THE FINANCIAL SECTOR IN THE PLANNING OF ECONOMIC DEVELOPMENT

by

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1. Introduction and Summary

Financial institutions play a central role in the process of economic development, channeling consumer savings into sectors where capital is most productive. How well they perform this role determines in large part the rate and distribution of economic growth.

In Mexico financial markets take on additional importance. The Bank of Mexico and subsidiary government agencies (primarily fidécomisos) actively encourage investment in particular sectors through a complex system of loan subsidies, selective rediscounting, and restrictions on portfolios of private banks.[1] Commercial banks, for example, Mexico's predominant financial intermediary, must loan 15.3% of their deposits to agriculture ("a la agricultura, ganaderia, avicultura, apicultura, pesca e industrias conexas") and 30% of their savings accounts ("ahorro") to low-income housing ("para la vivienda de interés social y/o bonos hipotecarios") approved by the Secretary of Finance ("Hacienda y Crédito Público").[2]

Analysis of such detailed policy tools, however, requires more information than we could glean from existing data, even with the aid of audacious assumptions. Instead we have constructed a semi-realistic general equilibrium model based on known characteristics of the Mexican economy in 1977. The model's two central features are its treatment of the intertemporal allocation of resources, which depends fundamentally on the way in which expectations are formed, and the introduction of money as a transactions medium.

Intertemporal allocation relies on the common theoretical device of dating capital. Firms use current capital to produce current goods and next period capital. Consumers sell their stock of current capital to firms and save (dissave) by buying more (less) next period capital. Government bonds are equivalent to capital from consumers' points of view, but do not enter production processes.

Rational expectations - here perfect foresight - is not a sufficiently powerful assumption for determining the time paths of prices. We assume, in addition, that the economy is on a steady state path. This enables us to use consol formulas to determine present values of capital and labor. Later, in simulations, we drop the steady state requirement but continue to use the consol formulas. The presumption is that near the steady state these equations are adequate approximations to actual perfect foresight solutions. In unguarded moments, we might even argue that our quasi-rational expectations are better replicas of "real life" than perfect foresight is.

We generate demands for money by putting real balances into utility and production functions. We realize that some economists begin to twitch when they see the words "money" and "utility" or "production function" in close proximity, but we do not find this treatment of money any more disagreeable than similar treatments of, say, bread, labor, or capital. Utility and production functions have proven to be useful constructs in the study of commodity and factor demands, despite their abstract and somewhat ephemeral natures. We think the same is true with money.

With the exception of money, the one-period model is identical to Jaime Serra-Puche (1981). Sixteen intermediate goods are produced by a fixed coefficients input-output technology from a single composite factor, value-added. Value-added in each sector is generated by a sector-specific Cobb-Douglas technology from four factors: rural labor, urban labor, capital, and money. All four factors are in fixed supply.

The first fifteen intermediate goods are converted into fifteen final consumer goods by a second fixed coefficients activity matrix. The final intermediate good is next period's capital stock, which is "produced" by transmitting this period's capital stock, net of depreciation, and by the capital goods sector (number 16).

The ten groups of consumers are distinguished by income class (poor, low income, low-middle income, middle income, and upper income) and location (rural and urban). Each is endowed with capital and either rural or urban labor which they supply inelastically in factor markets. Consumers use their factor income to buy the fifteen final goods, pay income and sales taxes, and save (buy tomorrow's capital or government debt.) Money is rented from the government to facilitate current consumption.

The government collects tax revenue, rents on money, and interest on its capital endowment, which may be negative if the government is a net debtor. Total revenues are then spent on intermediate goods and factors in fixed proportions.

General equilibrium in the model is computed with a global Newton algorithm. A benchmark simulation (section 3) shows that prices are close to those of Serra-Puche for the same tax structure. Having calibrated the model to this benchmark equilibrium we plan in our future research to examine the effect of policy experiments and monetary institutions (section 4).

2. The Model

The structure of the model was summarized in the introduction. Here we describe in detail our specifications of production, demand, and government activity, and our definition of equilibrium.

