URBANIZATION AND ECONOMIC DEVELOPMENT IN MEXICO

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PREFACE

Roughly 1.6 billion people, 40 percent of the world's population, live in urban areas today. At the beginning of the last century, the urban population of the world totaled only 25 million. According to recent United Nations estimates, about 3.1 billion people, twice today's urban population, will be living in urban areas by the year 2000.

Scholars and policymakers often disagree when it comes to evaluating the desirability of current rapid rates of urban growth in many parts of the globe. Some see this trend as fostering national processes of socioeconomic development, particularly in the poorer and rapidly urbanizing countries of the Third World; whereas others believe the consequences to be largely undesirable and argue that such urban growth should be slowed down.

As part of a search for convincing evidence for or against rapid rates of urban growth, a Human Settlements and Services research team, working with the Food and Agriculture Program, is analyzing the transition of a national economy from a primarily rural agrarian to an urban industrial-service society. Data from several countries selected as case studies are being collected, and the research is focusing on two themes: spatial population growth and economic (agricultural) development, and resource/service demands of population growth and economic development.

This paper is one of several focusing on one of five case studies: Mexico. In it, a General Equilibrium Model of Urbanization and Development is built for the Mexican economy. The model includes some important market distortions, a relevant sectorial division, as well as a meaningful migration process for the Mexican case.

A list of related papers in the Population, Resources, and Growth Series appears at the end of this publication.

ABSTRACT

The objective of this research is to provide an economic framework for the evaluation of the Mexican urbanization process over the past three decades. As this cannot be done in a static context, the development of a dynamic simulation model is proposed.

The model emphasizes a rural-urban dichotomy giving special attention to rural-urban migration. Urban areas consist firstly of an informal sector, characterized by easy entrance, little technological progress, and flexible wages; and secondly of a formal sector whose main characteristic is rigidity of wages. On the other hand, rural areas are divided into sectors comprising commercial and subsistence agriculture. Migration is a disequilibrium phenomena perceived as a function of expected wage differentials between urban and rural areas. Rural migrants are thought of as searching for formal-sector jobs while being employed in the informal sector, and in this sense, under-employment rather than open-unemployment is emphasized.

Other features of the model are the inclusion of a public sector, whose main role is to channel public funds for the accumulation of capital in both urban and rural areas; and the specification of consumer demand functions. It is believed that the above constitutes a proper framework to evaluate the macroeconomic effects of urbanization, such as changes in production structure, employment levels, distribution of income between urban and rural areas, and changes in demand patterns.

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I. INTRODUCTION

One of the aspects of urbanization in Third World countries receiving little attention by researchers is that of its relationship with the rest of the economy and its implications for further development. Yet, the pattern of urbanization experienced by less industrialized countries is causing concern to such a point that measures are being proposed or implemented in order to influence the direction of migratory flows or reduce natural growth of population (Yap, 1976b). However, there exists an evident lack of systematic analysis performed in the context of general frameworks where the direct and indirect effects of such measures can be evaluated. This appears surprising given the historical debate over the social costs and benefits generated by rapid trends of urbanization.

Twenty years ago, the first scholars of modern economic development identified industrialization and urbanization as the main structural changes a country must undergo in order to achieve desirable levels of welfare. This notion was introduced as the core element in theoretical formulations (Lewis, 1954; Fei and Ranis, 1961; Jorgenson, 1961) and considered as a necessary condition for economic growth.

The argument was based on the historical observation that economic systems were composed of sectors characterized by a marked difference in factor endowments (quantitative and qualitative). Major variations in resource allocation generally produced a shift of factors from the less to the more productive sectors. Historically, this shift took place from agricultural to non-agricultural activities, and the most widely documented factor movement is that of labor. This even contributed to the particular impact of raising the efficiency level in the production of food, thus creating an agricultural surplus which, together with the released labor, provided the basis for industrialization and urbanization.

Consequently, urbanization was looked upon as one of the faces of the economic development phenomenon and its role in the well-being of society was hardly questioned. Besides 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 transforming traditional demographic, political, and consumptive behavior into the modern attitudes of industrial societies. Therefore, it has been the practice of most developing countries concerned with the eradication of poverty to foster policies oriented towards the increase of capital formation, industrialization, and urbanization as a means of triggering economic progress and of achieving predetermined levels of growth. As expected, some countries have gone from predominantly agricultural to relatively more industrialized economies, simultaneously showing an evident transformation in the spatial structure of economic activity as manifested in a substantial increase in urbanization levels.

However, the cost of urbanization has been high. According to recent observations (Morawetz, 1974; Sethuraman, 1976; Souza and Tokman, 1976; Todaro, 1976; and Friedmann and Sullivan, 1974) current rates of urbanization in developing countries are displaying a threatening phenomenon. Contrary to theoretical expectations, labor transfers from rural to urban areas are exceeding the economic system's ability of absorbtion. This inevitably leads to the undesirable appearance of urban unemployment or underemployment as reflected by the proliferation of petty service activities. The argument, based on this observation, is that the Third World population became prematurely urbanized in the sense that the percentage of people living in the cities was greater than the current stage of development could support. The interplay of unprecedented levels in net fertility rates along with the primary economic goal of rapid industrialization, has resulted in the unique pattern of "over-urbanization" displayed by the majority of the Third World countries (Wellisz, 1971). Thus, 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. 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 portion of urban underemployed imposes another obstacle to development, to the extent that society is forced to provide larger amounts of urban social infrastructure at the expense of directly productive public investments. Therefore, according to this viewpoint, urbanization as experienced by contemporary developing countries will not necessarily bring the country to the desirable level of welfare as earlier scholars once thought, but on the contrary is to be considered a major bottleneck in development and in fact contributes largely to the persistence of underdevelopment.

Although valid, the above observations have generally been the conclusions of only partial analysis in which growth of tertiary sectors were sometimes indiscriminately equated to the growth of petty services without making distinctions between growth of socially desirable services (e.g., medicine, education, etc.) and the less socially desirable ones (Gilbert, 1976). Moreover, they have failed to analyze what the people employed in petty service activities would be doing otherwise:

> If the alternative was unemployment in rural areas and a life without access to social facilities, then the role of petty services in providing a limited opportunity for employment and for children to go to school might be seen as a positive force. (Gilbert, 1976, p. 91).

It was not until recently that studies began to show a detailed analysis of income gains and assimilation of migrants in the urban labor markets. Yap, for example, has shown for the Brazilian case that significant improvements on income have occurred for individual rural-urban migrants, despite their underemployment status, when their net urban earnings are compared with those of their non-migrant counterparts (Yap, 1976b).

Given the results of current research, we are not prepared to assume *a priori* that current urbanization trends in Third World countries are bound to lead either to stagnation or to further development. Instead, we are inclined to analyze, as objectively as possible, the relationships between urbanization and economic development. For that purpose, and given the various arguments presented above, it is clear that only in the light of a general dynamic framework can the net outcome of opposing forces, generated by urbanization and development, be evaluated. Such a framework should be comprehensive and flexible enough to depict the interrelations and feedbacks of economic and demographic variables identified with the process of development. The elaboration of such a framework, as applied to the Mexican case, is the subject of the following pages.

II. URBANIZATION AND ECONOMIC DEVELOPMENT IN MEXICO: A BRIEF OVERVIEW

Mexican urbanization, as observed during recent decades, has reached spectacular dimensions. The country's total population rose from 19.6 million in 1940 to 49 million in 1970. At the same time the total urban population rose from 3.9 million in 1940 to 22 million in 1970. This implies an annual total population growth of 3.1 percent and an annual total urban population growth of 6.0 percent. (Table A.1 and A.2.) Mexico is a special case in which rural-urban migration has caused a doubling of the proportion of urban to total population approximately every 20 years.*

Despite the magnitude of the problem it was not until recently that Mexican policymakers became concerned with the possible consequences that this rapid urbanization trend could have on the rest of the economy.** Nevertheless, to our knowledge no rigorous analysis has been performed on this relationship and if urbanization is to be encouraged or discouraged, a detailed account and evaluation of the effects of different policies does not exist for the Mexican case.

It is our contention that in order to be able to understand this peculiar process of urbanization, it is necessary to have at least a general idea of the socio-economic context in which it has been taking place. What follows is a brief description of the main features of Mexican economic development.***

Agricultural-Industrial Policies Conforming Rural-Urban Migration

Modern Mexican development has been characterized by an impressive growth of output and a series of structural changes. Activities linked to rural areas have considerably declined in

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*John Friedman has used this doubling rate of urban population to define hyperurbanization. See Friedman (1973) pp. 91-114.

