp.	Aspe
S_F	Endo	Foreign saving in mnp.	Aspe
T_Q	Exog	Import tax rate in pc	1960-64:AE 1965-91:QIG
T_X	Exog	Export tax rate in pc	1960-64:AE 1965-91:QIG
TB	Endo	Trade balance in mnp.	
ToT	Endo	Terms of trade.	
TW	Exog	Wage income tax in mnp.	1960-64:AE 1965-91:QIG
U	Endo	Unemployment in millions of people.	
V	Endo	Non-human wealth in mnp.	
W	Endo	Hourly wage rate for manufactural sector in np per hour.	YLS
W_D	Endo	Disposable wage income in mnp.	
W_{MIN}	Exog	Daily minimum wage in 16 urban cities in np per day.	LEMC
WPOP	Exog	Working population in millions of people.	LEMC
X	Endo	Total exports in mnp.	
X_{AG}	Endo	Export for agicultural goods including agriculture, livestock, fishery, and forest products in mnp.	LEMC
X_{MF}	Endo	Export for manufactural goods in mnp.	LEMC
X_{MN}	Endo	Export for mineral goods in mnp.	LEMC
X_{OIL}	Endo	Export for petroleum products and crude oil excluding natural gas in mnp.	LEMC
X_{SVC}	Exog	Export for services in mnp.	LEMC
X_G	Endo	Total exports for goods in mnp.	
Y	Endo	GDP in mnp.	LEMC
Y_{US}	Exog	U.S. GDP in billions of dollars.	IFS
Y_{OIL}	Exog	Crude oil production in millions of barrels.	LEMC
Y^*	Exog	Potential Y in mnp.	
π	Endo	Inflation rate in pc.	
π^e	Endo	Expected π in pc.	
d77	Exog	Dummy for 1977 capturing a major devaluation.	
d81	Exog	Dummy for 1981 capturing a lagged major devaluation.	

TABLE 1 Continued

Variable		Definition	Source
d82	Exog	Dummy for 1982 capturing a major devaluation.	
d85a	Exog	Dummy for 1985-91 capturing a rapid growth in Q_{CO}.	
d86	Exog	Dummy for 1986 capturing a major devaluation.	
d88	Exog	Dummy for 1988 capturing a precipitated drop in M.	

Note:

Endo	Endogenous variable.
Exog	Exogenous variable.
mnp	Millions of np in 1980 price.
np	Mexican new peso in 1980 price.
pc	Percentage point.
AE	Anuario Estadistico, Direccion General de Estadistica, Mexico.
Aspe	Aspe(1993).
EHM	Estadisticas Historicas de Mexico, Instituto Nacional de Estadistica, Geografia e Informatica, Mexico.
ESY	Energy Statistics Yearbook, UN.
Hofman	Hofman(1992).
IE	Indicadores Economicos, Banco de Mexico.
IFS	International Financial Statistics, IMF.
LEMC	La Economia Mexicana en Cifras, Nacional Financiera, Mexico.
QIG	Qinto Informe de Gobierno, Carlos Salinas de Gortari, Mexico.
SY	Statistical Yearbook, UN.
YLS	Yearbook of Labour Statistics, International Labour Office.
Warman	Warman and Thirlwall(1994)
WT	World Table, World Bank.

TABLE 2 A Macroeconometric Model for Mexico

Ⅰ. Stochastic Equations

Consumption-Saving Block

1. Private Consumption
$\log C = -.229 + .400 * \log C_{-1} + .126 * \log W_D + .369 * \log V_{-1} - .00018 * KFL - .088 * R$
(-1.37) (5.56) (4.85) (8.10) (-6.67) (-3.43)
Adj.R^2=.995 Durbin h=.790

2. Petroleum Consumption
$\log C_{OIL} = -1.610 + .825 * \log C_{OIL-1} - .020 * \log P_{OIL} + .252 * \log K$
(-5.12)(16.34) (-2.77) (4.91)
Adj.R^2=.990 Durbin h=-.157

3. Government Consumption
$\log G = .533 + .901 * \log G_{-1} + .014 * \log DC_G$
(4.91) (25.54) (.72)
Adj.R^2=.983 Durbin h=.767

4. Domestic Saving
$\log S_D = -2.786 + .238 * \log S_{D-1} + 1.416 * \log Y + .234 * R + .282 * ToT - .064 * \log EXD$
(-7.32) (3.47) (7.31) (4.68) (6.33) (-1.68)
$-.393 * \log V_{-1}$
(-3.45)
Adj. R^2=.975 Durbin h=.491