Production

Following Serra-Puche (1981) our production technology is a fixed coefficients input-output system augmented by substitutability among factors. A list of sectors (goods) is given in Table 1. We have found it useful to differentiate m intermediate goods, n final goods, and k factors. Only final goods are demanded by consumers.

The structure of the activity matrix, parts of which depend on prices of intermediate goods (p) and factors (w) is

$$
\text{(2.1)} \qquad \begin{array}{c c} & \begin{array}{cc} m & n \end{array} \\ \begin{array}{c} m \\ n \\ k \end{array} & \begin{bmatrix} A(p,w) & C \\ 0 & D \\ B(p,w) & 0 \end{bmatrix} \end{array}
$$

Columns of A are activities which produce intermediate goods using factor inputs given by B. C and D form a "black-box" activity submatrix which converts intermediate goods into final goods. The black box, which is common to input-output models, is required to reconcile different definitions of sectors in production and consumption data.

Factor coefficients (B) depend on factor prices and, through money, on intermediate goods prices as well. We think of intermediate goods as being produced by a single composite factor, value-added, which is produced in a particular sector j from four factors by a Cobb-Douglas production function:

$$VA_j = c_j r_j^{\delta_{1j}} u_j^{\delta_{2j}} k_j^{\delta_{3j}} m_j^{\delta_{4j}}, \quad \sum_{i=1}^{4} \delta_{ij} = 1,$$

where r_j, u_j, k_j, and m_j are inputs of rural labor, urban labor, capital, and money. The money input, m_j, is the ratio of nominal balance rented from the government for one period of rate s, to gross nominal receipts of the sector. Let A_j^+ denote the jth column of a matrix containing only the positive elements of -A (the inputs) but excluding imports, which presumably require foreign money. Then m_j is

$$m_j = M_j/p'A^+{}_j$$

The relevant factor price for m_j is therefore $w_4 = sp'A_j^+$. Factor input coefficients (elements of B) are derived by minimizing the cost of producing one unit of value-added:

$$\begin{aligned}
r_j &= \lambda_j\delta_{1j}/w_1 \\
u_j &= \lambda_j\delta_{2j}/w2 \\
k_j &= \lambda_j\delta_{3j}/w3 \\
m_j &= \lambda_j\delta_{4j}/sp'A_j^+ \\
\lambda_j &= \prod_{i=1}^{4} W_i^{\delta_{ij}}/c_j \prod_{i=1}^{4} \delta_{ij}^{\delta_{ij}}.
\end{aligned}$$

Demand for nominal balances of money is

$$M_j = \lambda_j\delta_{4j}/s.$$

Since the supply of money is fixed in nominal terms this version is useful for defining an equilibrium.

For the most part A is a fixed coefficients input-output matrix, but the final row, production of next period capital, depends on prices. Each activity produces, in addition to its sector's product, second-hand cpaital. That is, they produce a quantity of next-period capital equal to this period's capital input minus depreciation. Since capital input depends upon prices, so too do the future capital coeffients in A.

Consumption

Ten consumers, described in Table 2, are endowed with capital and labor which they sell in factor markets. The resulting income is used to pay income taxes on labor income, purchase current final goods gross of sales taxes (consume), rent money from the government, and purchase next period capital (save). By postulating Cobb-Douglas intertemporal utility functions we are able to separate the consumption/saving decision from decisions about which final goods to consume.

Let a typical infinite-lived consumer (the ith, say) maximize the function

$$\sum_{t=1}^{\infty} \rho_i^t \left[\sum_{j=1}^{n+1} \alpha_{ij} \ln x_{ijt} \right], \quad \sum_{j=1}^{n+1} \alpha_{ij} = 1,$$

where ρ is the consumer's subjective discount factor, n is still the number of final goods, and x_{ijt} is consumption of final good j at time t. By convention let the $(n+1)^{st}$ good be real balances of money. The i subscripts will be omitted to simplify the notation.