**The Ministry of Human Settlements was founded in early 1976, and its immediate concern has been the formulation of a National Plan of Urbanization. See SAHOP (1978).

***For a more detailed description of the workings of the Mexican economy see Reynolds (1970); Solis (1971); Hansen (1971); and King (1970).

their participation of total output, whereas urban bias activities have gained significant importance.

From 1940 to 1970, Mexican Gross Domestic Product (GDP)* per capita grew at an annual average rate of 3.2 percent. This is a particularly significant rate of output growth if we consider that for the same period the total population grew at a rate of 3.0 percent (Table A.3). A more detailed sectoral analysis can help to identify the main underlying changes in production structure that made this growth possible.

The share of GDP attributable to rural activities (primary sector) decreased from 19.4 percent in 1940 to 11.5 percent in 1970. For the same period, activities linked to urban areas (secondary sector) increased their participation from 25.1 percent to 34.0 percent. Particularly interesting is the fact that the manufacturing share of output alone went from 15.4 percent in 1940 to 22.5 percent in 1970 (Tables A.4. and A.5.). These figures imply that the country has gone from a predominately agrarian economy to a more industrialized one, satisfying in this way one of the prerequisites of economic progress.

What has made this growth and structural change possible? Mexican economic history reveals that current levels of industrialization and growth were made possible in part, by substantial increases in output and productivity in the agricultural sector. From 1940 to 1970 the total output per worker grew at an annual rate of 3.6 percent whereas the output per worker in the agricultural sector grew at an impressive rate of 3.4 percent. The same figures for industry and services were 2.7 percent and 1.8 percent, respectively. This implies that while output per worker in the economy as a whole almost tripled in a period of 30 years, agricultural output exhibited a 2.7 times increase, compared to 2.3 times for industry and 1.7 for services (see Table A.6, A.7, and A.8).

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*Gross Domestic Product is defined as Gross National Product minus net factor income from abroad.

Rising productivities in the agricultural sector have been considered by development scholars as one of the key elements in the modernization process. In an excellent article, Johnston and Mellor point out five ways in which rising agricultural productivity contribute to economic growth:

- o Meeting the growing internal demand for agricultural goods
- o Exporting the surplus to foreign markets providing the economy with the needed inflow of foreign exchange
- o Releasing labor force for non-agricultural activities
- o Transferring funds to non-agricultural activities which will contribute to the process of accumulation of capital
- o Enchancing the internal market for manufactured goods

(B. Johnston, and J. Mellor, 1961)

According to various studies most of these requirements were met, to a greater or lesser extent, by Mexican agricultural development. (See Solis, 1971, pp. 168-198, and Reynolds, 1970, ch. 2.)

Given the relevance of rising agricultural productivity in the process of development, it is of extreme importance for a developing country to design sound plans to bring about these increases. Looking into Mexican economic history, it can be seen that there were two ways in which post-revolutionary governments pursued this effort. Both policies shaped in a large extent the process of rural-urban migration and the current urbanization pattern.

First, the implementation of an extensive and profound agrarian reform during the 1930s not only provided the Mexican peasantry with the opportunity to possess a plot of land, but also for the first time, they were able to freely offer their labor services in either the rural or urban markets. To give an idea of the magnitude of this land reform, Solis reports that nearly

54.1 millions of hectares have been distributed since the 1930s (Solís, 1971, p. 155). This resulted in an evident deconcentration of land; in 1930 only 13 percent of cultivable land was in the form of *ejido** and private holdings smaller than 5 hecatres. By 1960 the figure was 53 percent (Hewitt de Alcantara, 1970, p.7). There are at least two ways in which this deconcentration of land contributed to the increase in agricultural output. On the one hand, land reform provided the peasant with the opportunity to freely choose which crop to grow, a factor which, according to Solís, helped to switch the use of some land from traditional and low productive crops to more commercial and productive ones (Solis, 1971, p. 158). On the other hand, and this as yet is an unproven hypothesis for the Mexican case, redistribution of land implied redistribution of income from those strata of population with low income elasticity of demand for agricultural goods to those with larger elasticity, possibly stimulating the demand for food. Nevertheless, due mainly to institutional factors as well as market forces the performance of the *ejido* land was not totally successful. The lack of access to financial sources (*ejido* land cannot be mortgaged) and more important the relatively small size of the plots hindered the formation of capital and increases in productivity (Solís, 1971, p.12). This has constrained a large portion of the agricultural sector from absorbing the technological innovations available because of the large capital-labor ratios required.

As a result, the expected increase in productivity with the implementation of a land reform policy was not met in many parts of the country. Furthermore, the particular increasing rates of population growth in these areas began to aggrevate the persistance of low productivity. This resulted in a critical food supply problem, causing the spread of subsistence consumption and the need for grain imports. These factors prompted the public sector to initiate a second, complementary policy.

Concomitantly to land reform, the government in Mexico formed a large scale program of public investment oriented to the development of a new and relatively more dynamic agricultural sector.

**Ejido* constitutes a group of land plots assigned to a community. Members of these communities can work the land during their lifetime and bequeath it to their descendents but cannot sell or pass it on to any non-community member.

In a recent statistical disclosure by the Banco de Mexico, it is shown how, in a period of ten years from 1940 to 1950, total annual gross fixed capital formation almost doubled as a percentage of GDP. The same study shows the highly important role of the public sector whose contribution to the capital formation was approximately 50 percent (Tables A.9 and A.10). This is particularly revealing because special attention was given by the Federal Government to the agricultural sector. Around 1940 the agricultural sector's share of public investment was 15 percent, increasing to 20 percent by 1945 (Table A.11). These funds were mainly directed to the clearing of new arable land, irrigation and communication infrastructure, and to the financing of research for new seed varieties. The new land was primarily given away in the form of private holdings and the average size of the plots provided the farmers with the adequate means needed to start up a significant mechanization process. This was reinforced by public policies, tending to reduce the relative price of capital resulting in a labor saving technology that began to spread in these new irrigated areas increasing productivity to highly significant levels.

These two policies of agricultural development, followed by the public sector, gave rise to an agricultural dichotomy which is well documented in the literature (Reynolds, 1970; Barraza, 1968; Flores, 1972; Johnston and Kilby, 1974; Solís, 1971; Hewitt de Alcantara, 1976). This dichotomy is made up of the existence of a commercial agricultural sector characterized by the use of irrigation systems, high capital-labor ratios, relatively high output per hectare, ability to adapt to technological changes and an entirely commercialized output. On the other hand, there is a subsistence agricultural sector which consists mainly of rain-fed agriculture, with low capital-labor ratios, and relatively low output per hectare. Farmers in this sector have been unable to adopt the kinds of technological change that has been offered to them.

Regarding the urban side of the story, Mexican industrialization has been evolving fairly rapidly and has been domestically oriented since the 1940s. Initially this orientation was a consequence of the Second World War, when foreign industries could not meet internal needs. After the war, the government imposed a policy of industrial protectionism against foreign competition. Other kinds of policies that fostered industrialization in Mexico were tax exemptions, subsidized financial funds, and an increasing attention to the development of the necessary infrastructure. Table A.11 shows evidence of the latter policy; public funds destined for industrial development practically doubled from 1940 to 1955, and the overall result is reflected in an impressive rate of annual growth: 7.5 percent from 1940 to 1970 (Table A.4).

However, the protectionism granted to the industrial sector, in conjunction with strong urban wage policies, resulted in a severe distortion of factor's prices. This led to the adoption, by the industrial sector, of highly capital-intensive technology.

> In the Mexican Economy, where machinery is scarce and labor abundant, prices of the former should be higher than the latter.... In other words, prices of factors of production should be in accordance to their respective abundance. But in Mexico this is not so. Techniques used in the production process of a wide sector of the Mexican Economy are the same or very similar to those used in other countries where labor is relatively scarce.... In Mexico, prices of factors of production have been modified in such a way that more intensive use of capital (scarce) has been encouraged relative to labor (abundant).* (Gollás, 1978, p. 81).

This technological aspect has constituted, in the long run, a major constraint for the Mexican economy in the effort to expand productive employment to a constantly growing urban labor force.

