# A General Equilibrium Model of Domestic Commerce in Mexico

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In this paper we develop a general equilibrium model of the Mexican economy that focuses on the commercial sector, particularly retailing. Consumers purchase goods in different retail establishments, that sell differentiated goods at different prices. Where each consumer decides to make purchases depends on various price and locational considerations. The model has been calibrated to replicate the Mexican economy in 1977, the latest year for which a complete data set is available. We use it to analyze both the impact of the 1980 fiscal reform, a major policy change for the economy as a whole, and that of a hypothetical development project aimed specifically at the commercial sector. Although our model was conceived and developed well prior to the current period of highly inflationary policies of the debt crisis, the latter was taken into consideration during both the simulations and their policy evaluation.

## 1. INTRODUCTION

Commerce is a neglected subject in economics. Development projects geared to agriculture, industry, and transportation are often implemented with little or no regard for their marketing or commercial impacts. These impacts may be crucial, however, for the proper evaluation of policy. In Mexico specifically, the commercial sector, wholesaling and retailing, generates more than one-fourth of value added. The current economic crisis that Mexico is experiencing has led the government to reduce its deficit as a proportion of GDP. There are numerous ways of achieving a given target of deficit reduction. The medium- and long-run effects may vary widely across different government policies. In particular, policies

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that cut subsidies and transfers should be studied for their effects on income distribution. The model presented in this paper is intended as a tool for the analysis of the incidence of commercial subsidies and government retailing activities. We develop a general equilibrium model of the Mexican economy that focuses on the commercial sector, particularly retailing. The model is then used to analyze both the impact of the 1980 fiscal reform, a major policy change for the economy as a whole, and that of a hypothetical development project aimed specifically at the commercial sector.

The need for a general equilibrium framework in this context should be clear. The huge size of the commercial sector and its degree of integration with the rest of the economy makes any other approach unattractive. On one hand, any major policy decision is certain to have a significant impact on the commercial sector. On the other, any policy decision designed to affect the commercial sector is certain to have spillover effects on the rest of the economy, which in turn feed back into the commercial sector.

The ultimate goal of this work is the construction of a programming model that can be used to analyze the impact on resource allocation and income distribution of government price control policies and of policies to promote modernization of the commercial sector. The present model is intended as a step in this direction. The underlying framework is that of a general equilibrium model similar to that described by Serra-Puche (1983) and Kehoe and Serra-Puche (1983a). The specification of the commercial sector is what distinguishes this model from previous work. Markets in general equilibrium models (and in economic theory in general) are typically composed of consumers on one side and producers on the other. In reality, the commercial sector plays a crucial role of intermediation between these two groups. In this model, consumers purchase goods in different retail establishments that sell differentiated goods at different prices. There are an infinite number of consumers distributed continuously (but not uniformly) over a bounded region in the plane. There is also a number of heterogeneous retail establishments located in this region. Where each consumer decides to make purchases depends on various price and locational considerations.

In the subsequent sections we describe the structure of the model, focusing particularly on the role of the commercial sector. We characterize an equilibrium of the model and briefly describe the computational procedure used to find it. We then describe how the model has been calibrated to replicate the Mexican economy in 1977, the latest year for which a complete data set is available. Next, we use the model to analyze the impact of two different sets of policy changes on the economy as a whole and the commercial sector in particular. Finally, we discuss the usefulness of this type of modeling exercise. We compare the specification of the model with the institutional aspects of commerce in Mexico, analyze the shortcomings of the model in terms of both specification and data, and point out directions for future research.

## 2. PRODUCTION

There are 61 goods in the model: 21 production sectors, 8 commercial sectors, 3 sectors of nonconsumption demand (government services, exports, and investment), 26 consumption goods, and 3 factors of production. The aggregation that we follow has been chosen with an emphasis on commerce in mind. A distinction is drawn between alcoholic and nonalcoholic beverages, for example, since they are often sold by different types of commercial establishments and face different sales tax rates and markups. In contrast, services are not disaggregated, because such a disaggregation would not be particularly relevant to a study of domestic commerce.

Each of the first 58 goods is produced by a constant-returns production activity that employs the other produced goods as intermediate inputs. In addition, the first 30 goods, the production sectors, the commercial sectors, and government services, employ the final three goods as factors of production. Intermediate inputs enter the specification of the production function in fixed coefficients form. Value added is produced by the three factors of production with the possibility of substitution governed by a Cobb–Douglas production function that differs from sector to sector. The advantage of this specification is that it allows us to use an input–output matrix to describe the intermediate transactions in production.

The 58 × 58 input–output matrix is of the form

$$B = \begin{bmatrix} A & -Z \\ 0 & D \end{bmatrix}. \tag{1}$$

Here, $A$ is a 32 × 32 input–output matrix that dictates intermediate transactions for the production sectors, commercial sectors, and non-consumption demand sectors. $Z$ is a 32 × 26 matrix that converts demand for consumption goods into demand for production goods. $D$ is a 26 × 26 matrix with total consumption of the consumption goods on the diagonal and zeros elsewhere.

$Z$ and $D$ serve to transform the aggregation of outputs from the first 32 sectors into a 26 good aggregation of consumption goods. The use of such a conversion matrix $Z$ is a standard device in applied general equilibrium modeling (see, for example, Fullerton, King, Shoven, and Whalley 1981). The conversion matrix serves as a black box, with production goods going

**Table 1:** List of Sectors

**Production**

1. Agriculture
2. Livestock
3. Forestry
4. Fishing
5. Mining
6. Petroleum and petrochemicals
7. Alcoholic beverages
8. Nonalcoholic beverages
9. Tobacco
10. Food products
11. Textiles
12. Wood products
13. Chemical products
14. Nonmetal production
15. Basic metals
16. Machinery
17. Automobiles
18. Electric energy
19. Transportation
20. Services
21. Construction

**Commerce**

22. Wholesalers
23. Public markets
24. Grocery stores
25. Conasupo
26. Supermarkets
27. Specialty stores
28. Department stores
29. Other retailers

**Nonconsumption Demand**

30. Government services
31. Imports–exports
32. Fixed investment and inventory accumulation

**Consumption Demand**

33. Bread
34. Tortillas
35. Cereals
36. Milk and milk products
37. Eggs
38. Other groceries
39. Fresh fruits
40. Fresh vegetables
41. Meat
42. Fish
43. Nonalcoholic beverages
44. Alcoholic beverages
45. Tobacco and tobacco products
46. Clothing
47. Shoes and shoe repair
48. Furniture and accessories
49. Household fabrics
50. Household appliances
51. Glassware and dishware
52. Medical products
53. Automobiles, parts, and repairs
54. Transportation
55. Household accessories
56. Educational articles
57. Articles for personal care
58. Services

**Factors of Production**

59. Rural labor
60. Urban labor
61. Capital and other factors

in and consumption goods coming out in fixed proportions. When a consumer buys furniture, for example, she is buying outputs from the textiles, wood products, chemical products, nonmetal production, and machinery sectors in fixed proportions given by the relevant entries in $Z$. She is also simultaneously purchasing commercial services, in the form of a markup, from some retail sector. Typically, some of the largest elements in $Z$ are those in the row, or rows, corresponding to the commercial sector. We have chosen to remove these elements from $Z$, however. As we shall explain, the present model makes the amounts of commercial services purchased from different retail sectors vary with prices and incomes rather than remain fixed in proportion to consumption.