Since money is used only for current transactions, and not as a store of value, the decision to hold real balances is contained entirely in the one-period problem. Consumers maximize momentary utility,

$$\sum_{j=1}^{n+1} \alpha_j \ln x_{jt},$$

subject to a fixed quantity of consumption C_t:

$$\sum_{j=1}^{n+1} q^*_{jt} x_{jt} = C_t.$$

The q^*_{jt} are prices of final goods including sales taxes. This yields demands of

$$x_{jt} = \alpha_j C_t / q^*_{jt}$$

In a manner analogous to production, the $(n+1)^{st}$ good, money, enters the utility function as ratio of nominal balances to nominal consumption C_t. If the rental rate on money is s then the cost per unit of real balances is sC_t and the demand for nominal balances is α_{n+1}/s.

The maximized value of one-period utility is

$$\ln C_t + \sum_{j=1}^{n+1} \alpha_j \ln(\alpha_j / q^*_{jt})$$

so the consumer's intertemporal problem, after omitting irrelevant constants, is to maximize

$$\sum_{t=1}^{\infty} \rho^t \ell n C_t .$$

The budget constraint requires that the present value of the consumption stream equal the value of today's capital endowment (K) plus the present value of present and future labor income (J):

$$\sum_{t=1}^{\infty} R_t \, C_t = K + J,$$

where R_t is the t-period discount factor. Current consumption is therefore

$$C_1 = (1-\rho)[K + J].$$

The only difficulty is in evaluating K and J, and this is one place our steady state assumptions sneak in. Consider first the present value of a permanent endowment ℓ of labor. At a constant real discount rate r and a constant after-tax real wage w_1^* or w_2^*, for rural and urban labor, this is

$$J = w_i^* \ell / r \qquad i = 1,2.$$

Next consider the value today of k units of capital. Each unit earns an after-tax rental p* and, after depreciation, returns $(1-\delta)$ units of capital next period. If the rental, depreciation, and discount rates are constant then the price of one unit of capital today is

$$w_3 = \sum_{t=0}^{\infty} \left(\frac{1-\delta}{1+r}\right)^t p^*$$

$$= \left(\frac{1+r}{r+\delta}\right) p^* .$$

The present value of a consumer's capital endowment is therefore

$$K = w_3 k.$$

Current income is given by

$$I = w_i^* \ell + p^* k, \; i = 1, 2,$$

so the saving rate is

$$\frac{I-C}{I} = 1 - (1-\rho)\left[\frac{K+J}{I}\right].$$

We calibrated the ρs to generate Serra-Puche's savings rates at his benchmark equilibrium prices.

Government and Foreign Sectors

The government serves in the model as a combination fiscal agent and financial intermediary. It collects income and sales taxes, charges rent on money, and purchases intermediate goods and labor. With real debt growth of 3% per year the government always runs a deficit. Nominal government expenditures are equal to

$$G = TAX + sM + w_3 D - p_{16}\, 1.03D$$

where

TAX = income and sales taxes paid by consumers

M = nominal money supply

s = rental rate on money

w_3 = price today of one unit of current capital

p_{16} = price today of next year's capital

D = -government debt in capital-equivalent units

Government debt, which is perfectly substitutable for capital in consumer portfolios, is rolled over each period. Interest payments on debt are included implicitly in the prices w_3 and p_{16} .

Total expenditures G are allocated among intermediate goods and labor in fixed physical proportions.

Our rudimentary foreign sector consists essentially of activity 15, net exports. This activity takes other intermediate goods and "produces" exports. There is no substitutability among intermediate goods so the export mix is fixed. The equilibrium trade deficit is fixed at its 1977 value in units of imported goods.

Equilibrium

Equilibrium in the model consists of a set of prices for which excess demands for all goods and factors are zero and all activities earn zero profits. The government and trade deficits are nonzero but fixed. In addition we impose certain steady state conditions to simplify expectational issues concerning the price of capital.