The implications of these policies for urbanization, and primarily for rural-urban migration, have been quite significant. On the one hand, the high rates of natural population growth; the extreme fragmentation of *ejido* land; and the technological impossibility to create more and more employment in commercial agriculture, have acted as strong "push" factors for the labor force from rural areas. On the other hand, the distortion of factor prices

*Translation is ours.

in urban areas, besides the urban concentration of public investment and public goods in recent years, have acted as strong "pull" factors. The result is a growing disparity of expected real wages between rural and urban areas, to which labor has responded by moving in a rather unique fashion.

Under these circumstances, what has been the effect of this massive transfer of labor force on the main macroeconomic variables of Mexico?

Urbanization and Output Growth

Transfers of population from rural to urban areas affects the supply of labor force at both places and productivity is expected to rise within rural areas. It will also rise in the urban areas, although not as rapidly as it would in the absence of rural-urban migration and under the pressure of rising capital-labor ratios.

In an attempt to isolate the role of rural-urban migration on these productivity changes,* we found that urbanization in Mexico is likely to have reinforced changes in the production structure and to have affected productivity levels positively. During the 1940-1950 decade, 53.0 percent of the aggregate productivity increase was attributed to shifts of labor from primary to secondary and tertiary sectors.** The 1950-1960 decade share was lower: 37.0 percent, due perhaps to the concentration of urban employment in activities with low productivity (disguised unemployment or underemployment). Moreover, the share shows a further decrease to 28.0 percent during the 1960s, which implies that as time goes by, the chances of increasing productivity by means of moving labor force from rural to urban areas are diminishing. This strategy of increasing productivity levels and

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* We acknowledge however, that rural-urban migration is only one factor of productivity change. Technical progress and capital formation constitute other factors.

** Assuming all primary activities as rural, and all other activites as urban, the flows can be considered as rural-urban. A detailed explanation of the estimation of this labor shift effect can be found in Appendix C.

fostering economic growth, relying on labor migration, seems to have worked out at the beginning of industrialization. More recently, however, urbanization seems to be fostering the spread of underemployment rather than the output per worker.

Urbanization and Employment

Under ideal circumstances, one would expect that during the process of development labor released from rural areas would be absorbed into industrial, high productive activities. This would not only prevent unemployment, but would also help narrow the income disparities between rural and urban areas. In reality, however, such a smooth transition is rarely found and it certainly has not been the experience of Mexico. Increasing Mexican sectoral productivities have, undoubtedly, enhanced employment opportunities. However, leading economic sectors, specifically those belonging to the urban-industrial, have exhibited very low rates of labor absorption. Thus, for a period of 30 years (1940-1970), industry has absorbed an average of only 19 percent of economically active population;* agriculture 54 percent; and services 27 percent (Tables A.12 and A.13). As was already briefly mentioned, there exist at least two explanations as to why the urban-industrial sector is unable to absorb a larger proportion of the growing urban labor force.

First, one is inclined to believe that non-market forces, such as unionism and labor welfare policies adapted by recent administration, have pushed the urban industrial wage above the level ensured by competitive conditions. To the extent that profit-maximizing firms tend to equate labor productivity to this "institutional wage", workers are forced to engage in other urban activities or to remain unemployed.

*These figures are derived from Mexican censuses where economically active population is recorded as those respondents who indicated that they had an occupation at the time of the interview, independent of their income (Isbister, 1971, p. 25). Therefore, underemployment is not detected. One generalized way of defining underemployment comprises all those activities that provide the worker with an income below the minimum wage officially set by the government.

Second, this distortion of factor prices in Mexico has encouraged the adoption of imported technologies which are not suitable for the country's relative factor supply. Industrial technology is generally imported from economic systems experiencing high wage-rental ratios. Rising wage-rental ratios in the economy leads to a process of substitution of capital for labor. There is evidence in Mexico of the industrial sectors inability to respond satisfactorily to changes in labor-factor supply. A very rough approximation of that sector's elasticity of substitution of capital for labor yielded a value of 0.79 percent.*

The overall result of these two forces is that a considerably large proportion of the growing urban labor force in Mexico is engaged in activities belonging to the so-called service or tertiary sector. However, the rather large size of this sector contrasts with the current stage of Mexican development, which leads us to believe that street vendors, petty merchants and other types of urban underemployment is proliferating.** Recent studies tend to partially confirm this belief,and it has been found that approximately 30 percent of the income in Mexico City and the State of Mexico is generated by these types of informal activities (Souza, 1976, p. 358). Another report states that 65 percent of the total population of Tijuana (a bordering city with the U.S.) belong to this sector (Nolasco, 1978).

In short, it undoubtedly seems that economic development in Mexico has had a concomitant effect in increasing high productive employment. However, massive rural-urban migration in combination with high net fertility rates, technological constraints and institutional factors seem to have impulsed the spreading of underemployment.

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*The estimation procedure and results are contained in Colosio (1978) which is available upon request.

**Urban underemployment has recently been studied as a separate sector of the urban economy, see for example Kannappan (1977). The sector has received various different names such as: unorganized, traditional, marginal, unprotected, informal etc.

Urbanization and Rural-Urban Income Disparities

Urbanization, through its migration component, has a definite impact on the distribution of income between rural and urban areas. The movement of workers from rural to urban areas tends to produce a more egalitarian rural-urban income distribution to the extent that rural out-migration alters productivity levels positively.

Mexican economic development has been characterized by a marked income differential between rural and urban areas. Nevertheless, this inequality has tended to decline in recent decades. Around 1940, the average income in urban areas was eight times greater than in rural areas. By 1970, this differential was five (Table A.14). Since one of the main components of average income is sectoral productivity,* rural-urban migration presumably had a lot to do with this gap reduction, for it is important to remember that a large proportion of productivity increase in the economy is explained by rural outmigration.

Despite this alternation of rural-urban disparities, the size of income distribution within both rural and urban economies appears to have deteriorated mainly because of growing underemployment. From 1940 to 1969, the share of income participation of the population with the lowest income (poorest 50 percent) fell from 19.1 percent to 15.0 percent (Table A.15). Moreover, the distributive consequences of the growing urban underemployment seems to be reflected in the results of a recent study on the components of Mexican income inequalities where it is shown that in 1968, 60 percent of the countrywide inequality was caused by inequalities within urban areas** (Table A.16).

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*Rural average income is measured as GDP per worker in primary sector, whereas urban average income is measured as GDP per worker in secondary and tertiary sectors. GDP per capita is a good proxy for average income in Mexico, see Van Ginneken (1976) pp. 39-40.

**Admittedly, all the evidence presented in this particular section falls short of considering ownerships of capital. The reason being lack of proper available data.

Urbanization and Consumption Structure

A common, neglected factor in economic development has been the role of demand, even through its importance has been recognized for a long time.

It is understood that the structure of consumption depends on a series of socioeconomic factors operating in society at a certain point in time. However, a longtime studied relationship is that of different consumption and income levels. Households with low income levels tend to satisfy their needs by allocating a large proportion of their income to the aquisition of basic goods, like food and clothing, whereas households with high incomes levels allocate a smaller proportion of their income to these types of goods and a larger part to those so-called durables such as automobiles, electrical appliances, etc. Therefore, to the extent that a society reaches a higher living standard, a larger consumption of industrial goods is expected.

One way urbanization contributes to the changes in consumption patterns is by contributing to the changes in real income levels. In the absence of rigidities, prices of industrial goods, in terms of agricultural goods, tend to decline with growing urbanization. Moreover, urbanization is expected to raise per capita income which would tend to increase consumption of high income elasticity goods. These income and price changes are expected to produce, in the medium run, a combined force, fostering the transformation of the structure of production.

In Mexico there is clear evidence of differentials in consumption patterns between rural and urban families. A survey on income and expenditures of Mexican households revealed that income elasticities for agricultural commodities were higher in rural than in urban areas, whereas income elasticities for manufactured goods were higher among urban than rural consumers (Banco de Mexico, 1966, pp. 407-413). It is in this respect that urbanization in Mexico may have, to a certain degree, contributed to the declining share of manufacturing output. However, a concise estimate of this is nonexistent for the Mexican case. Furthermore, in a dynamic context it is unclear yet as to what extent underemployment in urban areas hinders this expected transformation effect.

Thus far, we have talked about what we believe are some of the most important relationships of urbanization and various macroeconomic variables in Mexico. However, our views are supported only by the results of partial and isolated analyses found in the literature. A more robust and clearer evidence of these interactions can be obtained with the help of a systematic approach to the problem. The next section presents the structure of a macroeconomic model attempting to capture the main features of the Mexican economy.