## 3. CONSUMPTION AND COMMERCE

There are 12 consumer groups in the model. Two of them, the government and the foreign sector, are discussed in the next section. The other 10 represent aggregates of households in the Mexican economy and are divided into 5 income groups in both the urgan and the rural sector. Each of these consumer groups is endowed with stocks of capital and labor. Urban and rural labor are considered to be separate factors of production. Because we lack information on the spatial distribution of rural consumers and retail markets, we have decided to model demand in the rural sector in a different manner from that used for the urban sector: while consumer spending patterns by establishment vary in the urban sector, they are fixed in the rural sector. This convention is consistent with a hypothesis that tradition, more than economic factors, determines rural spending patterns.

Each of the five rural consumer groups can be thought of as a single consumer whose demand functions are derived by solving the problem of maximizing a utility function subject to a budget constraint. The income of a rural group is the value of its initial endowment net of income tax.

$$Y^h = (p_{59}w_{59} + p_{61}w_{61})(1 - i^h). \tag{2}$$

Here, $p_{59}$ and $p_{61}$ are the prices, and $w_{59}$ and $w_{61}$ the initial endowments of rural labor and capital; $i^h$ is the income tax rate faced by consumer $h$. This income is used to finance the purchase of a consumption bundle made up of goods 33 through 58 in the model. In addition, the consumer saves a constant fraction of income, which, in effect, becomes a purchase of the investment good 32. All goods but four, the investment good, automobiles, transportation, and services, and purchased from one of the seven types of retail establishments in our model. Purchasing a good from a retailer involves purchasing an amount of services from that retailer proportional to his commercial markup. In addition, the consumer pays a sales tax

**Table 2:** List of Consumers

| Net Household Income in Pesos per Month ($23 1977 Mex. = $1 1977 U.S.) |
|---|
| 1. Urban poor ($0–1800) |
| 2. Rural poor ($0–1800) |
| 3. Urban low income ($1801–3150) |
| 4. Rural low income ($1801–3150) |
| 5. Urban low–middle income ($3151–5725) |
| 6. Rural low–middle income ($3151–5725) |
| 7. Urban middle–income ($5726–13,400) |
| 8. Rural middle–income ($5726–13,400) |
| 9. Urban upper income ($13,401–) |
| 10. Rural upper income ($13,401–) |
| 11. Government |
| 12. Foreign sector |

proportional to the final price of the production. Thus, the final amount paid by a consumer for good $i$ sold by retail sector $j$ is the following:

$$\pi_{ij} = (p_i + m_{ij} pr_j)(1 + cf_i). \tag{3}$$

Here, $p_i$ is the producer price of good $i$; $m_{ij}$ is the physical markup on good $i$ in retail sector $j$ expressed in units of commercial services; $pr_j$ is the price index for that sector's services, which is determined by production costs, and $cf_i$ is the ad valorem tax rate on purchases of good $i$.

In the rural sector the proportion of spending in retail sector $j$ done by consumer $h$ on good $i$ is assumed to remain fixed. Let us denote this proportion as $\beta^h_{ij}$ where $\beta^h_{ij} > 0$ and $\Sigma^7_{j=1}\, \beta^h_{ij} = 1$. The utility function of the consumer is assumed to be Cobb–Douglas, which implies a constant proportion of income spent on each good. The demand functions are derived by maximizing this utility function subject to the income constraint (2). Letting the income proportions be denoted $\alpha^h_i$, $i = 32, \ldots, 58$, we can express the demand of consumer $h$ for good $i$ in sector $j$ as

$$x^h_{ij} = \alpha^h_i \beta^h_{ij} \frac{Y^h}{\pi_{ij}}. \tag{4}$$

The total demand for good $i$ is then

$$x^h_i = \alpha^h_i Y^h \left( \sum_{i=1}^{7} \frac{\beta^h_{ij}}{\pi_{ij}} \right), \tag{5}$$

while the induced demand for the commercial services of retail sector $j$ is

$$x_j^h = Y^h \sum_{i=33}^{58} \alpha_i^h \beta_{ij}^h \frac{m_{ij}}{\pi_{ij}} \quad (6)$$

The demand for those four goods not sold by retail establishments is simply

$$x_i^h = \alpha_i^h \frac{Y^h}{p_i(1 + cf_i)} . \quad (7)$$

This form of demand for commercial services could easily be incorporated into the fixed coefficients framework of the conversion matrix $Z$ if the portions $\beta_{ij}^h$ were equal across households, that is, if each household spent the same proportion of its total spending on good $i$ in sector $j$. (In fact, these proportions are not equal.) In such a situation, the entry in row $j$ and column $i$ in $Z$ would be $\beta_{ij} m_{ij} d_{ii}$. Here, $d_{ii}$ is the corresponding diagonal element of $D$, which denotes total consumption of good $i$. In other words, $\beta_{ij} m_{ij}$ units of commercial services from sector $j$ would have to be purchased with each unit of good $i$.

The demand functions for the five urban consumer groups differ from those above in that the proportions $\beta_{ij}^h$ are endogenous; that is, they change with relative prices. Actually, because of lack of information, only the proportions relating to public markets, grocery stores, Conasupo establishments, supermarkets, and department stores vary. (Conasupo is a government agency that runs a system of retail establishments.) The proportions for specialty stores and other retailers remain fixed. The model considers each of the consumer groups as an infinite number of consumers continuously distributed over a bounded region in the plane. The population distribution is not, however, assumed to be uniform. The number of retail establishments is small, but the relative proportion of each type is that observed in large urban areas. Similarly, the location of establishments in relation to the population distribution of the different income groups is intended to model the relative location of establishments in Mexico City.

Given this locational structure, each of the infinite number of consumers can be thought of as deciding on where to purchase his consumption bundle. Once again, the consumption bundle is chosen to maximize a Cobb–Douglas utility function. Now, however, the choice of establishment varies with location. The prices of goods vary across establishments because of different markups. In a later version of the model, we intend them to also vary because of different access to wholesale operations by different retailers. Currently, each retailer is assumed to pay wholesalers the same amount for each good. The consumer must decide in which establishment to purchase each type of good. In doing so, she must take into account not only price differentials but also convenience costs and transportation costs. If we could solve the problem of establishment choice for each consumer, we could determine the market area for each establishment by good. The establishment shares $\beta_{ij}^h$ could then be determined by integrating over the population distribution of consumer group $h$ in the market areas of the establishments of type $j$ for good $i$.

Unfortunately, although this procedure is simple enough conceptually, it is impossible to carry out analytically unless the model is drastically simplified. This could be done, for example, by assuming that the region in the plane is a line segment or a circle or that all establishments are identical. Since this type of simplification would defeat the purpose of the model, we have chosen another direction. Rather than attempt an analytical solution to the problem of consumer choice, we use numerical integration to approximate the solution.

The region under consideration is chosen to be a square that is subdivided into a grid of much smaller squares. In our computations we work with a $10 \times 10$ grid. The midpoint of each square in the subdivision is taken to represent the location of the population of the entire square. This midpoint has a population density associated with it for each consumer group. The idea now is to determine the establishment choice of each of the consumer groups at each of the midpoints of the squares in the subdivisions. By weighing the choices by the respective population densities and then summing we obtain the proportions $\beta_{ij}^h$.