5. Foreign Saving
$S_F = -529.34 + .256 * S_{F-1} - 333.03 * \log EX + 61.93 * \log NFDI + 22.94 * \log RSV_{OIL}$
(-14.38) (7.19) (-13.11) (8.92) (6.70)
$-90.06 * \pi - .366 * RH01$
(-4.96) (-6.14)
Adj.R^2=.884 Durbin h=-.551

Investment Block

6. Gross Fixed Private Investment
$\log I_P = -1.492 + .654 * \log K_{-1} + .651 * \log CU + .173 * \log DC_{P-1} + .054 * \log NFDI$
(-3.95) (12.13) (1.71) (5.72) (3.15)
$+.143 * \log EXD + .394 * RH01$
(3.83) (4.94)
Adj.R^2=.979 DW=1.587

7. Gross Fixed Government Investment
$\log I_G = -1.395 + .527 * \log I_{G-1} + .333 * \log DC_G - .308 * R + 3.923 * \triangle \log Y - .125 * \log D$
(-8.94) (12.72) (11.46) (-4.16) (12.16) (-4.36)
Adj.R2=.968 DW=.386

TABLE 2 Continued

Supply Block

8. Employment
$\log Nh = 1.970 + .671 * \log Nh_{-1} - .090 * \log W + .245 * \log Y - .037 * \log(P_{OUL}/P)$
(4.94) (13.64) (-4.18) (3.12) (-1.96)
$-.076 * \log K$
(-1.25)
Adj.R^2=.982 Durbin h=.588

9. Labor Force
$\log(LF/WPOP) = -.197 + .705 * \log(LF/WPOP)_{-1} - .030 * \log W + .147 * \log(N/WPOP)$
(-7.28) (19.24) (-4.52) (5.23)
$+.395 * \triangle \log(N/WPOP)$
(11.99)
Adj.R^2=.869 Durbin h=.856

10. Wage Rate
$\log W = -1.418 + .375 * \log W_{-1} - 1.475 * \log U + 1.443 * \log CU + .193 * \log W_{MIN}$
(-8.50) (6.11) (-4.82) (4.59) (4.48)
Adj.R^2=.779 Durbin h=.987

11. Output
$\log Y = -1.574 + .558 * \log Nh + 442 * \log K_{NR} + .816 * RH01$
(-20.48) (13.89) (23.68)
Adj.R^2=.997 DW =1.838

Financial Block

12. Demand for Money
$\log M = -.485 + .668 * \log M_{-1} + .350 * \log Y - .065 * Rn - .380 * d88 + .117 * RH01$
(-2.24) (18.83) (7.44) (-2.67) (-20.04) (2.40)
Adj.R2=.981 Durbin h=.579

13. Money Supply
$\log Mn = .644 + .659 * \log Mn_{-1} + .148 * \log(P * NFA) + .193 * \log(P * DC) + .325 * RH01$
(12.63) (24.41) (15.68) (8.45) (4.06)
Adj.R^2=.999 Durbin h=.988

14. Norminal Interest Rate
$Rn = -.528 + 1.073 * \pi^{e} + .332 * \log(P * Y) - .311 * \log Mn$
(-4.56)(13.00) (4.35) (-4.06)
Adj.R^2=.806 DW=1.238

15. Domestic Credit to Private
$\log DC_P = -9.130 + .220 * \log DC_{p-1} + .473 * \log S + .042 * \triangle \log NFA - .240 * \log ToT$
(-7.18) (2.78) (2.44) (1.31) (-1.85)

TABLE 2 Continued

$$-.856*\log(DC_G/DC)+1.223*\log Y$$
$$(-8.20) \qquad (4.19)$$
$$\text{Adj.}R^2=.963 \quad \text{Durbin h}=1.312$$

16. Domestic Credit to Government

$$\log DC_G=-2.434+.346*\log DC_{G-1}+.499*\log S+.0007*DEF+.660*\pi^e+.402*\log D$$
$$(-5.01)\ (6.52) \qquad (4.43) \qquad (4.62) \qquad (5.30) \quad (6.90)$$
$$-.232*RH01$$
$$(-4.84)$$
$$\text{Adj.}R^2=.972 \quad \text{Durbin h}=-.609$$