III. A MACROECONOMIC MODEL OF DEVELOPMENT AND URBANIZATION FOR THE MEXICAN ECONOMY

Efforts directed towards the construction of macroeconomic models--where interactions between urbanization and economic development could be analyzed--have been scarce. In Rogers's words:

> A fuller set of social consequences of rural-urban migration can be captured with a modelling framework that explicitly incorporates relationships between demographic and economic change. But progress in the development of such macroeconomic models has been very slow with the result that we have not advanced much beyond the pioneering framework provided by Coale and Hoover two decades ago. (Rogers, 1977, p. 47.)

Most studies on the economics of urbanization concentrate on the microeconomics of its main component: rural-urban migration. This has been done primarily with the purpose of elucidating the determinants of migration and the gains occurring to the migrant (Herrick, 1971; Gaude and Peek, 1976).

There are however some exceptions and Yap's study on Brazil is, in our view, one of the most complete and representative (Yap 1976a). In her analysis, the impacts of rural-urban migration are captured by means of a three-sector simulation model. She found that with lower than actual rates of migration the following variables experienced lower levels: rural-urban income differentials; sectoral value added; and capital accumulation. Furthermore, the sectoral wage inequality would have been greater under lower rates of migration. Therefore, the author concludes that rural-urban migration has been positive for the country's development. Although the study includes an informal urban sector, it fails to emphasize the structural relationships that exist between this sector and the modern-industrial one. This can be done by bringing demand into the analysis.

Quantitative development studies including supply and demand aspects in a general equilibrium framework are not very common in the literature. It is in this respect that the Kelley, Williamson and Cheetham (KWC) model represents a step forward in modeling economic development, for it includes supply and demand conditions interacting simultaneously (Kelley, et al., 1972). Their model correctly combines elements of growth theory with economics of development. However, in their attempt to generalize as much as possible, the authors fail to recognize some important and very common problems connected with current developing countries, such as urban (and rural) unemployment or underemployment; imperfections in both factor and output markets; and the frequently strong influence of the public sector.

In the following we present the structure of a simulation model for the Mexican economy. The model includes some important market distortions; a relevant sectorial division as well as a meaningful migration process for the Mexican case. With this model, we try to capture the behavior of the most important economic variables under a pronounced process of urbanization and development occurring in Mexico over the past three decades.

The Model

The model presented below is of the general equilibrium type exhibiting some market imperfections. Given the scarcity of consistent time series data for most of the variables to be considered, the econometric estimation of the model is not yet possible.* Instead, we have adopted a simulation modeling approach (see Simon, 1976; Kelley and Williamson, 1974; Yap, 1976a; Edmonston et al., 1976 among others, as an example of this type of study). Our purpose is:

- To formulate the structure of the model by means of a set of equations where the elements of three branches of economics are considered: Growth Theory; Economics of Development; and Economics of Migration
- To provide the model with a set of initial conditions and parameters which can be extracted from the literature or partially estimated

*See Barraza (1968) for a courageous yet unsuccessful attempt in this respect.

- To use computer simulation techniques to generate yearly results
- To evaluate the performance of the model by means of a comparison of the generated results with historical records
- To test the implications of varying certain policy variables in the general context provided by the model*

Sectors and Variables

The model consists of four productive sectors which differ among themselves in factor use, technical change, and organization of the means of production. There is also a public sector whose activities consist of taxing, investing and consuming. Since our ultimate objective is to capture the main relationships between urbanization and economic development, a special emphasis is given to a rural-urban dichotomy (see Table 1). The variables and parameters of our model-economy are given in Table 2.

Table 1. Sectors of the model-economy

SECTOR	CODE
Modern-Industrial	1
Commercial-Agriculture	2
Small-scale Agriculture	3
Urban-Informal	4
Public Sector	5

*This paper is restricted to the first point enumerated above. The fulfillment of the remaining points will be the subject of forthcoming papers.

Table 2. Variables and Parameters

Endogenous Variables

X_i = Gross output in sector i = 1,2,3,4

P_i = Relative price of output of sector i = 2,3,4 in terms of industrial output

W_i = Real wage rate in sector i = 2,3,4

L_i = Labor input in sector i = 1,2,3,4

K_i = Capital input in sector i = 1,2,3

r_i = Rate of return to capital i = 1,2,3

q_i = Rate of return to land i = 2,3

L_r = Rural labor force

L_u = Urban labor force

M_{ru} = Rate of net rural-urban migration

$\overline{S}_i$ = Total savings of sector i = 1,2,3

$\overline{Y}_i^c$ = After taxes income of capitalists in sector i = 1,2

$\overline{Y}_i^l$ = After taxes income of labor in sector i = 1,2

$\overline{Y}_3$ = After taxes income in sector 3

I_{11} = Funds invested into sector 1 originated in sector 1

I_{21} = Funds invested into sector 2 originated in sector 1

I_{12} = Funds invested into sector 1 originated in sector 2

I_{22} = Funds invested into sector 2 originated in sector 2

I_{i5} = Public funds destined for physical investment in sector i = 1,2,3.

G = Public budget

D_{1j}^c = Consumption of good 1 by capitalists of sector j = 1,2

D_{1j}^l = Consumption of good 1 by laborers of sector j = 1,2,3,4

Π_1 = Probability of obtaining a modern-industrial job

Π_4 = Probability of obtaining an informal job

D^c_{2j} = Consumption of good 2 by capitalists of sector j = 1,2

D^l_{2j} = Consumption of good 2 by laborers of sector j = 1,2,3,4

D^c_{3j} = Consumption of good 3 by capitalists of sector j = 1,2

D^l_{3j} = Consumption of good 3 by laborers of sector j = 1,2,3,4

D^c_{41} = Consumption of good 4 by capitalists of sector 1

D^l_{4j} = Consumption of good 4 by laborers of sector j = 1,4

D_5 = Public consumption

Exogenous Variables and Parameters

K = Initial total stock of capital

L = Initial total amount of labor

$\overline{W}_i$ = Real wage rate in manufacturing

x_i = Factor augmenting technological progress for capital in sector i = 1,2

λ^K_i = Rate of change of augmenting technological progress for capital in sector i = 1,2

y_i = Factor augmenting technological progress for labor in sector i = 1,2

λ^L_i = Rate of change of augmenting technological progress for labor in sector i = 1,2

A_i = Disembodied neutral technological progress in sector i = 1,2,3

λ^A_i = Rate of change of disembodied neutral technological progress in sector i = 1,2,3

θ_K = Distribution parameter of capital in sector 1

θ_L = Distribution parameter of labor in sector 1

δ_K = Distribution parameter of capital in sector 2

δ_L = Distribution parameter of labor in sector 2

δ_R = Distribution parameter of land in sector 2

ζ_1 = Distribution parameter of capital in sector 3

ζ_2 = Distribution parameter of labor in sector 3

N_r = Natural growth of population in rural areas

N_u = Natural growth of population in urban areas

ζ_3 = Distribution parameter of land in sector 3

σ_1 = Elasticity of substitution in sector 1

σ_2 = Elasticity of substitution in sector 2

ζ_4 = Productivity parameter of labor in sector 4

α_4 = Terms of trade parameters of sector 4

$\bar{C}$ = Cost of migration

k = Depreciation rate

s_i^c = Propensity to save by capitalists of sector i = 1,2

s_i^l = Propensity to save by laborers of sector i = 1,2

s_3 = Propensity to save in sector 3

τ_i^c = Tax rate to income of capitalists of sector i = 1,2

τ_i^l = Tax rate to income of laborers of sector i = 1,2

τ_3 = Tax rate to income in sector 3

$\hat{\tau}_1$ = Indirect tax rate on consumption of goods and services i = 1,2,3,4

λ_r^N = Natural rate of population growth in rural areas

λ_u^N = Natural rate of population growth in urban areas

ρ_1 = Elasticity parameter of sector 1 where $\sigma_1 = \frac{1}{\sigma_1 - 1}$

ρ_2 = Elasticity parameter of sector 2 where $\sigma_2 = \frac{1}{\sigma_2 - 1}$

R_2 = Land allocated to the commercial agriculture

R_3 = Land allocated to the small-scale agriculture

m = Migration parameter

ξ_i = Fraction of savings $\bar{S}_i$ invested in the same sector i = 1,2

ζ_i = Public investment parameters where i = 5,6,7,8,9,10,11

p_i = Allocation parameter of public consumption

d_i = Public consumption parameters where i = 0,1,2

b_3 = Minimal bundle of essential goods

a_{ij}^c = Private consumption parameter of capitalists in sector j consuming good i

a_{ij}^l = Private consumption parameter of laborers of sector j consuming good i

