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MIGRATION, URBANIZATION, AND DEVELOPMENT: A CASE STUDY OF MEXICO

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Donaldo Colosio, Luis Castro, and Andrei Rogers

INTRODUCTION

The International Institute for Applied Systems Analysis (IIASA) is a non-governmental research organization founded in 1972 on the initiative of the Academies of Science or equivalent institutions in more developed countries, both with market and planned economies. The Institute, supported primarily by annual contributions from its 17 member nations, conducts and stimulates research on problems of modern societies.

A group of scholars at IIASA is studying national processes of structural transformation, seeing to further our understanding of the relationships between agriculture, industry, and urbanization in economic development. An integral component of this activity is a collection of national case studies of urbanization and development experiences, among them Mexico's.

Mexico's development history is a particularly notable example of a structural transformation involving high fertility, large-scale commercial agriculture, massive rural to urban migration, and rapid urbanization. Thus, studies of agriculture's role in economic development strategy and the process of structural transformation that it induces in developing countries often point to Mexico as a polar prototype to countries such as Japan:

> Most developing countries face a basic issue of agricultural development strategy that can be crudely defined as a choice between the "Japanese model" and the "Mexican model"... the increase in farm output and productivity in Japan resulted from the widespread adoption of improved techniques by the great majority of the nation's farmers whereas in Mexico a major part of the impressive increase in agriculture output in the postwar period has been the result of extremely large increases in production by a very small number of large-scale, highly commerical farm operators (Johnston, 1970, pp.86-87).

The urban/demographic consequences of the Japanese and Mexican success stories differed significantly; it is, therefore, important to also keep them in mind when evaluating each of the two experiences. The aggregate annual population growth rate of Meiji, Japan was less than one percent; that of Mexico today is over three times as high. Urbanization proceeded at a relatively moderate pace in Japan during its structural transformation; in Mexico its pace has been startlingly high with Mexico City alone projected to have a population in excess of 30 million by the end of this century.

Analyses of the causes and consequences of internal migration, urbanization and development can usefully be carried out within the framework of formal models of demographic and economic (demoeconomic) development. Several approaches to the design of such a framework are available, ranging from the construction of a detailed planning model to the elaboration of a more aggregated general-equilibrium demoeconomic development and growth paradigm. The latter approach is followed in this study. A demoeconomic model in the tradition of economic dualism, as characterized by the work of Kelley, Williamson, and Cheetham (1972), forms the core of our analytical apparatus. While this paradigm has been shown to be quite useful in identifying several of the sources of economic growth and structural change in Japan, modifications in its structure appear to be necessary to increase its relevance to the study of urbanization in Mexico. Several of these modifications are outlined in the latter half of this paper.

URBANIZATION AND DEVELOPMENT IN MEXICO: A BRIEF OVERVIEW

The Mexican economy has experienced, in recent decades, a process of rapid industrialization and significant structural change. From 1940 to 1970, Gross Domestic Product (GDP) per capita grew at an annual average rate of 3.2% per annum [Solis (1971), pp.104-105]. This growth occurred at a time when the average annual rate of population growth was 3.5% [Unikel et al. (1976), p.32].

A more detailed sectoral analysis, identifies the principal underlying changes in the production structure that made this growth possible. The share of GDP attributable to activities linked to rural areas (agriculture, livestock, forestry and fishing), fell from 36% at the beginning of this century to 17% in 1965. In the same period, the share of the manufacturing sector increased from 16.5% to 25.3% [Solis (1971), pp.90-91].

This structural transformation did not occur without substantial changes in productivity levels. From 1940 to 1970, average product per worker in the economy as a whole, tripled. This was mainly the result of substantial relative growth in productivity per worker at the sectoral level, with agriculture exhibiting the highest relative increase of 123%, manufacturing an increase of 99%, and the third sector, composed mainly of service activities, showing a surprisingly high increase of 104% [Unikel et al. (1976), p. 32].

From the myriad of factors underlying these significant changes in productivity, one might expect that technological progress, rural-urban migration, and heavy infrastructural investment played an important role. The latter factor is generally considered to have been particularly crucial in raising the capital-labor ratio of the economy. A study by Hansen (1970) shows that, in a period of seven years (1940 to 1947), total annual gross fixed capital formation doubled as a percentage of GNP. It also shows the very important role of the public sector in capital formation [Hansen (1971), p. 61]. Special attention was given to the agricultural sector by the federal government

during the early stage of Mexico's development. Agriculture's share of federal investment was 10% around 1930, and increased to 19% by 1945 [Ibarra (1970), p.115].

With capital-labor ratios rising in the economy as a whole and in the agricultural sector in particular, one would expect a large flow of labor from rural to urban areas. Mexican statistics show how the country's population has gone through a spectacular change in its spatial distribution in recent years, as the urban population has increased from 4 million in 1940 to 21.5 million in 1970. For the same period, the proportion of urban total population has almost doubled every 10 years. [Table 1]. A significant contribution to this urbanization process is attributed to rural-urban migration, as indicated by a recent study which states that an average of 42% of urban growth in Mexico has been caused by rural out-migration [Unikel et al. (1976), pp. 44-46].

These transfers of the labor force are, undoubtedly, responsible for major changes in production, employment, income distribution, and consumption patterns. For example, during the decade following the years of heavy rural public investment (1940 to 1950), 54.2% of the change in aggregate productivity has been attributed to shifts of labor from agriculture to the industrial and service sectors [Colosio (1978a)]. This share was substantially lower (23.0%) for the decade 1950 to 1960, due perhaps to the concentration of employment in activities with low productivity. However, the shift-share index shows an unexpected increase (36.0%) during the 1960's, despite the continually increasing out-migration of labor from rural areas and the expanding employment in tertiary activities. A possible explanation is the rise of alternative employment opportunities in foreign labor markets (such as in the United States).

The fact that the manufacturing sector has not been dynamic enough to absorb the growing labor force is notable in the Mexican development experience. From 1940 to 1970, the industrial sector absorbed only an average of 19% of the total economically

active population, agriculture absorbed 55% and services 26%.