17. Balance of Payments

$$\triangle\log NFA=-.262+.067*\triangle\log NFA_{-1}+.007*\triangle\log NFDI-.241*\triangle\log DC$$
$$(-4.14)\ (2.10) \qquad (.74) \qquad (-2.34)$$
$$+4.794*\triangle\log Y+1.325*\triangle\log EX+1.346*\triangle\log RSV$$
$$(5.84) \qquad (9.45) \qquad (27.78)$$
$$\text{Adj.}R^2=.737 \quad \text{Durbin h}=.156$$

18. Exchange Rate

$$\log EX=.022+.417*\log EX_{-1}-1.121*\triangle\log(Y/Y_{US})+.124*\triangle\log(P/P_{US})$$
$$(1.44)\ (9.55) \qquad (-6.73) \qquad (2.50)$$
$$+.043*\log EX^e_{-1}+.117*d77+.627*d82$$
$$(1.33) \qquad (5.24) \quad (16.73)$$
$$\text{Adj.}R^2=.852 \quad \text{Durbin h}=.273$$

19. Capital Flight

$$KFL=-9.149+.208*KFL_{-1}-269.851*(R-R_{US})+277.495*\log EX+80.127*\pi^e$$
$$(-1.59)\ (10.54) \qquad (-14.53) \qquad (9.24) \qquad (4.42)$$
$$+.154*DEF+365.433*d82-.399*RH01$$
$$(6.67) \qquad (22.13) \qquad (-9.92)$$
$$\text{Adj.}R^2=.897 \quad \text{Durbin h}=.331$$

20. GDP Deflator

$$\log P=1.133+.291*\log P_{-1}+.178*\log(P*W)+.171*\log P_{OUL}+.243*\log P_Q$$
$$(7.80)\ (10.21) \qquad (5.62) \qquad (8.21) \qquad (8.86)$$
$$+.157*\log EXn+.206*\log P_{+1}^e+.252*RH01$$
$$(4.85) \qquad (7.93) \qquad (4.54)$$
$$\text{Adj.}R^2=1.0 \quad \text{Durbin h}=.784$$

21. Petroleum Price

$$\log P_{OIL}=.442+1.049*\log P_{OIL-1}+.211*\log P_{XOIL}+.151*RH01$$
$$(7.37)\ (64.64) \qquad (7.17) \qquad (4.06)$$
$$\text{Adj.}R^2=.989 \quad \text{Durbin h}=.310$$

TABLE 2 Continued

Trade Block

22. Export for Agricultural Goods

$$\log X_{AG} = .252 + .927 * \log X_{AG-1} + .831 * \log EX - 2.547 * \triangle \log(Y/Y_{US}) - .041 * \log T_X + .598 * d86 - .354 * RH01$$

(3.74) (37.07) (5.82) (-5.97) (-3.13) (7.86) (-5.81)

Adj.R^2=.992 Durbin h=-.242

23. Export for Petroleum

$$\log X_{OIL} = 1.957 + .952 * \log X_{OIL-1} + .545 * \log EX + .605 * \log P_{XPIL} + .224 * \log(Y_{OIL}/RSV_{OIL})$$

(11.40) (66.61) (3.03) (15.66) (4.09)

Adj.R^2=.994 Durbin h=.388

24. Export for Mineral Goods

$$\log X_{MN} = -3.937 + .961 * \log X_{MN-1} + 1.025 * \log EX + .527 * \log Y_{US} + .820 * d82$$

(-3.52) (55.53) (6.26) (3.58) (8.83)

Adj.R^2=.988 Durbin h=-.260

25. Export for Manufactured Goods

$$\log X_{MF} = -2.401 + .970 * \log X_{MF-1} + 1.868 * \log EX + .339 * \log Y_{US}$$

(-1.64) (54.42) (12.97) (1.72)

Adj.R^2=.995 Durbin h=.677

26. Import of Consumer Goods

$$\log Q_{CO} = 1.194 + .653 * \log Q_{CO-1} - .573 * \log EX + .064 * \triangle \log Y + .377 * \log OPEN - .245 * \triangle \log T_Q + .210 * d85a$$

(.92) (10.19) (-2.27) (.41) (4.86) (-2.41) (1.29)

Adj.R^2=.997 Durbin h=-.313

27. Import of Intermediate Goods

$$\log Q_{IN} = -4.420 + .532 * \log Q_{IN-1} + .689 * \log Y + .076 * \log(X_{AG} + X_{MN} + X_{MF})_{-1} - .413 * \log T_Q$$

(-12.28) (24.36) (14.09) (3.48) (-17.34)