Technology of the Economy

Urban Sectors

$$X_{1(t)} = A_{1(t)} \left[\theta_K \left(x_{1(t)} \; K_{1(t)} \right)^{-\rho_1} + \theta_L \left(y_{1(t)} \; L_{1(t)} \right)^{-\rho_1} \right]^{-\frac{1}{\rho_1}} \qquad (1)$$

$$X_{4(t)} = \zeta_4 \; L_{4(t)} \qquad (2)$$

Rural Sectors

$$X_{2(t)} = A_{2(t)} \left[\delta_K \left(x_{2(t)} \; K_{2(t)} \right)^{-\rho_2} + \delta_L \left(y_{2(t)} \; L_{2(t)} \right)^{-\rho_2} + \delta_R \left(R_{2(t)} \right)^{-\rho_2} \right]^{-\frac{1}{\rho_2}} \qquad (3)$$

$$X_{3(t)} = A_{3(t)} \; K_{3(t)}^{\zeta_1} \; L_{3(t)}^{\zeta_2} \; R_{3(t)}^{\zeta_3} \qquad (4)$$

Equations (1) and (2) depict the dualistic characteristic of most Mexican cities where it is very common to find a modern-industrial (formal) sector operating in conjunction with an informal sector (Souza and Tokman, 1976).

We assume that the structural composition of our modern-industrial sector is comprised mainly of firms with large capital-labor ratios whose output can be consumed or invested. By dividing the urban economy in a transversal fashion, firms belonging to this lumpted-industrial sector are: part of manufacturing (private and state owned); some type of highly mechanized services (e.g., banking, supermarkets, computerized services, etc.); transportation; energy, and some construction activities.

It has already been mentioned that one of the main features of this modern lumped-industrial urban sector is its limited substitution possibilities of capital for labor. Therefore, in order to examine this technological aspect we have adopted a constant-elasticity substitution (CES) production function (equation (1)). Such a function is able to exhibit a range of elasticity of substitution values of which one is unity. Besides the latter, there is one more important implication associated with the use of CES. In a long-run context, the factor shares on income are bound to vary. However, an elasticity of substitution equal to one implies that such shares will remain constant. It is only with elasticities of substitution different than one that it is possible to capture these variations of factor shares in income.*

On the other hand, the urban economy is also composed of what we are inclined to call an Informal Urban Sector (equation (2)) which is comprised of largely labor-intensive activities and accommodates all those members of the urban labor force (regardless of whether they are old members or new entrants) who are not able to find employment in industrial activities. The structure of the sector is characterized by easy entrance, low productivity levels, and almost no technological change. We assume, along with conventional views (Mazumdar, 1975; Fields, 1975; Kannappan, 1977; Sethuraman, 1976; Corden and Findlay, 1975) that the labor force for this sector behaves as in a perfect *casual* market and that each worker is provided with the same capabilities. Such being the case, we can think of the productivity parameter in equation (2) as being the product of: a) the "net value added" produced by a worker in a *day* of work, and b) the number of days of work in a certain period of time (Mazumdar, 1975).

Equations (3) and (4) on the other hand, try to capture the agricultural duality found in rural Mexico. Commercial agriculture is composed of all irrigated farms having relatively high capital intensive techniques, with relatively large rates of total technical progress, high proportions of output per hectare, and most of its output commercialized. This sector is represented in our model by a CES production function, allowing for variations in factor shares in income as well as for the limitations

*See Colosio (1978) for a brief summary of this well-known aspect of theory production.

in factor substitution. Conversely, there is an agricultural sector characterized as rain-fed agriculture, with low capital-labor ratios, relatively low technical progress, and most of its output destined for subsistence consumption. This sector is depicted by means of a Cobb-Douglas production function since variations in factor shares in income have not been substantially important.

As stated, the model includes the workings of a) factor augmenting, and b) disembodied technological progress.* Both types of technical change are defined as a function of time and are presented in Table 3.

Table 3. Functions of Disembodied and Factor Agumenting Technological Progress

Functions of Technological Progress	
Disembodied	Factor Augmenting
$A_{1(t)} = A_{1(0)} e^{\lambda_1^A t}$	$x_{1(t)} = x_{1(0)} e^{\lambda_1^K t}$
$A_{2(t)} = A_{2(0)} e^{\lambda_2^A t}$	$x_{2(t)} = x_{2(0)} e^{\lambda_2^K t}$
$A_{3(t)} = A_{3(0)} e^{\lambda_3^A t}$	$y_{1(t)} = y_{1(0)} e^{\lambda_1^L t}$
	$y_{2(t)} = y_{2(0)} e^{\lambda_2^L t}$

At the same time, the model is suitable for the analysis of a) output-raising effect of technological change, as well as for b) the factor saving bias of technological progress.

*For an excellent treatment of the subject see Allen (1967) and Dixit (1976). See also Yotopolous and Nugent (1976) for an empirical treatment.

The output-raising effect of technological change holding inputs is defined as

$$T_{i(t)} = \frac{\partial X_{i(t)}}{\partial_t} \frac{1}{X_{i(t)}} \qquad i = 1,2,3$$

such that for each one of the sectors we have:

$$T_{1(t)} = \lambda_1^A + \alpha_{1K(t)} \lambda_1^K + \alpha_{1L(t)} \lambda_1^L$$

$$T_{2(t)} = \lambda_2^A + \alpha_{2K(t)} \lambda_2^K + \alpha_{2L(t)} \lambda_2^L$$

$$T_{3(t)} = \lambda_3^A$$

where $\alpha_{ij(t)}$ represents the j^th^ factor's share in the income of the i^th^ sector at time t.

Factor-saving bias for capital and labor is commonly defined as:

$$B_{i(t)} = \frac{\partial X_{ik(t)}}{\partial_t} \frac{1}{X_{ik(t)}} - \frac{\partial X_{iL(t)}}{\partial_t} \frac{1}{X_{iL(t)}}$$

where $X_{ik(t)}$ and $X_{iL(t)}$ are marginal products of capital and labor, respectively, in the i^th^ sector. The latter equation implies that technical progress is labor-saving if $B_i > 0$; capital-saving if $B_i < 0$; and neutral if $B_i = 0$. (See Yotopolous and Nugent, 1976, p. 147).

It can be proved that the previous equation can be transformed into the following expression*

$$B_{i(t)} = \frac{\left(\lambda_{iL} - \lambda_{iK}\right)\left(1 - \sigma_i\right)}{\sigma_i} \quad .$$

In Mexico, there is some evidence that for both commercial agriculture and industrial sectors, technological progress has been labor saving.** Therefore, if we are willing to accept that $B_{1(t)} > 0$, we can conclude that $\lambda_{1L} > \lambda_{1K}$ since we have estimated a $\sigma_1 \approx 0.79$. A similar conclusion for the commercial agriculture sector is dependent upon the estimation of the elasticity of substitution for that sector.*** Nevertheless, since agricultural techniques in northern Mexico--where most of the commercial agriculture is to be found--hardly differ from those used in the southwest United States, we could adopt the findings of Lianos which are $B_2 > 0$ and $\sigma_2 > 1$, which imply, by means of the above equation that $\lambda_{2k} > \lambda_{2k}$ (see Lianos, 1971, p. 419).

Labor Markets

The total supply of labor force in the economy at any point in time, $L_{(t)}$, equals its distribution among rural labor force, $L_{r(t)}$, and urban labor force, $L_{u(t)}$. That is:

$$L_{(t)} = L_{r(t)} + L_{u(t)} \qquad (5)$$

---

*See Ferguson (1969) pp. 243-244.

**There is no quantitative ascertion of this. Nevertheless, some evidence is shown for the agricultural sector in Hewitt de Alcantara (1976) and for the industrial sector in Gollás (1978).

***Most of the estimations have been done by using Cobb-Douglas production functions. Therefore, by definition, elasticity is equal to one.

where

$$L_{r(t)} = N_{r(t)} - M_{ru(t)} \tag{6}$$

and

$$L_{u(t)} = N_{u(t)} + M_{ru(t)} \quad . \tag{7}$$

Equations (6) and (7) depict the natural and social composition of labor force in rural and urban areas,respectively. More specifically, the natural growth of population is given by:

$$N_r(t) = N_{r(0)} \; e^{\lambda_r^N t} \tag{8}$$

and

$$N_{u(t)} = N_{u(0)} \; e^{\lambda_u^N t} \quad . \tag{9}$$

The social composition is given by net rural-urban migration, $M_{ru(t)}$ which will be defined below.