Two factors contributing to this phenomenon are believed to be the high rate of population growth and the adoption of labor-saving industrial technology. The latter can be confirmed by determining the elasticity of substitution in the Mexican manufacturing sector, which is expected to be less than one. A first very rough approximation of such an elasticity [Colosio (1978b)] yielded a value of 0.79 indicating the industrial sector's inability to respond rapidly enough to changes in factor supply. This has forced a considerable proportion of the labor force to engage in tertiary activities, whose rather large size in Mexico's stage of development, indicates that street vendors petty merchants, and other forms of disguised unemployment are proliferating. This hypothesis is suggested in a study by Ibarra (1970, p.118), which concludes that the share of those with the lowest incomes (the poorest 50% of the population) fell from 19.1% of the total income in 1950 to 15.4% in 1963 to 1964. Further support is provided in a recent study on Mexican income inequalities which indicates that in 1968, 60% of the country-wide inequality was due to inequality within urban areas [Van Ginneken (1976), p.29].

In addition to affecting changes in productivity levels, the transfer of labor from rural to urban areas is likely to have had an impact on the rest of the economy by altering consumption patters in a manner that stimulated the growth of manufacturing output. A survey of income and expenditures of Mexican households developed in 1963, indicated that income elasticities for agricultural commodities were higher in rural than urban areas, whereas income elasticities for manufactured goods were higher among urban than rural consumers [Solis (1967), p.68].

In a situation of major demographic change, such as occurred in Mexico, differences in consumption behavior are likely to have a relatively large influence on the composition of demand an on

the production structure. The degree to which migrants adopt urban consumption habits undoubtedly accounts for a significant part of the declining share of agricultural output in Mexican GDP, and the concomitant increase in the share of manufacturing during the period 1940 to 1970. In this context, Reynolds has observed that, although the productivity of workers in lower skilled urban occupations may not have increased notably, these workers have widened the market for industrial goods that are subject to increasing returns, thereby permitting average productivity gains in the manufacturing sector [Reynolds (1970), p.182].

Table 1. Mexico's Population: Total, Urban, and Rural (in thousands)

YEAR	TOTAL POPULATION	URBAN POPULATION a	URBAN POPULATION b	RURAL POPULATION a	RURAL POPULATION b
1900	13607	1434	2563	12173	11044
1910	15160	1783	3034	13377	12126
1921	14334	2085	3287	12249	11047
1930	16553	2982	4234	13661	12319
1940	19649	3928	5420	15721	14229
1950	25779	7198	9223	18581	16556
1960	34923	12747	15504	22176	19419
1970	48377	21721	28329	26656	20048

Source: Unikel et al. (1976), p. 30.

a. Definition of urban: population in localities of 15,000 or more.

b. Definition of urban: population in localities of 2,500 or more.

URBANIZATION DYNAMICS IN MEXICO: TWO ALTERNATIVE SCENARIOS[1]

The urbanization of a national population evolves out of a particular combination of spatio-temporally changing rates of births, deaths, and internal migration. The process is characterized by distinct rural-urban differentials in fertility and mortality levels and their patterns of decline, and by a massive, largely voluntary, net transfer of population from rural to urban areas.

Over a decade ago, Ansley Coale (1969), identified some of the ways in which alternative demographic trends might affect the development of less developed countries. He focused on national rather than regional populations, considered only a single future course for mortality, and examined the demoeconomic consequences of two alternative future courses for fertility:

A) maintenance at its current level

and

B) a rapid decline to half its current level over a period of twenty-five years.

After generating the two alternative projections or "scenarios", Coale went on to

> inquire what effects these contrasting trends in fertility would have on three important population characteristics: first, the burden of dependency, defined as the total number of persons in the population divided by the number in the labor force ages (fifteen to sixty-four); second, the rate of growth of the labor force, or, more precisely, the annual per cent rate of increase of the population fifteen to sixty-four; and third, the density of the population, or, more precisely, the number of persons at labor force age relative to land area and other resources. Then we shall consider how these three characteristics of dependency, rate of growth, and density, influence the increase in per capita income.
> [Coale (1969), p.63].

[1] A fuller description and analysis of the urbanization scenarios developed in this section will appear in Rogers and Castro (1978).

In order to assess some of the important demographic consequences of rapid urbanization, we have disaggregated Coale's scenario-building approach by dividing his national population into urban and rural sectors and by introducing the impacts of rural-urban migration on their regional age compositions and population totals. Since our focus is on Mexico as a case study, we also have replaced Coale's hypothetical national population of a million people with the 1970 population of Mexico.

The Two Scenarios

Table 2 summarizes our assumptions regarding future patterns of urban-rural fertility, mortality, and migration, and it also sets out Coale's parametric assumptions for purposes of comparison. Scenario A, like that of Coale, assumes a continuation of current levels of fertility; Scenario B, again like that of Coale, assumes a sudden reduction in fertility levels. The future courses of mortality and internal migration are assumed to follow identical paths in both scenarios; thus fertility is the sole population change variable considered to be responsive to governmental policy. (The study of migration as a policy variable will be carried out in the future, within the framework of the demoeconomic model described in the latter half of this paper.)

Both scenarios start with the observed 1970 population as the initial population. But the projection exercise includes a historical projection (for the 1940 to 1970 period) that "tracks" the observed trajectories remarkably well, with the projected urban population, for example, always falling within 7% of the recorded values.