In most models with standard input-output activity structures (for example, John Shoven and John Whalley (1972), Andrew Feltenstein (1981), Serra-Puche (1981)) the problem of finding an equilibrium is easily reduced to the problem of finding an equilibrium vector of factor prices. In the present model, because the price of using real balances depends on prices of intermediate goods, this is not possible.

However, prices of final goods (q) are easily eliminated to reduce the dimensionality of the problem. Given a price vector p for intermediate goods, the zero profit conditions for final goods production are

$$p'C + q'D = 0$$

or

$$q' = -p'CD^{-1} \tag{2.2}$$

Let agggregate demand for final goods at these prices, given factor income and taxes, be g_2. Then final goods activities must be run at levels y_2 given by

$$Dy_2 = g_2.$$

Similarly, production of intermediate goods must equal their use in production of final goods. Thus intermediate goods activities (A) must be run at levels y_1 satisfying

$$Ay_1 + Cy_2 = 0. \tag{2.3}$$

Derived demand for factors is therefore

$$\begin{aligned} f &= By_1 \\ &= -BA^{-1}CD^{-1}g_2. \end{aligned} \tag{2.4}$$

In actually computing equilibrium we use (2.2) and set factor demands given by (2.4) equal to aggregate endowments. There are, however, several minor modifications which must be made to the analysis above. First, the government debt is included in consumer endowments of capital but cannot be used in production. We treat this by having the government buy back its debt from consumers at the start of each period and resell it at the end. Second, the government purchases intermediate goods and factors so (2.3) and (2.4) do not hold exactly. Finally, the foreign sector starts out with an endowment of imports equal to the 1977 trade deficit, so not all imports need to be "produced".

Table 1. List of Goods and Factors

Intermediate Goods

1. Agriculture
2. Mining
3. Petroleum and petrochemicals
4. Food products
5. Textiles
6. Wood products
7. Chemical products
8. Nonmetal production
9. Machinery and automobiles
10. Electric energy
11. Commerce
12. Transportation
13. Services
14. Construction
15. Imports
16. Next period capital

Final Goods

1. Bread and cereals
2. Milk and eggs
3. Other groceries
4. Fresh fruits and vegetables
5. Meat
6. Fish
7. Beverages
8. Clothing
9. Furniture
10. Electronic products
11. Medical products
12. Transportation
13. Educational articles
14. Articles for personal care
15. Services

Factors

1. Rural labor
2. Urban labor
3. Capital
4. Money

3. Computation of the Benchmark Equilibrium

The equilibrium conditions described in the previous section reduce to the conditions that profits on final goods are zero

(1.1) $f_1(w,p) = 0$

that excess demand for factors is zero

(1.2) $f_2(w,p) = 0$

and that the government budget constraint be satisfied

(1.3) $f_3(w,p) = 0.$

By Walras law one of these equations is redundant -- we chose to eliminate the excess demand for money equation. Denote the remaining equations $\tilde{f}(w,p)$. The equilibrium is then defined by

(1.4) $\tilde{f}(w,p) = 0.$

As a computational check we verified that our solution to (1.4) equated excess demand for money to zero.

Computation of Equilibrium

Frequently equilibria are computed using a variant of Scarf's algorithm such as Eaves or Merrill's method. To simplify comparative statics we instead chose Smale's global newton method, which, like the fixed point methods, is guaranteed to converge. Global newton is based on the observation that the solution to the differential equation

(1.5) $[D\tilde{f}_{(p,w)}] \begin{bmatrix} \dot{p} \\ \dot{w} \end{bmatrix} = \theta[\text{sgn det } D\tilde{f}_{(p,w)}]\tilde{f}(p,w),$

where sgn θ is determined by a boundary condition. When $\theta = -1$ and sgn det $D\tilde{f} = +1$ near an equilibrium (1.5) can be written as

$$(1.6) \qquad \begin{bmatrix} \dot{p} \\ \dot{w} \end{bmatrix} = -[D\tilde{f}_{(p,w)}]^{-1} \tilde{f}\ (p,w)$$

which is just a continuous-time version of ordinary Newton's method. Like Eaves' or Merrill's algorithms, Scarf's algorithm converges like Newton's method in the neighborhood of an equilibrium. We found that it worked quickly and effectively.