In our specification of demand, we distinguish among three types of goods, convenience goods, shopping goods, and specialty goods. This classification scheme has been used in the marketing literature since Copeland (1923); see Bellenger and Greenberg (1977) for a recent critique of this scheme. Convenience goods are those articles that consumers wish to buy with a minimum of effort, usually carrying a low unit price. Price differentials among convenience goods are small and markups tend to be slim. They are items bought regularly. Shopping goods, on the other hand, are goods that consumers purchase after carefully comparing on the basis of availability, cost, quality, and so on. They tend to be goods with larger unit costs and goods that are purchased less frequently. Specialty goods are goods for which many consumers are habitually willing to make an effort to purchase in a specific type of establishment. They tend to be goods that are highly differentiated across establishments.

**Table 3:** Classification of Goods

| | | |
|---|---|---|
| | **Convenience Goods** | |
| Bread | Tortillas | Cereals |
| Milk | Eggs | Other groceries |
| Nonalcoholic beverages | Alcoholic beverages | Tobacco |
| Articles for personal care | | |
| | **Shopping Goods** | |
| Fresh fruits | Fresh vegetables | Clothing |
| Furniture | Household fabrics | Household appliances |
| Glass and dishware | Medical products | Household accessories |
| Educational articles | | |
| | **Specialty Goods** | |
| Meat | Fish | Shoes and shoe repair |

We do not attempt to explain purchases of specialty goods: Retail shares corresponding to these goods remain fixed. To purchase convenience goods and shopping goods, the consumer can go on a shopping trip to a public market, Conasupo, supermarket, or department store. On any shopping trip she incurs a single fixed transportation cost. In contrast, when a consumer makes purchases at a grocery store, she incurs a transportation cost proportional to the amount of her purchase. The idea is that shopping trips are made at regular intervals and involve increasing returns to scale in terms of transportation and search costs relative to purchases. In contrast, trips to the corner grocery store occur as the need arises and are often made for a single item, for example, a loaf of bread or pack of cigarettes. Shopping goods differ from convenience goods in that, while all of a consumer's demand for shopping goods can be purchased on shopping trips, only a fixed percentage of her demand for convenience goods can. A consumer can buy a carton of milk while on a weekly shopping trip to a supermarket, for example, but she has to buy another carton later in the week at the corner grocery store.

The choice made by each of the consumers at each location depends, as we have mentioned, on three factors: price differentials, convenience costs, and transportation costs. The convenience costs are specific to type of establishment and good, and vary among consumer groups. These costs are proportional to the consumer's valuation of her time, which is given by the wage $p_{60}$. The presence of these convenience costs differentiate goods by type of establishment. The cost factor involved in the purchase of good $i$ in establishment of type $j$ by consumer $h$ is the following:

$$tc_{ij}^h = \pi_{ij} + c_{ij}^h p_{60}. \tag{8}$$

In addition, the consumer is subjected to transportation costs of

$$td_{ij}^h = d_j(ta^h p_{53} + tb^h p_{54} + tc^h p_{60}), \tag{9}$$

if she makes purchases at a grocery store. If, however, she makes a shopping trip, then (8) represents the marginal cost of purchasing a good while

$$sd_{ij}^h = d_j(sa^h p_{53} + sb^h p_{54} + sc^h p_{60}) \tag{10}$$

represents the fixed cost of making the shopping trip. Here, $ta^h$, $tb^h$, $tc^h$, $sa^h$, $sb^h$, and $sc^h$ are transportation cost parameters specific to the consumer group, and $d_j$ is the distance of the consumer to the nearest establishment of type $j$.

The problem that faces the consumer is how to formulate a shopping plan that maximizes her utility subject to the budget constraint. This problem could be viewed as a nonlinear integer programming problem. Fortunately, it is easy to solve since there is such a small number of alternatives. The consumer chooses a shopping plan that involves trips to four types of establishments, public markets, Conasupo establishments, supermarkets, and department stores. In choosing among plans, the consumer considers only the nearest establishment of each types. Sixteen alternative plans account for every possible combination of shopping trips. One plan involves making no shopping trips; four plans involve one trip, six plans involve two trips; four plans involve three trips; and one plan involves all four possible trips. If the consumer chooses to make more than one shopping trip, she buys a good at the establishment with the lowest marginal cost (8). To determine the consumer's demand, we evaluate the indirect utility function for each of the 16 shopping plans and choose the plan that yields the highest utility. Having thus determined the consumer demands at each midpoint in the grid for each consumer group, we use the numerical integration procedure described above to determine total demand.

An interesting feature of the above specification is that although the individual demand functions that result are discontinuous, their aggregate is continuous. A small change in prices can induce a consumer to change her shopping plans discontinuously because of the nonconvexity involved in the fixed cost of making a shopping trip. Since consumers are continuously distributed over the region and shopping costs are continuous in distance, however, the integral of all demands can easily be shown to be continuous. This result can be viewed as a simple application of the work that has been done on smoothing by aggregation (see, for example, Sondermann 1980). The idea is that market areas of firms vary continuously with prices.

Even when we resort to a discrete approximation to the continuous distribution of consumers in order to carry out the numerical integration procedure, this discontinuity presents no problem. The aggregate demand function may not be continuous but it is a convex-valued, upper-semi-continuous, point-to-set correspondence if there are an infinite number of consumers at every point (see Starr 1969). In such a situation, if prices are such that a consumer is indifferent between two shopping plans, she does one or the other. The fixed costs of shopping trips make carrying out a convex combination of the two unattractive. In the aggregate, however, convex combinations are possible. A certain proportion of consumers do one, the rest do the other. As the grid becomes finer and finer, the discontinuities caused by a shift in shopping plans at any one square become smaller and smaller relative to aggregate demand. We have found that our $10 \times 10$ grid is fine enough to yield aggregate demand functions that are close to being continuous.

## 4. NONCONSUMPTION DEMAND

The government in this model taxes production, imports, consumer income, and sales. It also earns a return on some of the physical capital that it owns. It uses this revenue to purchase goods and services and to invest. The tax rates used in the model are the effective average tax rates. Any tax evasion is assumed to be neutral, in other words, independent of the source and level of income, as well as of the type of the good. The lack of information about evasion and its distribution makes it difficult to look for nonneutral criteria to distribute the effect of evasion when computing the effective tax rates.

The government differs from other consumers in the model in that it issues endogenously determined debt. In addition, the government acts as a producer in generating a public good, government services, using the 30th column of input–output matrix $B$. These services are bought by the government in its capacity as a consumer. When the government demands these services, it actually demands, through the intermediate requirements of this activity, from every sector of the economy.

Each consumer group $h$, with income $Y^h$, faces an income tax rate $i^h$. The income tax revenue received by the government is

$$I = \sum_{h=1}^{12} i^h Y^h. \tag{11}$$

Prior to the introduction of the value-added tax, in addition to having a general turnover tax rate (*impuesto sobre ingresos mercantiles*), the Mexican tax system had a large number of special taxes applied to specific sectors. Our specification takes full account of this tax system. Let $ci_i$ be the *ad valorem* tax rate paid by the producer of good $i$, $i = 1, \ldots, 32$, on sales. Similarly, let $cf_i$ be the *ad valorem* tax rate paid by consumers of good $i$, $i = 33, \ldots, 58$, on purchases. These tax rates are computed as the weighted sum of taxes on all goods aggregated into good $i$ in the model. The total revenue collected from these taxes is expressed

$$C = \sum_{i=1}^{32} p_i ci_i a_{ii} y_i + \sum_{i=33}^{58} p_i cf_i \sum_{h=1}^{10} x_i^h. \tag{12}$$

Here $a_{ii}$ is a diagonal element of the input–output matrix, $y_i$ is the associated activity level, and $x_i^h$ is the total expenditure on good $i$ by household $h$, including commercial markups. This specification takes into account the cascade effect of the turnover tax system: the total tax is reflected in the final price of the good after going through all the stages of production and commercialization. The more stages the good goes through, the larger is the cascade effect of the tax.