Figure 1 shows that the urbanization trajectory projected for Mexico accords well with the historical experience of nations that have already become highly urbanized. Mexico's 1970 urban population (here defined as the population living in places with more than 2,500 inhabitants) of 28 million constituted roughly 55% of the national total. By the turn of this century, about three-fourths of Mexico's population is projected to be

Table 2. Initial values and assumptions in the two projection models

	COALE	IIASA - MEXICO MODEL	
		Urban	Rural
Initial values (1970)			
Population (000s)	1,000	28,329	20,048
Death Rate*	14/1000	9.3/1000	13.0/1000
Birth Rate*	44/1000	43.9/1000	44.5/1000
Outmigration Rate*	--	3.0/1000	23.0/1000
Future Paths			
Mortality	Decline over 30 years to level with an expectation of life at birth of 70 years; then unchanged	Decline as in Coale's model, but over 25 years; then unchanged	Decline as in Coale's model, but over 35 years; then unchanged
Fertility	A. Unchanged	A. Unchanged	A. Unchanged
	B. Reduction of 50% over 25 years; then unchanged	B. Reduction as in Coale's model, but over 25 years; then unchanged	B. Reduction as in Coale's model, but over 30 years; then unchanged
Migration		Unchanged	Increase of 120% over 25 years; then a reduction to 80% of that peak over 40 years; then unchanged

*Rates for Mexico are for 1970 and were obtained by rough estimations using historical data.

urban in each of the two scenarios. According to Table 3, at this time the urban population will have increased to 14 times its 1940 level if fertility is maintained at 1970 levels and to just over 11 times if fertility is sharply reduced in the manner defined by Scenario B. The corresponding multiples of the 1970 urban population are approximately four and three, respectivly.

Demographic Consequences

Figure 2 shows how the three population characteristics studied by Coale (1969), vary in their significance in the short, medium, and long runs in our two scenarios of Mexico's future population growth and urbanization. The first principal impact of the decline in fertility is a 25% decrease in the dependency burden over two generations, followed in the subsequent two generations by an increase that brings the ratio to approximately 85% of its current level. The medium-run impact of fertility reduction begins to appear about 15 to 20 years after the onset of the fertility decline, producing an annual rate of labor force growth that decreases for about 60 years and then rises, over the next 40 years, to a level that remains relatively fixed thereafter. Finally, the long-run effects of reduced fertility start to become significant after 60 years; at this point the size of the high fertility population is roughly twice that of the one with reduced fertility, and this ratio assumes ever increasing dimensions thereafter.

The introduction of migration as a component of change and the concomitant spatial disaggregation of a national population into urban and rural sectors brings into sharp focus urban-rural differentials in dependency burdens and in the patterns of their decline following fertility reduction. This is also true of the differentials in the initial growth rates of the labor force population and the paths by which they converge to their long-run levels.

The dependency ratio in urban areas in Mexico was over 20 points lower than its rural counterpart in 1940, but a convergence of the two ratios reduced the difference to 7 points by

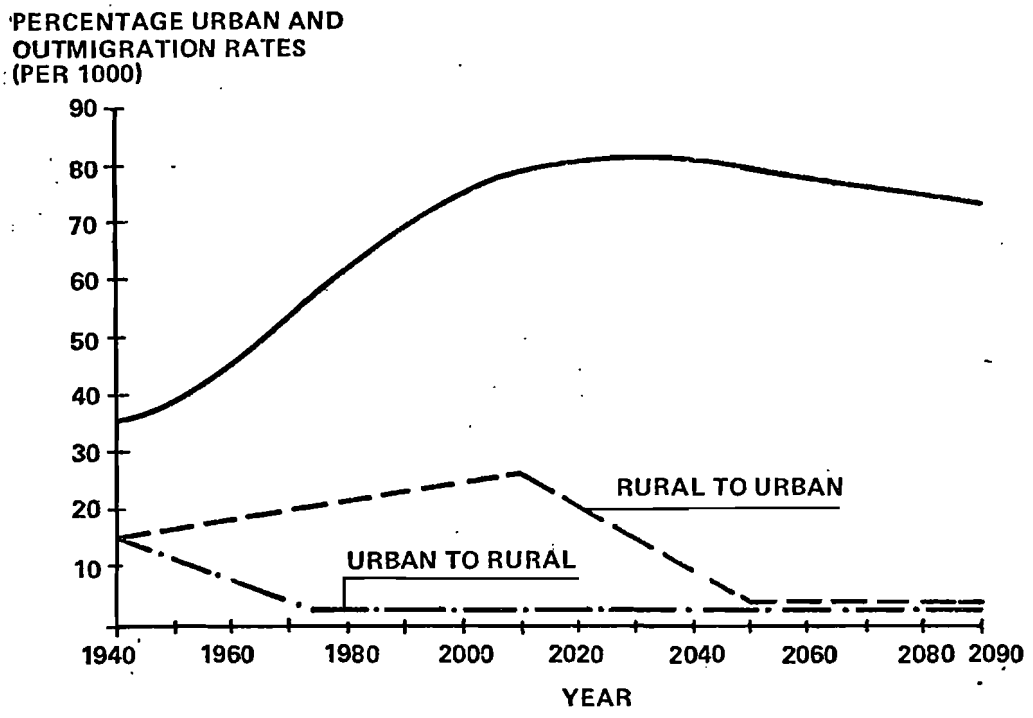

Figure 1. Percentage urban, and rural - urban and urban - rural outmigration rates.

1970. This difference ultimately drops to practically zero in both scenarios, with the ratio stabilizing at just over 200 in the constant fertility projection and leveling off at about 30 points under that total in the reduced fertility scenario.

The annual rates of growth of the labor force population in urban and rural areas in 1940 were 0.035 and 0.020, respectively. By 1970 the difference between these two rates more than doubled, with the urban rate peaking at 0.050 percent per annum. In scenario A this rate declines to a stable level of 0.034; it drops even further in the reduced fertility projection, stabilizing at a level of 0.018.

The rural rate, declining at first, begins to "turn-around" by the end of the century in Scenario A and after some twenty years later in Scenario B. In the constant fertility projection it levels off at an annual rate of increase of 0.040 percent; in the reduced fertility scenario the stabilization comes earlier and stands at the lower rate of 0.023, just exceeding its 1940 level.

The economic consequences of the projected patterns of dependency, growth, and density in the two urbanization scenarios are similar to those described by Coale (1969), but they now include a spatial dimension. First, the pressure for allocating a much higher proportion of the national product toward consumption is likely to be greater in the high fertility population because of its greater dependency burden. The capacity to raise net investment levels in such populations, therefore, will be seriously impaired. But if urban households save a larger fraction of their income than do rural households, rapid urbanization could have a positive influence on the national savings rate.