Adj.R^2=.997 Durbin h=-.151

28. Import of Capital Goods

$$\log Q_{CA} = -1.266 + 1.047 * \log Q_{CA-1} + 2.478 * \log Y + .148 * \log I - .334 * \triangle \log T_Q$$

(-2.94) (59.82) (3.93) (2.25) (-6.30)

Adj.R^2=.990 Durbin h=.554

Expectations

29. Expected GDP Deflator

$$\log P_{+1}^{e} = -.703 + .928 * \log P + .156 * \log Mn + .00001 * (P * DEF) + 1.347 * \log CU + .323 * d86$$

(-3.01) (22.54) (4.58) (11.11) (3.76) (7.91)

Adj.R^2=.999 Durbin h=1.204

TABLE 2 Continued

30. Expected Exchange Rate

$$\log EX_{+1} = -.129 + .543 * \log EX + .0004 * DEF - 1.727 * \triangle \log(Y/Y_{US}) - .074 * \triangle \log NFA + .319 * \triangle(M/M_{US}) + .027 * \log(D/Y) + .662 * d81$$

(-1.65) (8.21) (5.06) (-7.85) (-5.47) (4.58) (2.32) (16.59)

Adj.R^2=.881 Durbin h=.784

Ⅱ. Identities

1. Current account	$CA=X-Q$
2. Capacity utilization	$CU=Y^{*}/Y$
3. Total government debts	$D=D_D+D_F$
4. Total domestic credit	$DC=DC_P+DC_G$
5. Fiscal deficits	$DEF=INC_G-EXP_G$
6. Expected EX devaluation	$EXD=EX_{+1}^{e}/EX$
7. Investment	$I=I_P+I_G+I_V$
8. Total capital stock	$K=K_R+K_{NR}$
9. Market openness	$OPEN=(X+Q)/Y$
10. total imports	$Q=QG+Q_{SVC}$
11. Total imports of goods	$QG=Q_{CO}+Q_{IN}+Q_{CA}$
12. Interest rate	$R=Rn-\pi^{e}$
13. Total savings	$S=S_P+S_F$
14. Trade balance	$TB=XG-QG$
15. Terms of trade	$ToT=P_X/P_Q$
16. Unemployment	$U=LF-N$
17. Non-human wealth	$V=B+K+NFA$
18. Disposable wage income	$W_D=Nh*W-TW$
19. Total exports	$X=XG+X_{SVC}$
20. Total exports for goods	$XG=X_{AG}+X_{OIL}+X_{MN}+X_{MF}$
21. Inflation rate	$\pi=\log(P/P_{-1})$
22. Expected inflation rate	$\pi^{e}=\log(P_{+1}^{e}/P)$