Imports are assumed to be a single homogeneous good. This good is obtained from the export column of input–output matrix $B$, denoted $a_M$. The model has an aggregate tariff that applies to this good when used as an input. All those activities using imports as inputs to the production process face this aggregate tariff. The revenue from taxing imports is expressed

$$T = p_M t_M \sum_{j=1}^{17} |a_{Mj}| y_j. \tag{13}$$

where $a_{Mj}$ is the nonpositive number that denotes use of imports by activity $j$, $j \neq M$. $p_M$ is the price index for the aggregate import good, and $t_M$ is the tariff rate. The government's total tax revenue is the sum

$$R = I + C + T. \tag{14}$$

The composition and level of government expenditures are viewed as independent policy decisions. In the absence of simulated changes, our behavioral assumption is that they stay fixed in real terms. The government can be thought of as maximizing a fixed proportions utility function constrained by a budget constraint of the form

$$Y^G = p_{32} w_{32}^G + p_{61} w_{61}^G + R, \tag{15}$$

where $p_{32}$ and $w_{32}^G$ are the price and the endowment of bonds in the hands of the government, and $w_{61}^G$ is the government's endowment of physical capital. Consumers regard government bonds as perfect substitutes for physical investment when making savings decisions. The government's utility function has only two nonzero coefficients, that for government services and that for investment. An obvious, but probably less realistic alternative to this specification would be to have the government choose an expenditure pattern that maximizes some sort of social welfare function. Since the purpose of this model is to analyze the impact of government policy, however, we have chosen the specification in which government behavior is exogenous.

An interesting feature of the model is that the government may spend more than it receives in revenues. Such a deficit appears endogenously above as a positive endowment of the investment good in government's budget constraint. As the level of government revenue varies, we allow the deficit to adjust so that the level of government expenditures remains fixed. In the computation of the original equilibrium, this endowment is equal to the actual government deficit evaluated in 1977 prices. Even though the focus of this model is on micro issues in the commercial sector, we have found that the treatment of such macro phenomena as government deficits is crucial to our results (see Kehoe and Serra-Puche 1983a). We have, therefore, chosen a specification that we feel has the right trade-off between simplicity and realism.

The specification of the foreign sector in this model is very simplistic. Nevertheless, it captures the structure of the balance of trade and the corresponding capital flow. Imports are a noncompetitive, homogeneous good that is demanded as an intermediate input in the production process. Final consumption of imports is, of course, accounted for within the fixed coefficient structure of the input–output matrix. Similarly, the physical composition of exports is fixed, although this can easily be varied in simulations.

The relationships between exports and imports is given in the 31st column and row of matrix $B$. A coefficient in this row, $a_{Mj}$, represents the physical input of the noncompetitive import per $a_{jj}$ units of output in sector $j$. A coefficient in the column, $a_{iM}$, represents the total exports done by sector $i$, where exports are aggregated within sectors using base year prices. This convention allows the economy to produce imports by exporting goods in fixed proportions. Implicitly, the economy generates foreign exchange that it uses to finance imports. The tax or subsidy rates on the elements of the 31st column represent export taxes or subsidies. The tax rates on the elements of the 31st row represent tariff rates.

We define one more consumer, the rest of the world, who exists only to allow us to explain what happens to the flows that comprise the balance of trade. This consumer can be thought of as demanding exports in fixed proportions, so that the coefficients of the 31st column of matrix $B$ represent his demand function. In return for these exports, he provides an amount of the import good given by the diagonal element of the export column. This consumer is also endowed with an amount of imports that is equal to the actual trade deficit when evaluated in 1977 prices. With this income he invests. Thus, any deficit on the trade account has a corresponding surplus on the capital account.

The trade deficit is determined exogenously. To make it endogenous, we would have to specify the foreign sector in much more detail. Nonetheless, it is possible to use the model to examine the effects of shocks in the foreign sector by simulating changes in the coefficients of the import row and export column of the activity analysis matrix, as well as changes in the exogenous trade deficit.

Although our model is static, we must account for the investment that takes place during the period of analysis. We introduce an activity that produces the investment good. This activity is represented as the 32nd column, $a_V$, of matrix $B$ where $a_{iV}$, $i \neq V$, is a nonpositive number that represents the investment purchases from sector $i$ per $a_{VV}$ units of total investment. Total physical investment in the economy is given by

$$V = S + GI + TD - GD \tag{16}$$

where $S$ is total savings by consumers, $GI$ is government investment, $TD$ is the trade deficit, and $GD$ is the government deficit.

## 5. EXISTENCE AND COMPUTATION OF EQUILIBRIUM

We tie together the components of the model described in the previous three sections by defining the concept of equilibrium. The utility maximizing consumption bundles chosen by consumers vary with prices and incomes, which in turn vary with prices and, in the case of the government, with tax receipts. Consumers' responses to a price vector $p$ and a level of tax receipts $R$ can be aggregated into a vector of excess demand functions $\xi_i(p,R)$, $i = 1, \ldots, 61$. As we have mentioned, $\xi_i$ is continuous, at least for strictly positive price vectors. It is also homogeneous of degree zero in $p$ and $R$. That is, excess demands are not affected if all prices and tax receipts are multiplied by the same positive constant. Let $t(p,R)$ denote total taxes paid by consumers, including taxes on final consumption and income. $t$ is continuous and homogenous of degree one in $p$ and $R$. Moreover, $\xi_i$ and $t$ obey the following version of Walras's law

$$\sum_{i=1}^{61} p_i \xi_i(p,R) + t(p,R) \equiv R, \tag{17}$$

which can be derived by adding up all of the consumers' budget constraints.

Producers demand factors of production in proportions that minimize costs given the Cobb–Douglas production functions for value added in each sector. Let $E(p)$ be the $61 \times 58$ input–output matrix that includes factor demands:

$$E(p) = \begin{bmatrix} A & -Z \\ 0 & D \\ F(p) & 0 \end{bmatrix}. \tag{18}$$

Here, $F(p)$ is the $3 \times 32$ matrix of factor demands that vary with prices. These factor demands are continuous and homogeneous of degree zero in $p$. Define the matrix $\bar{E}(p)$ by the equation

$$\bar{e}_{ij} = e_{ij} - s_{ij}|e_{ij}|. \tag{19}$$

Here, $s_{ij}$ denotes the tax on the sales or purchases of good $i$ by sector $j$; the tax rates $s_{ij}$ include the taxes $ci_i$ and tariff $t_M$ discussed previously. In this notation, $p\bar{E}(p)y$ represents the after-tax profitability of the production plan $E(p)y$ where $y$ is a $58 \times 1$ vector of nonnegative activity levels. The total tax revenue accruing from such a production plan is $p(E(p) - \bar{E}(p))y$.

A vector of prices $p^*$, a tax receipts level $R^*$, and a vector of activity

$$p^*\bar{E}(p^*) = 0. \tag{20}$$

$$\xi(p^*,R^*) = E(p^*)y^*. \tag{21}$$

$$R^* = t(p^*,R^*) + p^*(E(p^*) - \bar{E}(p^*))y^*. \tag{22}$$

$$\sum_{i=1}^{61} p_i^* + R^* = 1. \tag{23}$$

Condition (20) requires that all activities make zero profits after payment of taxes. This is the familiar profit maximization condition for a constant-returns production technology. Condition (21) is the condition that demand equals supply. Condition (22) requires that the level of tax receipts that enters the governments budget be equal to what it actually collects. Condition (23) is only a price normalization that we are permitted by the homogeneity of $\xi$, $t$, and $E$: If ($p^*$, $R^*$, $y^*$) is an equilibrium, then ($\lambda p^*$, $\lambda R^*$, $y^*$) is also for any $\lambda > 0$.