Rural Labor Demand

It is assumed that entrepreneurs in commercial agriculture remunerate labor according to the level of labor marginal product. Therefore, from equation (3) it follows that real wages for this sector $\frac{W_{2(t)}}{P_{2(t)}}$ are given by

$$\frac{W_{2(t)}}{P_{2(t)}} = \left(\delta_2 \; A_{2(t)} \; \gamma_{2(t)}\right) [\cdots\cdot]^{\frac{1}{\sigma_2 - 1}} \left(\gamma_{2(t)} \; L_{2(t)}\right)^{-\frac{1}{\sigma_2}} \tag{10}$$

where $P_{2(t)}$ is the price level of commercial agriculture output in terms of price level of industrial output.

Equation (10)* can be rearranged to express labor demand as

$$L_{2(t)} = \left(\frac{W_{2(t)}}{P_{2(t)}}\right)^{-\sigma_1} \left(A_{2(t)}\delta_2\right)^{-\sigma_2} [\cdots\cdot]^{\frac{\sigma_2}{\sigma_2-1}} \left(Y_{2(t)}\right)^{(\sigma_2-1)} \qquad (11)^*$$

One of the consequences of land reform in Mexico was the fact that peasants became not only the suppliers of labor input but also the owners of whatever capital was involved in the production process. Therefore, it is not unrealistic to think of total income accruing to farmers in subsistence agriculture as the average product at every point in time. In other words, income in this sector includes wage rate plus the flow value of capital and the imputed rents to land. Thus,

$$\frac{W_{3(t)}}{P_{3(t)}} = \frac{X_{3(t)}}{L_{3(t)}} \quad . \qquad (12)$$

Equation (12) implies that income accruing to farmers in subsistence agriculture is in direct relation to the amounts of capital and land, and inversely related to the amount of labor used in the production process. Therefore, the optimal amount of labor employed in this sector is given by:

$$L_{3(t)} = \left(\frac{P_{3(t)}}{W_{3(t)}}\right)\left(X_{3(t)}\right) \qquad (13)$$

---

*Unless otherwise stated, the notation $[\cdots\cdot]$ denotes

$$\left[\delta_1\left(X_{2(t)}\ K_{2(t)}\right)^{-\rho_2} + \delta_2\left(Y_{2(t)}\ L_{2(t)}\right)^{\rho_2} + \delta_3\left(R_{2(t)}\right)^{-\rho_2}\right]^{-\frac{1}{\rho_2}}$$

We assume that in urban areas, industrial entrepreneurs hire labor factor to the point that marginal product equates an *institutional wage* rate, set by social governmental policies. Therefore, real wages $\bar{W}_{1(t)}$, are expressed as

$$\bar{W}_{1(t)} = \theta_L \, A_{1(t)} \, Y_{1(t)} \, [\cdots\cdot]^{\frac{1}{\sigma_1 - 1}} \left(Y_{1(t)} \, L_{1(t)} \right)^{-\frac{1}{\sigma_1}} \tag{14}$$

from which we obtain the labor demand by this sector at time (t):

$$L_{1(t)} = \left(\bar{W}_{1(t)}\right)^{-\sigma_1} \left(A_{1(t)} \, \delta_1\right)^{-\sigma_1} \left(Y_{1(t)}\right)^{(\sigma_1 - 1)} \quad [\cdots\cdot]^{\left(\frac{\sigma_1}{\sigma_1 - 1}\right)} , \tag{15}$$

By means of the assumptions made with respect to the urban informal sector, we assume wages to be the result of income sharing. That is

$$W_{4(t)} = P_{4(t)} \frac{X_{4(t)}}{L_{4(t)}} \tag{16}$$

where $P_{4(t)}$ is the terms of trade between the modern-industrial and the informal-urban sectors, and is defined as

$$P_{4(t)} = \alpha_4 \left(\frac{X_{1(t)}}{X_{4(t)}} \right) , \qquad \alpha_4 > 0 \tag{17}$$

and

$$L_{4(t)} = L_{u(t)} - L_{1(t)} \tag{18}$$

Equations (16) and (17) illustrate one of the main features of our model-economy: the structural relationships existing between modern-industrial and informal service sectors. Despite the fact that physical productivity of labor (ζ_4) is assumed constant and the same for every laborer, real wages can vary. The real wage rate is directly related to output in the modern-industrial sector, and inversely related to the number of participants in the informal sector. This can be better illustrated by substituting (17) into (16) yielding

$$W_4 = \frac{\alpha_4 \; X_{1(t)}}{L_{4(t)}} \quad . \tag{19}$$

In rural areas, labor is allocated to commercial and small-scale agriculture in such a way that real wages of both sectors are equalized. That is:

$$W_{2(t)} = W_{r(t)} = W_{3(t)} \quad . \tag{20}$$

This condition implies that once rural-urban migration takes place, the remaining rural population (see equation 6) is fully employed by means of the wage adjustment mechanism.

If we assume, for the sake of illustration, that everything except labor is constant in the agricultural production process, then the rural employment conditions at certain periods of time can be represented by Figure 1.*

In Figure 1, line MM represents productivity of labor in subsistence agriculture whereas NN represents productivity in commercial agriculture. The latter line is steeper than the former representing the duality in productivity levels as exhibited by Mexican agriculture. Furthermore, notice that line MM represents

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*Figures 1, 2 and 3 are based on those presented in Corden and Findlay (1975).

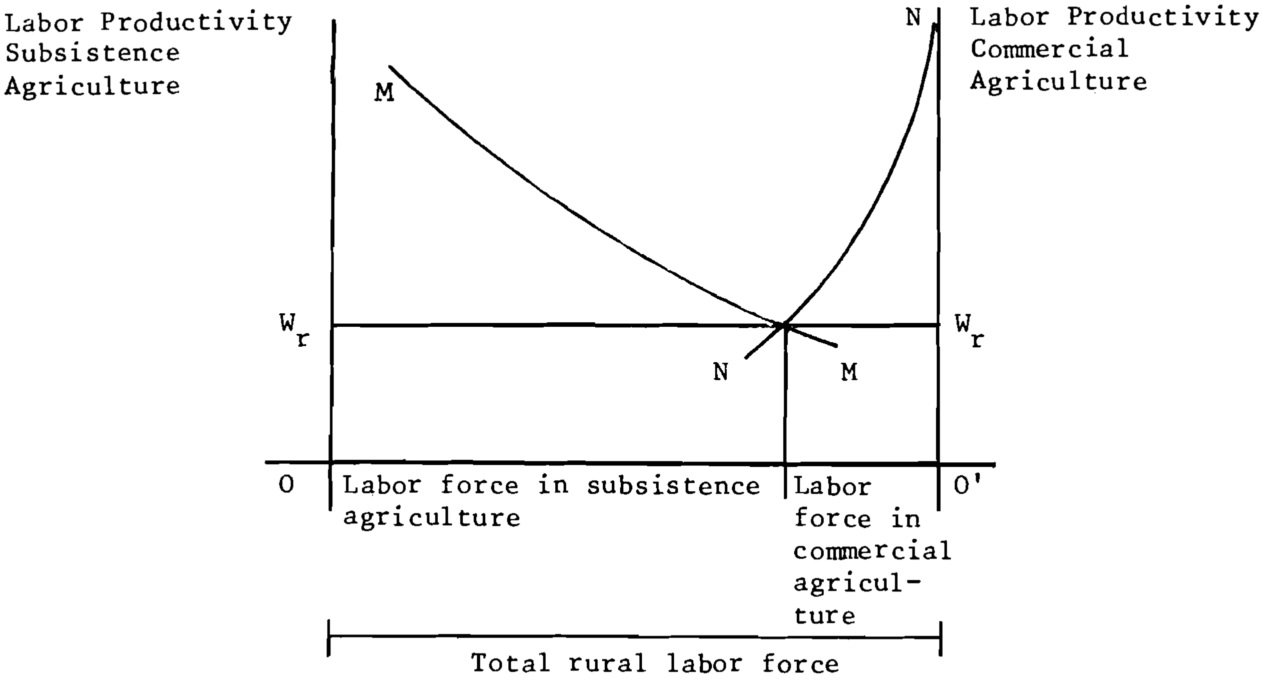

Figure 1. Rural labor force allocation

average productivity rather than marginal productivity including, therefore, returns to capital. Since rural-rural migration is not the subject of our study, we assume that a common wage prevails for both sectors. This rural wage, W_4, is set by the intersection of the two lines in Figure 1, given the full employment allocation of labor in rural areas.