The short-run depressing influence of a higher burden of dependency on savings and investment in the higher fertility population is exacerbated in the middle-run by a higher growth rate of the labor force. The population with the higher rate of labor force growth will find it more difficult to increase the per worker productivity of its economy. This difficulty will be especially severe in the nation's urban areas, where high levels

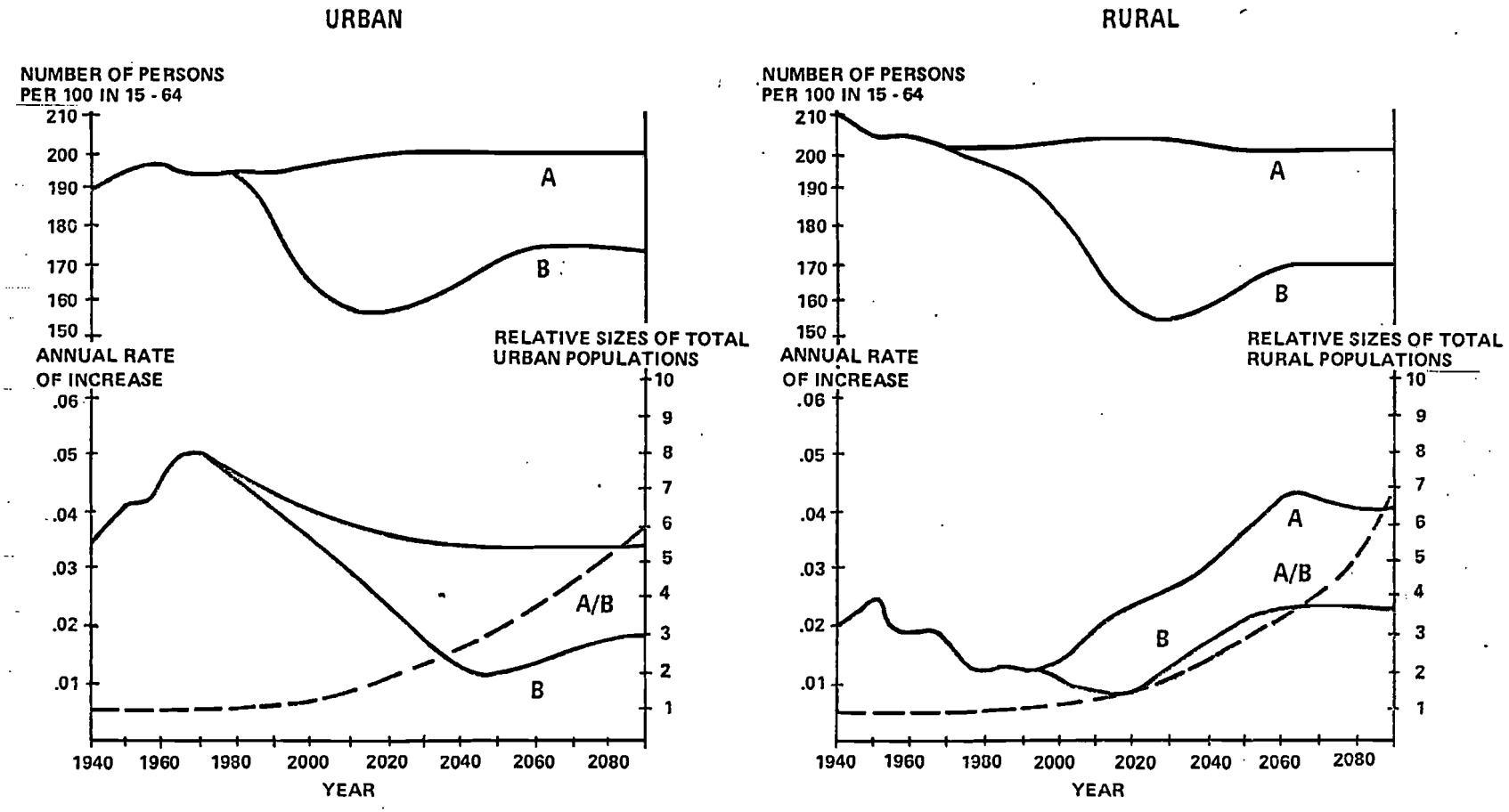

Figure 2. Dependency burden, annual rate of increase of population aged 15 - 64 years and relative sizes of total populations: alternative urban - rural projections.

of rural-urban migration reduce the per capita endowment of capital and social infrastructure in cities and contribute to high rates of unemployment and underemployment.

Growing urban unemployment and underemployment in today's less developed countries have sharply underscored the urgent need for an efficient and equitable allocation of human resources between the urban and rural sectors of national economies. The determinants of rural-urban migration and the consequences of such migration for economic development warrant careful study. An important contribution to such study can come from improved demo-economic models of dualistic development.

A THREE-SECTOR MACRO-MODEL OF THE MEXICAN ECONOMY[2]

In building a macrodemoeconomic model of Mexican development, one must keep in mind the need for a framework that is comprehensive enough to depict the interrelationships and feedbacks of economic and demographic variables identified with the process of development. This presents a trade-off between the level of aggregation and the feasibility of empirical implementation. The model described below is a three-sector model that provides a general dynamic framework in which the net outcomes of opposing forces, generated by urbanization and development can be assessed.