The zero-profit condition implies, among other things, that Conasupo reacts to changes in relative prices in the same profit-maximizing manner as competitive retailers. It is easy to change this specification to one where Conasupo markups are fixed in real terms and profits of losses are absorbed by the government (see Kehoe and Serra-Puche 1983b). For the simulations reported in this paper, however, we use the specification with endogenous markups, since we feel it is more realistic.

An equilibrium of this model can be found using a fixed-point algorithm of the type developed by Scarf (1973). This algorithm can be easily modified to locate an equilibrium of a model with a government that taxes and spends (see Shoven and Whalley 1973). The computation of equilibrium for this model can be drastically simplified by reducing the search for equilibrium to one over the four dimensional space of factor prices and tax receipts. The zero profit condition (20) can be used to determine prices of the first 58 goods as functions of the factor prices. Condition (21) can then be used to compute activity levels and demand for factors (Kehoe and Serra-Puche 1983a). This dimension reduction is essential in making computations of an equilibrium a feasible task. To evaluate the excess demand function requires that demands of each of the 5 urban consumer groups be determined at 100 different locations. To find the demands of each of these 500 different consumers, each of the 16 discrete choices for shopping plans must be examined. It is essential that the number of demand function evaluations be kept as small as possible.

One specification that we use to simplify computation is that the model of consumer behavior presented in the previous section is used only to determine the shares $\beta_{ij}^h$. It is not used to determine induced demands for automobiles and transportation. Thus, although a fall in transportation costs would result in an increased demand for department store services, for example, a decrease in department store markups would not result in an increased demand for transportation. Although this is undoubtedly a shortcoming, it greatly eases the computational burden. The computation of an equilibrium for this model usually takes between 3 and 5 minutes of CPU time on an IBM 370/168.

## 6. DATA AND CALIBRATION

There are more than 7000 nonzero parameters involved in the specification of the model. They have been derived from observations of the Mexican economy in 1977 and have been carefully calibrated to replicate the economy in that year.[1]

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[1] The principal published sources of data used for the model are listed below:

*Censo Comercial, Año 1975.* (1977) Mexico City: Secretaría de Programación y Presupuesto.

The production side of the economy has been specified using the input–output matrix of Mexico for 1970. Using the RAS method, we have updated it to 1977. A comparison between the RAS version of the 1970 matrix and an RAS version of the 1975 matrix, both for 1977, does not indicate any great discrepancies in the coefficients. Rather than indicating an absence of structural change in the Mexican economy, however, this most likely indicates a paucity of fresh information in the 1975 matrix. The intermediate demands are derived from the interindustry transactions of the input–output table. The disaggregation of transactions of the commercial sector into those of wholesalers and retailers has been obtained from unpublished worksheets of the Sistema de Cuentas Nacionales de la Dirección General de Estadística in the Secretaria de Programación y Presupuesto. Transactions information for Conasupo has been obtained directly from that agency. The disaggregation for other retail sectors has been done using the commercial census as a guide. The reader should be warned, however, that this disaggregation is a weakness of the current version of the model.

The value-added parameters, required for the computation of the demand for primary factors, have been computed under the assumption of profit maximization. The elasticity of substitution between factors has been assumed to be one in every sector, due to the lack of reliable estimates. This leads to the Cobb–Douglas specification for all the production functions described earlier. Results of sensitivity tests on these elasticities in a similar model are given in Serra-Puche (1979).

The demand side of the economy has been obtained from the household survey of Mexico for 1977. The demand parameters $\alpha_i^h$ are the shares of expenditure on good $i$ by consumer $h$ observed in the survey, adjusted so as to have the market demands equal to the final consumption column in the input–output matrix. The initial endowments of the consumer groups have also been adjusted to equal the value added figures in the national accounts. Similarly, the shares of expenditure on good $i$ by consumer $h$

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*Encuesta Nacional de Ingresos y Gastos Familiares en 1977.* (1980) Mexico City: Secretaría de Programación y Presupuesto.

*Indicadores Tributarios.* (1978) Mexico City: Secretaría de Hacienda y Crédito Publico.

*Información Económica: Producto Interno Bruto y Gasto, 1970–1979.* (1980) Mexico City: Banco de México, S.A.

*Matriz de Insumo-Producto de México, Año 1970.* (1976) Volume I. Mexico City: Secretaría de Programación y Presupuesto.

*Plano Mercadológico del Area Metropolitana de la Ciudad de México.* (1978) Mexico City: Buró de Investigación de Mercados, S.A.

*Submatriz de Consumo Privado por Objeto del Gasto y Rama de Actividad de Origen, Año 1970.* (1980) Mexico City: Secretaría de Programación y Presupuesto and Banco de México, S.A.

done in establishment type $j$, $\beta^h_{ij}$, are those observed in the survey adjusted to be consistent with the input–output figures. Much of the information on price differentials, markups, and commercial establishment location has been obtained from the Subgerencia de Precios, Encuestas, y Metodologías of the Banco de México. Further information on location of establishments and location of consumers by income group has been obtained from a map of Mexico City and an accompanying booklet published by a private consulting firm, Buró de Investigación de Mercados.

The parameters for convenience and transportation costs that determine the consumers' shopping plans have been painstakingly calibrated to be consistent with both the locational information for consumers and establishments and the expenditure proportions reported in the household survey. Fixing prices at their benchmark levels, we vary the cost and convenience parameters until the shares $\beta^h_{ij}$ that emerge from computation of aggregate demand are equal to the values derived from the consumer expenditure survey. The values thus derived for these parameters are encouragingly plausible. For example, the parameters that dictate the maximum proportion of expenditure on a convenience good that can be made while on a shopping trip increase monotonically with consumer income. This proportion goes from 0.2930 for the urban poor to 0.3059, to 0.4506, to 0.5500, to 0.6166 for the urban upper income group. This is consistent with the observation that poorer consumers, without access to automobiles and refrigerators that allow large shopping trips, tend to make more frequent purchases of perishable commodities than do more affluent consumers.

The information on the government activity is taken from the input–output matrix, including the value-added parameters. To obtain tax information we have carefully aggregated the actual tax rates so as to match our aggregation. Our original specification includes the turnover tax and the special taxes specific to particular goods. The tax that each good in our model faces is a weighted average of effective rates. Once the correct aggregation has been done, we compute effective tax rates by finding the turnover tax and the special tax rates that yield the actual government revenue in 1977. We assume neutrality of tax evasion within the sector or aggregate good. The income tax rates are effective rates derived while keeping the whole income tax structure unchanged. Here, evasion is again assumed to be neutral across consumers and independent of the income source. The tariff and the export taxes are computed by finding the rates that yield the actual revenues, without too many complications, since imports are a single homogeneous good and all exports face the same tax rate. The foreign sector information only requires the trade deficit of Mexico for 1977, which is consistent with the rest of the variables. We also take into account the governments deficit in 1977 which, as mentioned, is included in the government's vector of endowments in the entry that corresponds to the investment good.