In urban areas, labor is allocated to modern-industrial and informal service sectors in such a way that an urban wage gap arises. Specifically, industrial entrepreneurs behave efficiently to equate the marginal product of labor to an institutional (exogenously given) wage, which is supposed to be higher than that which would prevail under competitive conditions. This can be clarified by means of Figure 2, which is drawn assuming static conditions.

Under competitive conditions, the common urban wage would be W_4 and the allocation of urban labor force at certain points in time would be OZ for the informal sector and O'Z for the industrial sector, that is, the intersection of QQ and W_4.

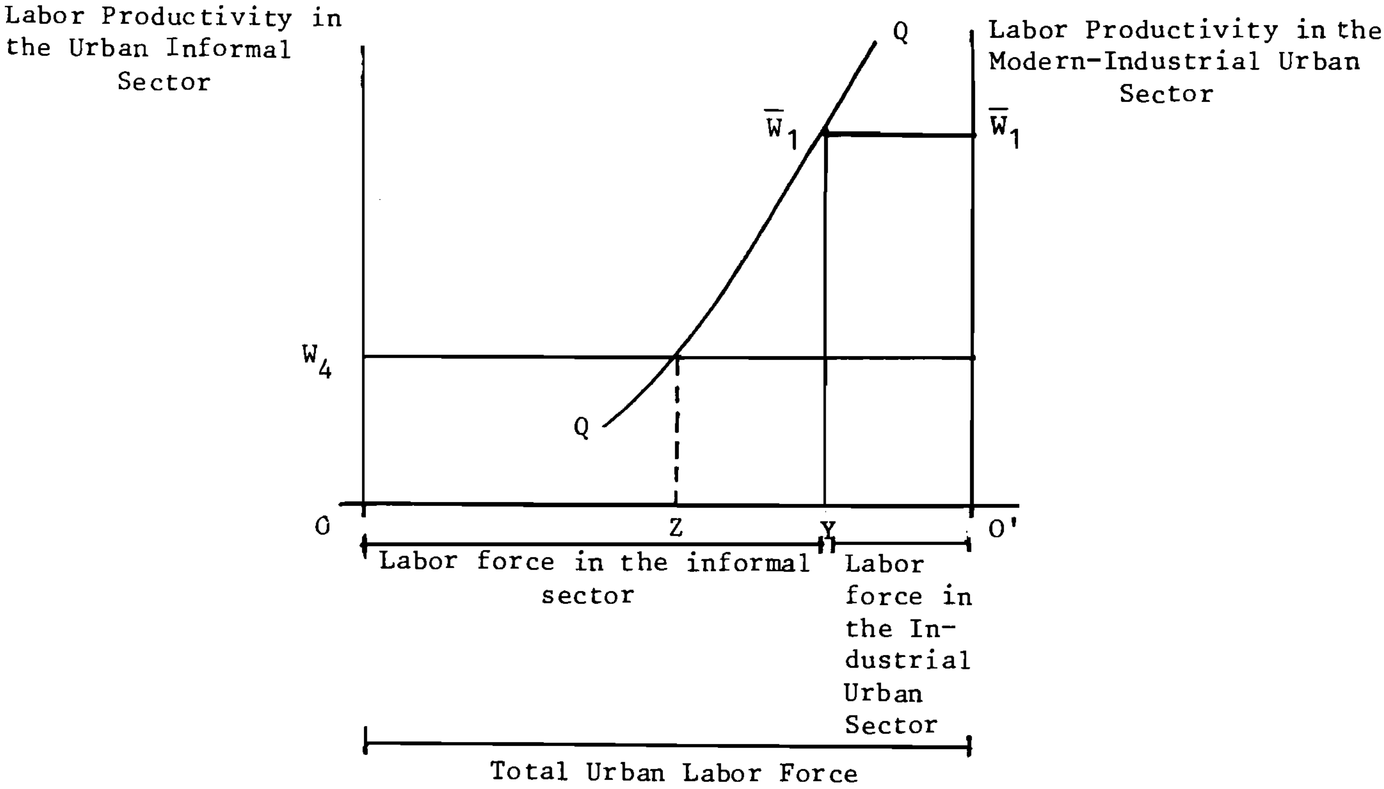

Figure 2. Urban labor force allocation

However, industrial entrepreneurs facing a wage level of $O'\overline{W}_1$, are forced to employ O'Y labor. In our model, instead of considering ZY as unemployed urban labor force, it is assigned to an underemployed status, expanding in this way the informal sector to OY.

Labor Migration

Rural-urban migration in our model is motivated mainly by economic forces.* Labor moves from rural to urban areas as a response to differentials in *real expected wages*.** The theory of migration, based on the concept of expected wage, is well

*This is not a bad assumption for the Mexican case. In a migration survey, seventy percent of the migrants to the city of Monterrey, Mexico, have declared to be moving for economic reasons (Gilbert, 1976, p. 115).

**For a detailed exposition of the concept of expected wages see Todaro (1969); Harris and Todaro (1970); Todaro (1976); Fields (1975); Corden and Findlay (1975); and Rempel (1978).

suited for our modeling purposes since it was set forward with the aim of explaining positive rates of rural-urban migration, despite the presence of urban unemployment or underemployment.

The theoretical argument is that the urban expected wage, W_u^{ε}, is defined as the *discounted value* of the wage that a migrant expects to earn in the city. Algebraically:

$$W_u^{\varepsilon} = \int_{t=0}^{n} \Pi_{1(t)} \, \overline{W}_1 \, e^{-rt} \, d_t + \int_{t=0}^{n} \Pi_{4(t)} \, W_{4(t)} \, e^{-rt} \, d_t$$

where r denotes a common discount rate; n the time horizon and $\Pi_{1(t)}$ and $\Pi_{4(t)}$ are the probabilities of obtaining employment in industrial and informal activities, respectively. These probabilities are a function of the proportion of urban workers already employed in the two sectors and of the rate of new employment openings as well. Thus,

$$\Pi_{1(t)} = \phi_1 \left(\eta_1, \frac{L_{1(0)}}{L_{u(0)}} \right) \quad , \qquad \phi_1' > 0$$

and

$$\Pi_{4(t)} = \phi_4 \left(\eta_4, \frac{L_{4(0)}}{L_{u(0)}} \right) \quad , \qquad \phi_4' > 0 \quad .$$

Note that η_1 (the rate of change of labor demand in industry) can be obtained by deriving equation (15) with respect to time,* whereas the rate of change of jobs in the informal sector, η_4 depends upon the new number of available days of work, which in turn, depends on changes in demand for the service.

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*More general formulations determine this rate, not only by subtracting productivity growth to output growth as it would be in our case, but also by considering labor turnover. See Stiglitz (1974).

Migration is considered to be rational in the extent that present value of urban wages, net of migration costs, $\bar{C}$, is greater than the present value of rural wages. Therefore, migration $M_{ru(t)}$ can be expressed in a general form as

$$M_{ru(t)} = F\left[\left(W^{\varepsilon}_{u(t)} - \bar{C}\right) - \bar{W}_{r(t)}\right] \quad , \quad F' > 0$$

where

$$\bar{W}_{r(t)} = \int_{t=0}^{N} W_{r(t)} \, e^{-rt} \, dt \quad .$$

Thus, migration will cease when the following condition holds

$$W^{\varepsilon}_{u(t)} - \bar{C} = \int_{r=0}^{N} W_{r(t)} \, e^{rt} \, dt \quad .$$

For our purposes, we adopt the postulates of this theory and a short time horizon is assumed for computational convenience. Therefore, potential migrants take as expected urban wages the weighted average of current modern and informal sector wages, where the weights are the relative labor shares. Thus,

$$W^{\varepsilon}_{u(t)} = \Pi_{1(t)} \, \bar{W}_{1(t)} + \Pi_{4(t)} \, W_{4(t)} \tag{21}$$

where

$$\Pi_{1(t)} = \frac{L_{1(t)}}{L_{u(t)}}$$

and

$$\Pi_{4(t)} = \frac{L_{4(t)}}{L_{u(t)}} \quad .$$

Rural-urban migration, $M_{ru(t)}$, is therefore considered to be rational as long as the expected urban wage, net of migration costs, exceeds the current value of rural wage. Migration in our model economy is expressed as

$$\frac{M_{ru(t)}}{L_{r(t)}} = \left[\frac{W^{\varepsilon}_{u(t)} - \bar{C}}{W_{r(t)}}\right]^{m} - 1 \qquad (22)$$

where migrants are expressed as a proportion of total rural population and m is a parameter.