In light of the scarcity of consistent time series data for most of the variables to be considered [Solis (1970a)], the possibility of carrying out an econometric estimation of the model is very small. Therefore, we are planning to follow a recent trend in economic modeling [see Pindyck and Rubinfeld (1976), pp.332-334; Simon (1976); Kelley and Williamson (1974); Yap (1976)]. This trend embodies:

- o the formulation of the model's structure by means of a set of equations, including all those elements of economic theory that are relevant for the understanding of economic growth and structural changes;
- o the adoption of a set of initial conditions and parameters, based on historical records or point estimates that must be supplied for the operation of the model;
- o the use of computer simulation techniques to generate annual results;
- o the evaluation of the model by a comparison of the behavior of its principal variables against the historical record;

[2]The model outlined in this section is a preliminary version of one that has been informally discussed at staff meetings in the Human Settlements and Services Area at IIASA and whose structural basis was first presented at a Mexican Task Force Meeting held at IIASA on May 16-19, 1978 [Colosio (1978a)]. It will ultimately be published as part of a doctoral dissertation currently being written by Colosio at the Institute.

- o the assessment of the impacts of changes in particular variables and parameters on demoeconomic development, evaluating the results within the overall general framework (i.e., counterfactual analysis).

Production

The model consists of three sectors that differ in factor use, technical change, and organization of the means of production. Since the purpose of this analysis is to capture the main macrodemoeconomic effects of the urbanization process in Mexico, we emphasize a rural-urban dichotomy. Moreover, in urban areas the economy is split into two sectors: modern and traditional. The modern-industrial sector is composed mainly of large scale firms whose output can be consumed and/or invested. These are generally considered to be manufacturing (including state-owned enterprises); capital intensive services (e.g., supermarkets, car-wash establishments, computerized services, banking, etc.); transportation; energy and construction [Unikel (1976)].

Since one of the interesting features of development is the impact of variations in factor shares on incomes, and this in turn is possible only with a non-unitary elasticity of substitution, we postulate a CES production function for the modern-industrial sector. This gives us a range of elasticity values among which is the unitary elasticity. Thus,[3]

$$G_1(t) = \left[\delta\left(e^{\lambda_K t} K_1(t)\right)^{-\rho} + (1-\delta)\left(e^{\lambda_L t} L_1(t)\right)^{-\rho}\right]^{-\frac{1}{\rho}} \quad . \quad (1)$$

[3]The following notation is adopted:
Subscript 1 denotes modern-industrial sector,
Subscript 2 denotes agricultural sector,
Subscript 3 denotes informal service sector.

where

$G_1(t)$ = output of modern-industrial sector;

δ = distribution parameter;

ρ = substitution parameter, where $\rho = \frac{1-\sigma_1}{\sigma_1}$ and σ_1 is the elasticity of substitution in the industrial sector;

λ_K, λ_L = technological parameters;

$K_1(t)$ = capital input in the industrial sector at time t;

$L_1(t)$ = labor input in the industrial sector at time t.

This sector's main characteristcs are: limited possibilities for factor substitution [Colosio (1978b)] and labor saving technology [Strassmann (1968)]. Therefore:

$$0 < \sigma_1 < 1$$

In addition to these technical aspects, there are institutional factors (e.g., a fixed minimum wage in the industrial sector) that restrict the modern-industrial sector's capacity for absorbing a fast-growing urban labor force. This has had the inevitable consequence of creating a considerable pool of unemployed, and/or underemployed, labor [Isbister (1971)]. In our simulation model of the Mexican economy, we do not consider open unemployment; however, we do account for the existence of an informal service sector.

The structure of the service sector is characterized by easy entrance, low productivity levels, relatively low capital intensity, and little technological change [Mazumdar (1976)]. Its output is entirely consumed in urban areas. Thus, viewing

labor as the only input, we postulate the following simple production function:

$$G_3(t) = \alpha(t)\ L_3(t) \quad . \tag{2}$$

where

$G_3(t)$ = output of the informal service sector;

$L_3(t)$ = labor force underemployed;

$\alpha(t)$ = productivity of underemployed labor.

The rate of change in productivity is assumed to be low, but positive, over time. Changes in the productivity of the informal sector are determined by the formal sector, in a manner described below [Weber (1975)].

In this preliminary version of the model, agriculture is considered as a single sector whose output is destined for final consumption. Thus, it represents a mixture of relatively capital intensive irrigated agriculture (such as exists in northern Mexico) and labor intensive rain-fed agriculture, in which productivity per worker is much lower (such as exists in much of central and southern Mexico). Therefore, the production relations are expressed as:

$$G_2(t) = \left[\theta\left(e^{\lambda_K t}\ K_2(t)\right)^{-\nu} + (1-\theta)\left(e^{\lambda_L t}\ L_2(t)\right)^{-\nu}\right]^{-\frac{1}{\nu}} \quad . \tag{3}$$

where

$G_2(t)$ = output of the agricultural sector;

θ = distribution parameter;

ν = substitution parameter, where $\nu = \frac{1-\sigma_2}{\sigma_2}$ and σ_2 is the elasticity of substitution in the agricultural sector.

λ_K, λ_L = technological parameters;

$K_2(t)$ = capital inputs in the agricultural sector at time t;

$L_3(t)$ = labor inputs in the agricultural sector at time t.

Labor Markets

In the initial design stage of the model, we assume a homogeneous labor force. This assumption will be relaxed at a later stage to allow for differences in skills.

The total labor force in the economy, L(t), is equal to the sum of labor in the three sectors. Thus,

$$L(t) = L_1(t) + L_2(t) + L_3(t) \quad . \tag{4}$$

Growth of the total labor force over time is given exogenously:

$$\frac{\dot{L}(t)}{L(t)} = n_1 \frac{L_1(t)}{L(t)} + n_2 \frac{L_2(t)}{L(t)} + n_3 \frac{L_3(t)}{L(t)} \quad . \tag{5}$$

where the dot denotes a time derivative. The rate of labor force increase in industry, in the informal sector, and in agriculture are represented by n_1, n_2, and n_3, respectively. These could be considered as being derived from data on the natural increase of the population and on labor force participation [Yotopoulus and Nugent (1976)].

We assume that $n_2 > n_1$ and that n_3 takes on a value between n_1 and n_2. This reflects the fact that workers in the informal sector, by being underemployed, have not had the opportunity to experience a complete transformation of their attitudes from traditional to modern [Gilbert (1976)].