Units have been normalized so that all market prices and activity levels should be one. Computation yields a price vector whose elements are indeed equal to one to six significant digits. Similarly, all activity levels are also one and yield the correct tax revenue. The revenue from indirect taxation, sales taxes, and import tariffs is identical to the actual revenue observed in Mexico in 1977 (123,430 million 1977 pesos). Income tax revenue is also identical to the actual revenue (93,386 million 1977 pesos). Consequently, total government revenue from taxation computed by the model (216,816 million 1977 pesos) is identical to the total tax revenue actually observed. In fact, the model has been calibrated so that the values of all major macroeconomic variables coincide exactly with those actually observed.

## 7. RESULTS OF SIMULATIONS

In this section, we use two comparative statics exercises to illustrate potential uses of the model. In the first, we simulate the introduction of the 1980 fiscal reform in Mexico. This is a major policy change for the economy as a whole. We are particularly interested in its impact on the commercial sector. In the second, we simulate a subsidy policy aimed at the commercial sector. Here, we are interested in the spillover effects on the rest of the economy.

After changing the parameters of the model, we compute a new equilibrium. We then compare the new equilibrium with the benchmark, focusing on changes in prices, activity levels, patterns of consumption, and utility indices. In general, it is difficult to ensure that this type of model has a unique equilibrium (Kehoe 1982). Using a technique described by Kehoe and Whalley (1982), however, we have carried out an exhaustive search to verify that the equilibrium of a more aggregated version of this model is indeed unique.

The fiscal reform of 1980 converted a turnover tax system into a consumption value-added tax system. We introduce this change into the model by eliminating all taxes on intermediate production and adjusting tax rates on final demand. In both systems, a tariff rate of 8.4263% is applied to imports. A value-added tax rate of 10% is applied to final purchases of all commodities with several notable exceptions: All purchases of agricultural produce are exempt. Similarly, purchases of

**Table 4:** Indirect Taxes

| Sector | Turnover Tax | Value-Added Tax | Sector | Turnover Tax | Value-Added Tax |
|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 30 | 0.0 | 0.0 |
| 2 | 0.002082 | 0.0 | 31 | 0.123184 | 0.0 |
| 3 | 0.014378 | 0.0 | 32 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 33 | 0.006784 | 0.0 |
| 5 | 0.043061 | 0.008781 | 34 | 0.006779 | 0.0 |
| 6 | 0.148888 | 0.052064 | 35 | 0.006847 | 0.0 |
| 7 | 0.207627 | 0.0 | 36 | 0.003076 | 0.0 |
| 8 | 0.000951 | 0.0 | 37 | 0.003071 | 0.0 |
| 9 | 0.000840 | 0.0 | 38 | 0.007185 | 0.0 |
| 10 | 0.024850 | 0.0 | 39 | 0.0 | 0.0 |
| 11 | 0.028569 | 0.0 | 40 | 0.0 | 0.0 |
| 12 | 0.038372 | 0.0 | 41 | 0.007932 | 0.0 |
| 13 | 0.052950 | 0.0 | 42 | 0.004612 | 0.0 |
| 14 | 0.034242 | 0.0 | 43 | 0.148900 | 0.181771 |
| 15 | 0.061501 | 0.0 | 44 | 0.117852 | 0.212269 |
| 16 | 0.037199 | 0.0 | 45 | 0.595531 | 0.552328 |
| 17 | 0.084865 | 0.0 | 46 | 0.022664 | 0.090158 |
| 18 | 0.039964 | 0.0 | 47 | 0.022520 | 0.090158 |
| 19 | 0.014384 | 0.0 | 48 | 0.038250 | 0.090158 |
| 20 | 0.017821 | 0.0 | 49 | 0.023334 | 0.090158 |
| 21 | 0.015468 | 0.0 | 50 | 0.070189 | 0.090158 |
| 22 | 0.0 | 0.0 | 51 | 0.043209 | 0.090158 |
| 23 | 0.0 | 0.0 | 52 | 0.045248 | 0.090158 |
| 24 | 0.0 | 0.0 | 53 | 0.269857 | 0.236300 |
| 25 | 0.0 | 0.0 | 54 | 0.0 | 0.090158 |
| 26 | 0.0 | 0.0 | 55 | 0.054504 | 0.090158 |
| 27 | 0.0 | 0.0 | 56 | 0.014721 | 0.0 |
| 28 | 0.0 | 0.0 | 57 | 0.033908 | 0.090158 |
| 29 | 0.0 | 0.0 | 58 | 0.032731 | 0.041345 |

educational materials and professional services are exempt. Transactions that occur on the border are taxed at a rate of 6%; we take this into account by averaging the two tax rates using 1977 expenditure weights. Finally, some special taxes, particularly those on purchases of alcoholic beverages, soft drinks, tobacco, and automobiles, remain in effect. Most other special taxes, particularly those on exports, have been abolished. The results are reported in Table 5 along with results of the same simulation of a similar model where proportions of consumer expenditures by establishment remain fixed. The prices reported are producer prices, net of markups and indirect taxes.

**Table 5:** Producer Prices and Activity Levels (urban wage = numeraire)

| | Fiscal Reform Fixed Proportions | | Fiscal Reform Endogenous Proportions | | Commercial Subsidies | |
|---|---|---|---|---|---|---|
| Sector | Price | Activity Level | Price | Activity Level | Price | Activity Level |
| 1 | 0.9744 | 1.0193 | 0.9714 | 1.0162 | 1.0097 | 1.0251 |
| 2 | 0.9727 | 1.0252 | 0.9699 | 1.0242 | 1.0077 | 1.0209 |
| 3 | 0.9595 | 1.0160 | 0.9567 | 1.0160 | 1.0068 | 0.9976 |
| 4 | 0.9504 | 1.0322 | 0.9475 | 1.0317 | 0.9971 | 1.0298 |
| 5 | 0.9367 | 1.0137 | 0.9343 | 1.0153 | 1.0011 | 0.9721 |
| 6 | 0.8862 | 1.0273 | 0.8849 | 1.0285 | 1.0072 | 0.9963 |
| 7 | 0.7731 | 1.0300 | 0.7713 | 1.0305 | 0.9986 | 1.0489 |
| 8 | 0.9645 | 0.9802 | 0.9625 | 0.9914 | 0.9953 | 1.0547 |
| 9 | 0.9720 | 1.0363 | 0.9697 | 1.0357 | 1.0025 | 1.0388 |
| 10 | 0.9515 | 1.0280 | 0.9490 | 1.0270 | 1.0027 | 1.0271 |
| 11 | 0.9528 | 0.9768 | 0.9508 | 0.9770 | 1.0019 | 1.0050 |
| 12 | 0.9316 | 1.0127 | 0.9296 | 1.0119 | 0.9975 | 0.9969 |
| 13 | 0.8892 | 1.0090 | 0.8973 | 1.0109 | 0.9915 | 1.0061 |
| 14 | 0.9277 | 1.0119 | 0.9256 | 1.0133 | 1.0001 | 0.9668 |
| 15 | 0.8998 | 1.0130 | 0.8978 | 1.0148 | 0.9962 | 0.9653 |
| 16 | 0.9176 | 1.0158 | 0.9158 | 1.0178 | 0.9953 | 0.9914 |
| 17 | 0.8384 | 1.0507 | 0.8364 | 1.0526 | 0.9875 | 0.9801 |
| 18 | 0.9258 | 1.0134 | 0.9240 | 1.0137 | 1.0065 | 1.0011 |
| 19 | 0.9500 | 0.9839 | 0.9481 | 0.9838 | 1.0034 | 0.9998 |
| 20 | 0.9679 | 1.0170 | 0.9659 | 1.0175 | 1.0090 | 1.0018 |
| 21 | 0.9404 | 1.0106 | 0.9384 | 1.0123 | 0.9949 | 0.9381 |
| 22 | 0.9939 | 1.0121 | 0.9916 | 1.0135 | 0.9240 | 0.9787 |
| 23 | 0.9780 | 1.0225 | 0.9759 | 1.0510 | 0.8348 | 0.9153 |
| 24 | 1.0008 | 0.9981 | 0.9981 | 0.9773 | 0.9275 | 1.1517 |
| 25 | 0.9850 | 1.0373 | 0.9828 | 0.9493 | 1.0120 | 1.4843 |
| 26 | 0.9956 | 1.0122 | 0.9933 | 1.0248 | 1.0149 | 0.8664 |
| 27 | 0.9950 | 0.9859 | 0.9926 | 0.9857 | 1.0156 | 1.0060 |
| 28 | 0.9970 | 0.9905 | 0.9948 | 1.0350 | 1.0149 | 0.9413 |
| 29 | 0.9988 | 1.0639 | 0.9962 | 1.0638 | 0.9706 | 1.0186 |
| 30 | 0.9778 | 1.0000 | 0.9766 | 1.0000 | 0.9989 | 1.0000 |
| 31 | 0.8287 | 1.0147 | 0.8267 | 1.0162 | 0.9945 | 0.9727 |
| 32 | 0.9252 | 1.0106 | 0.9231 | 1.0123 | 0.9866 | 0.9381 |
| 33 | 0.9566 | 1.0318 | 0.9540 | 1.0215 | 1.0042 | 1.0172 |
| 34 | 0.9566 | 1.0336 | 0.9540 | 1.0301 | 1.0042 | 1.0324 |
| 35 | 0.9566 | 1.0223 | 0.9540 | 1.0200 | 1.0042 | 1.0346 |
| 36 | 0.9647 | 1.0226 | 0.9620 | 1.0176 | 1.0058 | 1.0352 |
| 37 | 0.9647 | 1.0220 | 0.9620 | 1.0196 | 1.0058 | 1.0427 |
| 38 | 0.9559 | 1.0319 | 0.9533 | 1.0313 | 1.0038 | 1.0350 |
| 39 | 0.9744 | 1.0175 | 0.9714 | 1.0121 | 1.0097 | 1.0464 |