Benchmark Equilibrium

Table 2 gives the benchmark equilibrium we computed. It is not directly comparable to Mexican prices in the base period 1976-77 (which in our price normalization are unity) since we used current value-added taxes rather than the old sales tax. For comparative purposes, we give the prices computed by Serra-Puche for the new tax system. As can be seen, the two sets of prices are quite close. Our inclusion of a financial sector does lead to minor differences in the predicted effect of the sales tax.

Table 2. Benchmark Equilibrium Prices

Intermediate Goods	Base Simulation	Serra-Puche	% Discrepency
1. Agriculture	1.075	1.065	0.9
2. Mining	.993	1.006	-1.3
3. Petroleum	.899	.889	1.1
4. Food	1.027	1.015	1.2
5. Textiles	1.032	1.021	1.1
6. Wood	1.000	1.000	0.0
7. Chemical	.941	.947	0.6
8. Non-metal	.990	.996	0.6
9. Machinery	.962	.961	0.1
10. Electricity	.981	.983	0.2
11. Commerce	1.102	1.072	2.8
12. Transportation	1.016	1.013	0.3
13. Services	1.059	1.038	2.0
14. Construction	1.022	1.008	1.4
15. Imports	.895	.889	0.7
16. Next Period Capital	27.436	.994	na
Final Goods			
1. Bread	1.073	1.034	3.8
2. Milk	1.096	1.052	4.2
3. Groceries	1.005	.969	3.7
4. Fruit	1.114	1.067	4.4
5. Meat	1.066	1.028	3.7
6. Fish	1.086	1.044	4.0
7. Beverages	.963	.925	4.1
8. Clothing	1.047	1.020	2.6
9. Furniture	.999	.979	2.0
10. Electronics	.973	.952	2.2
11. Medical	.980	.960	2.1
12. Transportation	.873	.870	0.3
13. Education	1.037	1.016	2.1
14. Personal	1.001	.981	2.0
15. Services	1.017	1.000	1.7

Table 2. (cont'd.)

Factors	Base Simulation	Serra-Puche	% Discrepency
1. Rural labor	1.000	1.057	5.7
2. Urban labor	1.000	1.028	2.8
3. Capital	28.259	1.093	na
4. Money	.0238	na	na

4. Proposed Policy Experiments

The major purpose of constructing a general equilibrium model is to trace the differential effects between sectors of policy changes. The model we have constructed is oriented largely towards analyzing changes in monetary policy. Two types of monetary policies are of interest.

General monetary policies are policies designed to affect overall economic activity. They include alteration in the rate of growth of the money base, changes in the tax level or in government spending, and changes in the composition of national debt. Our model is not the ideal one for analyzing the overall effects of these policies: a smaller, more detailed model calibrated on time series data would probably be better. However, general policies also have sector-specific effects. For example, changes in the composition of the national debt may displace private investment. This has two effects. It may change overall activity -- GNP -- and it can change sector proportions depending on capital intensities and interactive income effects. We argue that a general equilibrium model of the type we have constructed offers the best hope of understanding intersectoral shifts.

A second type of monetary policy, of particular importance in a country such as Mexico, are specific monetary policies. These attempt to separately influence the supply of funds to different sectors and primarily take the form of selective credit controls. Whether these policies have the desired effect -- increasing agricultural activity in Mexico, for example -- depends on whether the effect of the implicit tax or subsidy can be shifted. This can be answered only by a general equilibrium model.

Footnotes

1. A good source of history and institutional detail circa 1960 is Dwight Brothers and Leopoldo Solis M., *Mexican Financial Development* (University of Texas Press, 1966).

2. See Banco de Mexico, *Moneda y Banca* (Marzo 1979), "Tasas de Reserva Bancaria Obligatoria: Bancos Multiples," page 87.