Demand for labor in the agricultural sector is assumed to be a derived function:

$$W_2(t) = p_2(t)\left(G_2(t)\right)^{\frac{1}{\sigma_2}}\left(e^{\lambda_L t}\, L_2(t)\right)^{-\frac{1}{\sigma_2}} \quad . \qquad (6)$$

where

$W_2(t)$ = wage rate in the agricultural sector;

$p_2(t)$ = exogenously determined terms of trade between agriculture and industry.

Because of institutional factors and national social governmental policies in Mexico, it is not unreasonable to assume a rigid downward manufacturing wage rate. Therefore, we assume an exogenously-given wage for the modern-industrial sector, which is set above the competitive level. Thus,

$$\bar{W}_1(t) = \left(G_1(t)\right)^{\frac{1}{\sigma_1}}\left(e^{\lambda_L t}\, L_1(t)\right)^{-\frac{1}{\sigma_1}} \quad . \qquad (7)$$

where

$\bar{W}_1(t)$ = wage rate in the industrial sector, given in terms of the industrial good;

Equation 7 implies that there will never be excess demand for labor at the current minimum wage. At every point in time, this minimum wage will cause a level of employment in the manufacturing sector to fall below that which would prevail in competitive situations.

The urban labor force that is not employed in the manufacturing sector is considered to be surplus and is allocated to the informal sector. A significant share of labor in this sector is underemployed. Thus,

$$L_3(t) = L(t) - L_1(t) - L_2(t) \quad . \qquad (8)$$

Before determining the wage rate, we propose the following hypothesis. The productivity of a worker in the informal services sector is the same no matter where is his location. However, the price of the service is not independent of location. It is the number of job-seekers in Mexico City, for example, that sets the price difference with respect to other centers of the world. The consumer there has plenty of choice and can "bargain" the price down. Thus, we assume that the wage of an employee in the informal sector is inversely related to the number of workers and directly related to the demand for the service.

According to Equation 2, average and marginal products coincide and are given by $\alpha(t)$. If we equate the wage rate $W_2(t)$ to the average (= marginal) product, we have that

$$W_3(t) = p_3(t)\ \alpha(t) \quad . \qquad (9)$$

where

$W_3(t)$ = wage rate in the informal sector;

$p_3(t)$ = terms of trade between the informal sector and the rest of the economy as given by:

$$p_3(t) = f\left(\frac{G_3(t)}{G_1(t)}\right)$$

But, observe that (9) also can be written as

$$W_3(t) = \frac{G_3(t)}{L_3(t)}\, p_3(t) \quad . \tag{10}$$

Furthermore, since labor in the informal sector is underemployed, we may assume that demand for its output is always met; therefore

$$G_3(t) = D_{31}(t) + D_{33}(t) \quad . \tag{11}$$

where

$D_{31}(t)$ = demand for services originating in the industrial sector;

$D_{33}(t)$ = demand for services originating within the same sector.

We assume, for the time being, that a constant portion of income from each urban sector is destined to the consumption of services [Mazumdar (1975)]. Therefore,

$$D_{31}(t) = \xi\, G_1(t)$$

$$D_{33}(t) = \tau\, G_3(t)$$

therefore

$$G_3(t) = \xi\, G_1(t) + \tau\, G_3(t)$$

or

$$G_3(t) = \left(\frac{\xi}{1-\tau}\right) G_1(t)$$

So that

$$W_3(t) = \left(\frac{\beta\, G_1(t)}{L_3(t)}\right) p_3(t) \quad . \qquad (12)$$

where

$$\beta = \left(\frac{\xi}{1-\tau}\right)$$

Observe that productivity in the formal sector, $\alpha(t)$ is directly related to the marginal propensity to consume and to income in other sectors. At the same time, it is inversely related to the amount of workers employed in the sector. These aspects seem to be generally viewed as the main determinants of productivity in the informal sectors [Rempel and Lobdell (1977), ch.5].

Labor Migration

The urban labor force is augmented over time, not only by natural increase, but also by the net number of workers migrating from rural areas. Therefore, if we define total urban labor force at time t to be $N(t)$, we have that

$$N(t) = L_1(t) + L_3(t) \quad .$$

and the growth of the urban labor force is given by

$$\dot{N}(t) = n_1 L_1(t) + n_3 L_3(t) + m(t) [1-u(t)] \quad . \qquad (13)$$

where $m(t)$ is the proportion of migrating agricultural workers $M(t)$, to the total agricultural labor force $L_2(t)$:

$$m(t) = \frac{M(t)}{L_2(t)} \quad . \qquad (14)$$

The specification of the migration function is one of the elements that deserves a more detailed analysis. For the time being the specification of the migration function is made in a general form. However, in the future, we shall adopt a version

of the Todaro hypothesis [Harris and Todaro (1970)] that views migration as a function of the difference between expected urban real wages and agricultural real wages. For the moment, we consider expected urban real wages, $W^e(t)$, to be the weighted average of industrial wages and informal services wages, where the weights are the respective proportions of urban labor force employed in each sector:

$$W^e(t) = \frac{W_1(t)\ L_1(t) + W_2(t)\ L_2(t)}{N(t)} \quad . \tag{15}$$

In this case, the migration function can be expressed as

$$m(t) = F\left(W^e(t) - W_2(t)\right) \quad , \quad F^1 > 0 \tag{16}$$

Notice that Equation 16 is general enough to include any kind of cost (transportation, psychic, etc.) related to the migration process. Migration in this model is a sign of disequilibrium in the labor market. At equilibrium

$$W^e(t) = W_2(t) \quad .$$

and net migration is zero.

Capital Markets

The stocks of capital in both the agricultural and modern-industrial sectors are assumed to be augmented by private and public investment. Thus,

$$K_j(t) = K_{1j}(t) + K_{2j}(t) + K_{4j}(t) \quad , \quad j = 1,2 \tag{17}$$

where $K_{ij}(t)$ is the stock of capital in sector j, owned by capitalists of sector i, and where the subscript 4 denotes government.