*(continued)*

**Table 5:** *(continued)*

| Sector | Price | Activity Level | Price | Activity Level | Price | Activity Level |
|---|---|---|---|---|---|---|
| 40 | 0.9744 | 1.0115 | 0.9714 | 1.0018 | 1.0097 | 1.0555 |
| 41 | 0.9529 | 1.0391 | 0.9504 | 1.0392 | 1.0030 | 1.0481 |
| 42 | 0.9510 | 1.0392 | 0.9483 | 1.0395 | 0.9999 | 1.0370 |
| 43 | 0.9639 | 0.9800 | 0.9619 | 0.9912 | 0.9956 | 1.0557 |
| 44 | 0.7731 | 1.0312 | 0.7713 | 1.0316 | 0.9986 | 1.0553 |
| 45 | 0.9720 | 1.0389 | 0.9697 | 1.0379 | 1.0025 | 1.0469 |
| 46 | 0.9528 | 0.9608 | 0.9508 | 0.9612 | 1.0019 | 1.0138 |
| 47 | 0.9505 | 0.9623 | 0.9485 | 0.9621 | 1.0016 | 1.0116 |
| 48 | 0.9154 | 0.9970 | 0.9135 | 0.9992 | 0.9953 | 1.0314 |
| 49 | 0.9494 | 0.9648 | 0.9475 | 0.9674 | 1.0013 | 1.0142 |
| 50 | 0.9172 | 1.0304 | 0.9153 | 1.0303 | 0.9955 | 1.0546 |
| 51 | 0.9201 | 1.0097 | 0.9181 | 1.0097 | 0.9975 | 1.0486 |
| 52 | 0.8899 | 1.0176 | 0.8880 | 1.0263 | 0.9916 | 1.0419 |
| 53 | 0.9125 | 1.1217 | 0.9105 | 1.1216 | 0.9922 | 1.0207 |
| 54 | 0.9500 | 0.9622 | 0.9481 | 0.9619 | 1.0034 | 1.0099 |
| 55 | 0.9180 | 1.0178 | 0.9161 | 1.0244 | 0.9957 | 1.0242 |
| 56 | 0.9316 | 1.0546 | 0.9296 | 1.0286 | 0.9975 | 1.0358 |
| 57 | 0.9246 | 0.9983 | 0.9226 | 0.9948 | 0.9994 | 1.0392 |
| 58 | 0.9643 | 1.0191 | 0.9623 | 1.0190 | 1.0085 | 1.0043 |
| 59 | 0.9058 | | 0.9011 | | 0.9806 | |
| 60 | 1.0000 | | 1.0000 | | 1.0000 | |
| 61 | 1.0066 | | 1.0038 | | 1.0247 | |

There are significant differences between the results of the simulation with fixed proportions and that with endogenous proportions. When proportions are endogenous, for example, some of the largest changes are in the retail activities. Activity in public markets (23) increases by 5% in the simulation with endogenous proportions, but increases by only 2% in the simulation with fixed proportions. Activity in Conasupo establishments (25) decreases by 5% in the simulation with endogenous proportions, but actually increases by almost 4% in the simulation with fixed proportions. The changes in consumer expenditure patterns are also reflected in differences in levels of consumption of consumer goods: The simulation with endogenous proportions results in an increase in consumption of educational articles of less than 3%, for example, while that with fixed proportions results in an increase of more than 5%.

One way of analyze the distributional impact of any policy is to calculate changes in utility indices. Percentage changes in the values of utility functions can be interpreted as percentage changes in real incomes: The Cobb–Douglas functions are weighted geometric means of consumption of different goods. A 5% increase in utility, for example, corresponds to a 5% increase in income if prices are constant. The percentage changes in utility levels are reported in Table 6 along with percentage changes in the sums of all urban and of all rural consumer groups.

Notice that the reform helps urban consumers more than it does rural consumers. The overall impact, however, is close to a Pareto improvement. This is explained by the treatment of the government deficit. The fiscal reform results in a fall in tax revenue of more than 19%. Since the level of government expenditures is fixed, the consequence is an increase in the government deficit. The additional government bonds are regarded as an increase in net wealth by consumers. Moreover, the increase in the deficit has the effect of raising demand for urban labor more than that for rural labor. See Kehoe and Serra-Puche (1983a) for analysis of these issues and comparisons of the fixed expenditures specification with a fixed deficit specification.