FIGURE 1 Private Consumption

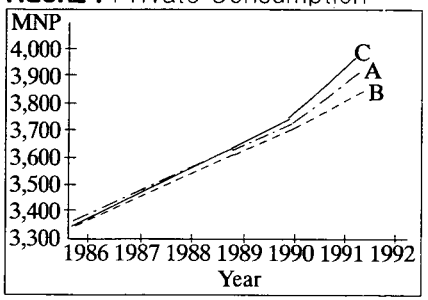


FIGURE 2 Private Gross Fixed Investment

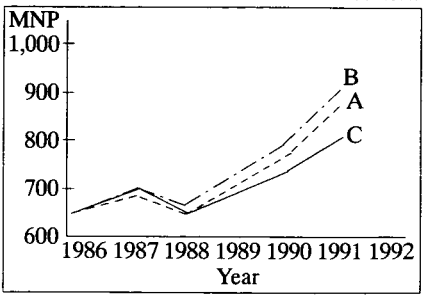


FIGURE 3 Wage Rate

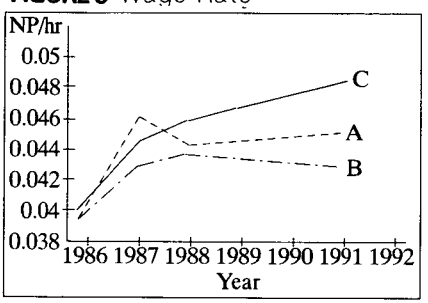


FIGURE 4 Output

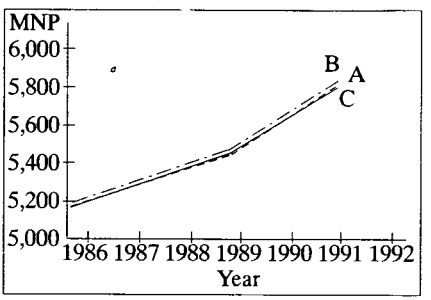


FIGURE 5 Exchange Rate

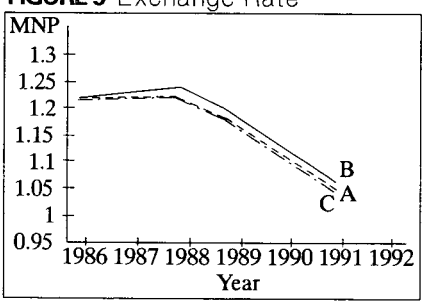


FIGURE 6 GDP Deflator

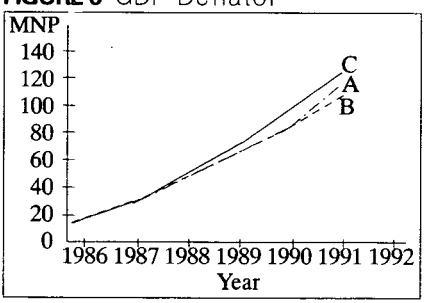


FIGURE 7 Export for Agricultural Goods

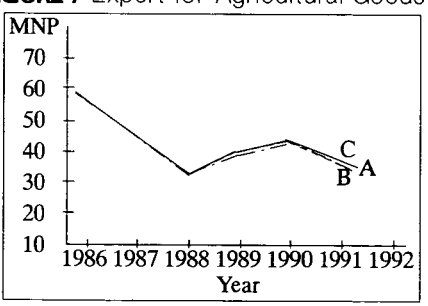


FIGURE 8 Export for Petroleum

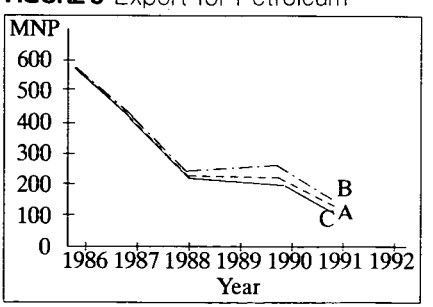


FIGURE 9 Export for Mineral Goods

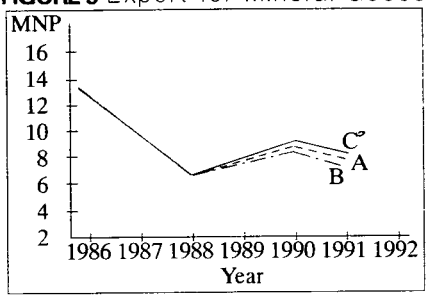


FIGURE 10 Export for Manufactural Goods

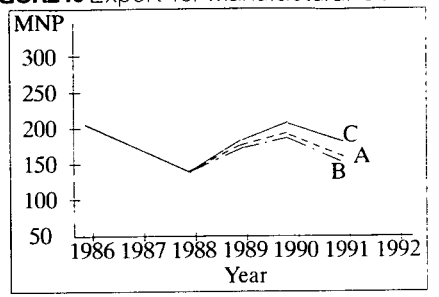


FIGURE 11 Import of Consumer Goods

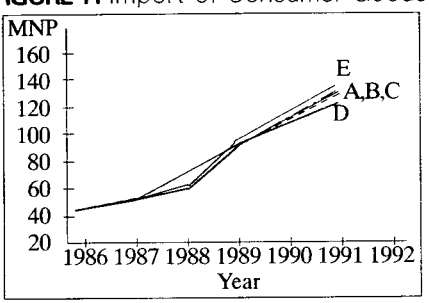


FIGURE 12 Import of Intermediate Goods

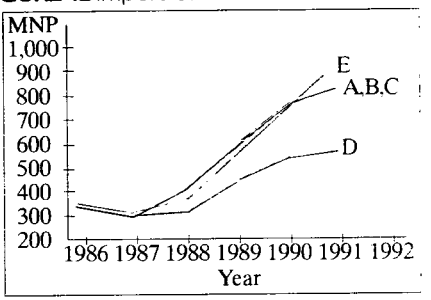
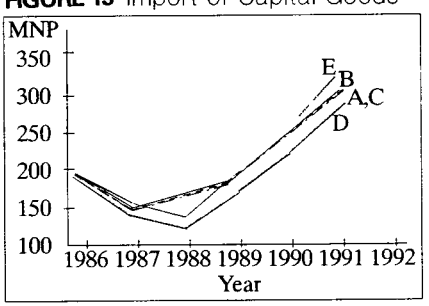


FIGURE 13 Import of Capital Goods



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