Capital accumulation is given by

$$\dot{K}_j(t) = \bar{I}_j(t) - \kappa K_j(t) \quad , \quad j = 1,2 \tag{18}$$

where $\dot{K}_j$ is net investment, $\bar{I}_j(t)$ is total gross investment and κ is the rate of depreciation (assumed to be constant and identical in both sectors).

It is assumed that a portion of the income of both capitalists and workers in the agricultural and modern-industrial sectors is allocated to savings. Thus,

$$\begin{aligned} S_j^c(t) &= s_j^c \, Y_j^c(t) \\ & \qquad\qquad j = 1,2 \\ S_j^l(t) &= s_j^l \, Y_j^l(t) \end{aligned} \tag{19}$$

where $S_j^c(t)$ and $S_j^l(t)$ are total savings from capitalists and workers of sector j; s_j^c and s_j^l are the marginal propensities to save. Incomes accruing to both capitalists and workers are assumed to be net of taxes.

Although the income of workers has been determined, the incomes of capitalists remain to be defined. Assuming maximizing behavior, we may express these as

$$Y_i^c(t) = e^{\lambda_K t} \left[r_i(t) \, K_{i1}(t) + r_i(t) \, K_{i2}(t) \right] \tag{20}$$

$$i \text{ L } 1,2$$

Equation 20 implies that technical progress occurs equally to capital in both sectors. Returns to capital in agriculture and industry are denoted by $r_i(t)$. Under competitive circumstances these returns should be equal to the marginal productivity of capital in each sector. That is,

$$r_i(t) = \left(Q_i(t)\right)^{\frac{1}{\sigma_i}} \left(e^{\lambda_K t} K_i(t)\right)^{-\frac{1}{\sigma_i}} \qquad i = 1,2 \tag{21}$$

The process by which savings are allocated to either sector has long attracted the attention of economists [Kelley, et al. (1972)]. Since Mexican capital markets bear a considerable degree of imperfection [Solis (1970b)], it is not reasonable to adopt a purely neoclassical mechanism. Instead we posit an allocation process that is a mixture of exogenous and market-guided decisions [Yap (1976a)]. Then,

$$I_j^P(t) = \zeta \ \bar{S}_j(t) \qquad , \qquad j = 1,2 \tag{22}$$

where $I_j^P(t)$ is the amount of private savings invested in the sector of origin j, while ζ is a parameter. $\bar{S}_j(t)$ is the sum of the savings of capitalists and workers in sector j. The remaining savings, $S_j^R(t)$, are allocated to agriculture and to industry according to the current differential in rates of return.

Thus,

$$i_1^R(t) = \frac{I_1^{PR}(t)}{S_1^R(t)} = \begin{cases} e^{-\eta_1\left(r^*(t)\right)} & \text{if } r^* \geq 0 \\ 1 & \text{if } r^* < 0 \end{cases} \tag{23}$$

$$i_2^R(t) = \frac{I_2^{PR}(t)}{S_2^R(t)} = \begin{cases} e^{-\eta_2\left(r^*(t)\right)} & \text{if } r^* \leq 0 \\ 1 & \text{if } r^* > 0 \end{cases}$$

where i_j^R is the proportion of total residual savings $S_j^R(t)$, invested in the same sector I_j^{PR}, and $r^*(t) = \left(r_2(t) - r_1(t)\right)$.

Governmental revenues, $G_4(t)$, are directed toward the provision of public goods, $P(t)$, and public investment, $I_4(t)$. Total expenditure on public goods is a function of total labor force in both urban and rural areas:

$$P(t) = \gamma_1 N(t) + \gamma_2 L_3(t) \quad . \tag{24}$$

Physical investment is a function of population concentration and private investment:

$$I_4^u(t) = \gamma_3 \frac{N(t)}{L(t)} + \gamma_4 \left(I_1^P(t) + I_1^R\right) \quad . \tag{25}$$

The remaining portion is considered to be a residual:

$$I_4^R(t) = G_4(t) - P(t) - I_4^u(t) \quad . \tag{26}$$

This residual is allocated to agriculture and the modern-industrial sectors as follows:

$$I_{42}(t) = \gamma_5 \, I_4^R(t) \quad . \tag{27}$$

and

$$I_{41}(t) = \left(I_4^R(t) - I_{42}(t) \right) \quad . \tag{28}$$

The model presented so far, emphasizes the supply aspects of the economy. The model can be expanded in at least two useful ways. First, demand functions for final products can be specified for workers and for capitalists [Kelley et al. (1972); Lluch et al. (1977)]. Second, in order to increase realism, international trade must be considered in any demoeconomic analysis of the Mexican economy. Both extensions are currently underway.

CONCLUSION

Scholars and policymakers often disagree when it comes to evaluating the desirability of current rates of rapid urbanization and massive rural-urban migration in the less developed world. Some see these trends as effectively speeding up national processes of socioeconomic development, whereas others believe their consequences to be largely undesirable and argue that both trends should be slowed down.

Those taking the negative view argue that most developing countries are "over-urbanized" in the sense that urban growth rates have greatly outdistanced rates of industrial development and economic growth. This has created an imbalance that finds cities in the less developed world perpetually struggling with crisis. Despite substantial gains in industrial production, new jobs do not appear at anywhere near the rates required to employ a significant portion of the growing urban labor force. Despite impressive improvements in urban housing, food availability, educational services, and transportation facilities--squatter settlements proliferate, hunger and illiteracy are in evidence everywhere, and traffic congestion is worse than before. And, most importantly, resources that could otherwise be applied to more directly and immediately productive uses instead must be diverted to satisfy the ever growing demands for urban social services and infrastructure.

Supporters of current urbanization and migration patterns in developing countries point to the modernizing benefits of urbanization and to the improved well-being of most rural-urban migrants. They contend that urbanization transforms people's outlook and behavioral patterns, while broadening their skills and fostering in them the greater acceptance of innovations and rationality necessary for generating sustained wealth and power in a modern society. They also argue that concern on welfare grounds is probably misplaced, because despite job insecurity and squalid living conditions most rural-urban migrants are better off than they were prior to their move. Their transfer from

the farm to the city enables them to raise their personal income and to obtain social services of a much wider variety and superior quality than were available to them before.