That urban consumers gain relative to rural consumers is not dependent on the fact that urban consumers have the freedom to change shopping patterns while rural consumers do not. Urban consumers also gain relatively more when their shopping patterns are fixed. Giving them the freedom to change shopping patterns does, of course, increase the

**Table 6:** Percentage Changes in Utility Indices

| Consumer | Fiscal Reform Fixed Proportions | Fiscal Reform Endogenous Proportions | Commercial Subsidies |
|---|---|---|---|
| 1 | 6.19 | 5.50 | 3.37 |
| 2 | 2.28 | 2.24 | 3.49 |
| 3 | 6.71 | 5.78 | 3.01 |
| 4 | 0.41 | 0.31 | 2.71 |
| 5 | 4.17 | 5.30 | 2.47 |
| 6 | −0.12 | −0.25 | 2.32 |
| 7 | 4.48 | 5.91 | 2.77 |
| 8 | 2.82 | 2.88 | 2.64 |
| 9 | 5.74 | 6.80 | 2.85 |
| 10 | 0.00 | −0.16 | 1.46 |
| Urban | 5.15 | 6.32 | 2.80 |
| Rural | 1.44 | 1.39 | 2.56 |

differential in gains. Notice that the reform also favors the poor and upper income groups more than it does the middle ones. This is easily explained by changes in relative prices. The fall in the price of food (33–34) favors the lower income groups. The fall in price of investment and bonds (32) and the rise in the return on capital (61), on the other hand, have a favorable impact on the upper income groups, who have the highest savings propensities and own most of the capital.

The second simulation, as we have mentioned, involves a subsidy policy aimed at the commercial sector. Specifically, the government subsidizes value added in the commercial sector as follows: wholesalers (22) receive a subsidy of 10%; public markets (23) receive a 20% subsidy; grocery stores (24) receive a 10% subsidy; and other retailers (29) receive a 5% subsidy. Moreover, the number of Conasupo establishments (25) rises from 8 to 25 in our 10 × 10 grid. The number of other establishments remains fixed.

This policy might appear contradictory to the stabilization program currently being implemented in Mexico, which has sharply cut government subsidies. This policy could be accompanied, however, by a shift of resources from other, less efficient, subsidy policies. In particular, Conasupo could shift resources from price support and control policies to retailing operations. Even with net cuts in subsidies, this shift would allow Conasupo to substantially increase the number of retail establishments. With the choice of appropriate locations for new establishments, this policy would have more potential to improve income distribution than simple price controls since the latter tool is unable to discriminate. The Mexican government has to operate within a delicate balance between subsidy and transfer cuts on one side, and the deterioration of the real income of the poorest groups in the society on the other. The present simulation shows the potential of subsidies to retailers to improve income distribution. It does not, however, incorporate a shift in resources from one policy tool to another. The model we have developed would provide an ideal tool for studying policies that do shift resources.

The intention of this policy is to improve income distribution. The establishments receiving subsidies are those that figure heavily into the shopping plans of the poorer income groups. That this policy has the desired effect is easily seen in Table 6. Notice that this simulation, as the previous one, results in a Pareto improvement. Again, this is the result of a decrease in the net tax burden. The overall impact of this policy is, however, more progressive than the fiscal reform, particularly in the rural sector. That rural consumers do not have the freedom that urban consumers do to change shopping patterns dampens relative increases in rural utility levels.

One of the most significant results of this simulation is the 48% increase in the activity of Conasupo (25). Obviously, this result is dependent on our locational model of consumer demand: In particular, notice that Conasupo markups actually increase by 1.2% because of increases in costs. In spite of this, the increase in the Conasupo activity is the largest in the economy. Notice that activity in both public markets (23) and supermarkets (26) declines significantly. The decline in public markets is particularly significant because it occurs in spite of the large subsidy. On the other hand, activity in grocery stores (24) increases by 15%.

There are, moreover, significant spillover effects on the rest of the economy. For example, the return to capital increases by more than 2% compared to urban labor. This change is reflected in all the prices and activity levels in the economy. Furthermore, the relative magnitudes of these changes are not uniform nor are they easily predicted: consumption of nonalcoholic beverages (43) increases by 5.6%; consumption of bread (33), in contrast, increases by only 1.7%.

Viewing the results of these two simulations makes it obvious that a general equilibrium framework is needed to analyze effects of government policies on the commercial sector. It is further obvious that our modeling of consumer demand plays an important role in the final results. In both scenarios some of the most significant changes in prices and activity levels are in the commercial sector. Comparing the results of the two scenarios suggests that commercial subsidies may be a more efficient tool for altering income distribution than indirect taxes.

## 8. CONCLUDING REMARKS

The model we have described is meant to be a first attempt at constructing a flexible tool for evaluating the impact of policy changes on resource allocation and income distribution in Mexico. The strength of the model is that consumers choose among different retail establishments when making purchases. The model is, consequently, well suited to answering questions of two types: What is the impact on the commercial sector of a major policy change elsewhere in the economy? What are the spillover effects on the rest of the economy of a policy change aimed at the commercial sector?

The model has a number of weaknesses, however. A major one is the treatment of the wholesale activity. Unfortunately, data limitations do not allow us to distinguish among different types of wholesale establishments. For the same reason we do not allow establishments that engage in both wholesale and retail activities simultaneously. Ideally, we would want to have demand for wholesale services by retailers varying with prices and locational considerations in a manner analogous to the demand for retail services by consumers.

Another shortcoming of this model, perhaps more than in other applied general equilibrium models, is the perfect competition assumption. Each retail establishment in the model faces a downward sloping demand curve for its services because of the transportation costs that face nearby consumers. In the present version of the model, the establishment does not exploit this market power. Yet, many interesting pricing policies result from this market power, the use of loss leaders, for example. Furthermore, all of the locational variables in the model are taken as parameters. An interesting, but difficult, task would be to incorporate some endogeneity of establishment location and market power into the model.

An interesting and important line of research would be to incorporate some endogeneity of establishment location and market power into the model. This would not be an easy task, however. In the present formulation, each establishment faces different demand conditions. Since demand functions cannot be expressed analytically, solving for the markups that maximize the profits of a specific establishment, holding prices and other markups fixed, would have to be done numerically. Allowing the markups of all establishments to vary, we could use a game-theoretic concept of equilibrium to pin down their interrelationships. We could then allow entry and exit and changes in locational patterns to occur until some kind of monopolistically-competitive equilibrium is reached. Unfortunately, solving for an optimal location equilibrium in this type of model seems to be an impossible task. It is difficult enough in a partial equilibrium model in which consumers are uniformly distributed over a circle and purchase a single good from homogeneous establishments (Eaton 1976). Any model is, of course, an abstraction from reality. In the present version of this model, we have chosen to ignore market power and locational considerations. We have not chosen, however, to ignore heterogeneity of goods or establishments or nonuniformities in distribution of consumers.

The current model also neglects price control phenomena, which is of crucial relevance to domestic commerce in Mexico. Purchases of many types of food, for example, are heavily subsidized by the government. Although the computational procedure could easily be modified to allow fixed prices and/or subsidies, there are problems of how to specify rationing of demand. A related problem with the data is that unfulfilled demands are not directly observable. Kehoe and Serra-Puche (1983b) have developed a model in which the government controls prices using taxes and subsidies and supply is always equal to demand.

The lack of data on rural markets has caused us to hold the proportion of spending by rural consumers in each establishment fixed. The problem here is mostly one of data, although rural markets, with their traditional forms of trading, would probably require a somewhat different specification for consumer demand than urban markets. The data problem, along with several other information problems, is currently being solved by direct surveys oriented toward collecting data relevant to this model.

Another set of data problems is connected with the specification of value added. A more attractive specification would allow several different types of capital goods. Such a differentiation is particularly relevant if the model is to be used to analyze loan policies for different commercial establishments. Another improvement that could be made would be to have different elasticities of substitution among factors of production.

In spite of these shortcomings, however, the model should prove to be a valuable tool for policy analysis. It is flexible enough so that we can incorporate new data when it becomes available and modify the specification when the need arises. Moreover, we can overcome many of the limitations mentioned above by changing exogenous variables to simulate endogenous changes.

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