As recently as two decades ago, industrialization and urbanization were seen to be the main structural changes that a country had to undergo in order to achieve desirable levels of welfare. This notion was introduced as a core element in several well-known theoretical formulations of economic development [Lewis (1954); Fei and Ranis (1961); Jorgenson (1961)] and was considered to be a necessary condition for economic growth and modernization. The argument reflected the historical observation that increases in per capita income have been the result of substantial growth in the available stocks of factors of production (labor, capital, and natural resources) and of the adoption of revolutionary technical improvements [Kuznets (1966)].

In cases where economic systems are composed of sectors characterized by marked differentials in factor endowments (both quantitative and qualitative), major variations in resource allocation generally produce a shift of factors from the less to the more productive sectors. Historically, this shift has taken place from agricultural to non-agricultural activities, and the most widely documented factor movement is that of labor. This has had the particular impact of raising the efficiency level in the production of food, creating an agricultural surplus that together with the released labor, has provided the basis for industrialization and urbanization. The agricultural surplus can be transferred to the industrial sector either directly for the satisfaction of intermediate and/or final demands, or indirectly through taxes, savings, and earnings out of export activities; at the same time, population transfers meet the industrial sector's demand for labor. In this regard Keyfitz observes that:

> All urbanization depends on sufficient productivity in agriculture to create a food surplus above the needs of producers and the means to transport that surplus.... Seen from one point of view, the country-side provides a

> market for the disposal of city products; from another point of view it becomes richer by selling its products in the city. But since the demand for food is less elastic than that for manufacture, a smaller and smaller proportion of labor comes to be tied up in the production of food and larger proportions can be released for industry. [Keyfitz (1977) p.146].

Urbanization was looked upon as one of the basic aspects of economic development, and its role in determining the wellbeing of society was hardly questioned. Moreover, because of the economic benefits reflected in productivity gains (as a result of rural-urban movements of labor) it was alleged that urbanization had the particularly beneficial effect of modernizing traditional demographic, political, and socioeconomic behavior. Thus governments concerned with the eradication of poverty fostered policies oriented toward increasing capital formation, industrialization, and urbanization as a means of triggering the mechanisms of economic progress. As a result, a number of countries have evolved from predominantly agricultural to more industrialized economies, with an evident transformation in the spatial structure of demo-economic activity becoming manifested in a substantial increase in urbanization levels.

The cost has been high however. An increasing number of scholars [Morawetz (1974); Sethurman (1970); Souza and Tokman (1976); and Todaro (1976)] see current rates of urbanization in developing countries as a threatening phenomenon. Contrary to theoretical expectations, labor transfers from rural to urban areas are exceeding the industrial sector's ability to absorb the increasing urban labor force. This leads to urban unemployment and/or underemployment, and to a proliferation of petty service activities. The argument, based on these observations, is that the population of the Third World has become prematurely urbanized, in the sense that the percentage of people living in the cities is greater than the current stage of development can support. The interplay of unprecedentedly high levels of natural increase along with the primary economic goal of rapid industrialization, has produced, it is argued, the unique pattern of

"over-urbanization" displayed by the majority of Third World countries. By not being gainfully employed in industrial activities, large portions of the urban population present an obstacle to economic development. They are forced to engage in low-productivity tertiary activities and are subjected to marginalization. In this way, the expected changes in consumption work, and demographic behavior, which are believed to be the outcome of urbanization and necessary for the "modernization" process, are delayed. Furthermore, this large population of the urban underemployed imposes an additional obstacle to development, to the extent that society is forced to provide larger amounts of urban social infrastructure and services at the expense of directly productive public investments. Therefore, urbanization as experienced by contemporary developing countries, should not be equated with development; on the contrary, it should be viewed as a major bottleneck contributing to the persistence of underdevelopment.

Although valid, the above observations have often been the conclusions of partial analyses, in which the growth of tertiary sectors have occasionally been indiscriminantly equated with the growth of petty services, with no distinction being made to distinguish between the growth of socially desirable and undesirable services. Moreover, they have failed to analyze what people now employed in petty service activities would be doing otherwise. Only recently have analyses of the income gains and assimilation experiences of migrants in urban labor markets been carried out. Yap, for example, has shown for the Brazilian case that significant improvements in income levels have occurred for individual rural-urban migrants, despite their underemployed status, when their net urban earnings are compared with those of their non-migrant counterparts [Yap (1976b)].

It is evident from the arguments presented above, that only a general dynamic framework that assesses the net outcomes of opposing forces generated by urbanization and development can lead to a comprehensive and systemic evaluation of the interrelationships and feedbacks among economic and demographic variables in the process of development.

The model presented in the preceeding section should provide a suitable framework for the analysis and understanding of urbanization and economic development patterns in Mexico. By means of simulation techniques we plan to explore two important aspects of this historical phenomenon. First, we shall measure the reliability of the modeling effort by testing its ability to replicate the patterns of Mexican demoeconomic growth for the period 1940 to 1970. This test will compare the growth behavior displayed by certain variables of the model with historical experience. Second, the simulation process will offer the possibility of identifying the impacts of different social policies on Mexican growth and urbanization. This will be done by altering key variables or parameters, without a resort to partial analysis.

In a sense, the model will provide us with a "laboratory", in which tests will be performed in order to learn what would have happened if policies had been different from what they were historically. Examples such as the following come to mind:

- What would have been the effects on urbanization and economic growth of different rates of rural-urban migration?
- What would have been the effects on urbanization of different rates of natural increase?
- What would have been the effects of different levels of private and public investments?
- What would have been the effects of different production technologies?
- What would have been the effects of different fiscal policies?

In short, a number of experiments will be performed using this model in order to develop a system-wide analysis of different policies and their repercussions on the development of the Mexican demoeconomy.

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