If the real expected urban wage, net of migration costs, exceeds the value of the rural wage, then some workers will move into the cities. However, due to institutional and technological factors, part of these immigrants will enhance the numbers of unemployed. Migration to the cities decreases the probability of obtaining an industrial job and at the same time depresses the informal sector wage rate. As a result $W^{\varepsilon}_{u(t)}$ goes down. If expected urban wages, net of migration costs, fall to the same level as rural wages, then migration stops. If it falls even further, the migration process is reversed. This wage equalization process is reinforced by rural outmigration to the extent that extraction of members of the rural labor force increases rural productivity levels, pushing the rural wage upwards. In short, the equilibrium condition is expressed as:

$$W^{\varepsilon}_{u(t)} - C = W_{r(t)} \quad .$$

However, in the context of our model, it seems that equalization between rural and urban wages in Mexico is far from being achieved as shown by the unique current urbanization pattern.

Figure 3 shows, in a static fashion, the allocation of labor to both rural and urban activities. It was drawn in such a way that migration appears to be profitable. Rural wage, W_r, determined by competitive conditions, appears to be much lower than the expected urban wage, W^{ε}_u, even if migration costs, C, are deducted. As long as such a difference persists, migration will take place. The effect of the institutional wage, $\bar{W}_1$, in urban employment and in generating migration also appears in the figure. Had competitive conditions prevailed, urban wage would be set up at the intersection of QQ and W_4. This, besides increasing productive employment, from OV to OV', would prevent rural-urban labor flows from taking place, since the costs of migration would be greater than the wage differential.

Capital Markets

The total stock of capital in the economy, at every point in time, $K_{(t)}$, is given by the sum of existent capital in commercial agriculture, $K_{2(t)}$, industry, $K_{1(t)}$, and subsistence agriculture, $K_{3(t)}$. Thus

$$K_{(t)} = K_{1(t)} + K_{2(t)} + K_{3(t)} \quad . \tag{23}$$

In our model, we adopt the specificity of capital assumption advanced by Kelley, Williamson and Cheetham (1972). This assumption refers to the fact that once capital is assigned to one

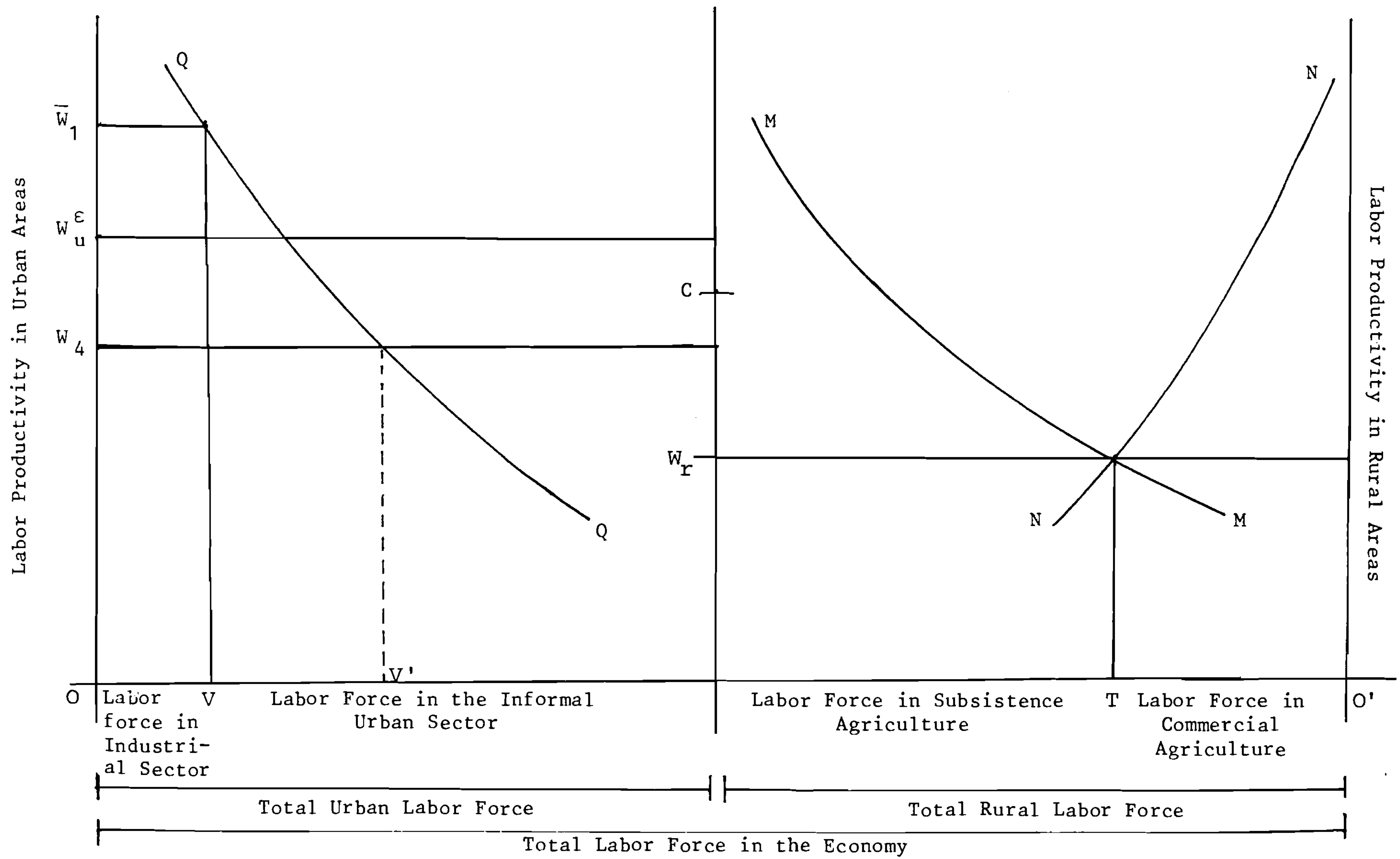

Figure 3. Labor Force Allocation

sector it cannot easily be removed and transferred to other sectors, even if the differentials in interest rates are significant. Only by means of new investment is it possible for capital owners to respond to interest rate differentials.

At every point in time, capital in each sector is owned, not only by that sector's capitalists, but also by capitalists from other sectors. Thus,

$$K_{1(t)} = K_{11(t)} + K_{12(t)} + K_{15(t)} \tag{24}$$

$$K_{2(t)} = K_{21(t)} + K_{22(t)} + K_{25(t)} \tag{25}$$

$$K_{3(t)} = K_{33(t)} + K_{35(t)} \tag{26}$$

where subscript 5 denotes the government.

For commercial agriculture and the industrial sector, variations in the stock of capital, $\dot{K}$, are a function of gross investment, minus depreciation. Then,

$$\dot{K}_{ij(t)} = I_{ij(t)} - \kappa K_{ij(t)} \qquad \begin{matrix} i = 1,2 \\ j = 1,2,5 \end{matrix} \tag{27}$$

where $\dot{K}_{ij(t)} \gtrless 0$, and κ is the depreciation rate assumed to be equal for all sectors. Therefore:

$$\dot{K}_{i(t)} = \dot{K}_{i1(t)} + \dot{K}_{i2(t)} + \dot{K}_{i5(t)} \quad . \qquad i = 1,2 \tag{28}$$

On the other hand, variations of capital stocks in subsistance agriculture depend upon whatever investment the peasants are able to realize themselves, and more important, whatever investment is realized by the public sector. Then:

$$\dot{K}_{33(t)} = I_{33(t)} - \kappa K_{33(t)} \tag{29}$$

$$\dot{K}_{35(t)} = I_{35(t)} - \kappa K_{35(t)} \tag{30}$$

Therefore

$$\dot{K}_{3(t)} = \dot{K}_{33(t)} + \dot{K}_{35(t)} \tag{31}$$

where, as before, $\dot{K}_{ij(t)} \gtrless 0$.

Total investment, in our model, is equal to total savings. Savings $\overline{S}_{j(t)}$, in each sector, are equivalent to the sum of savings realized by capitalists, $S^{c}_{j(t)}$, and by labor $S^{l}_{j(t)}$. Therefore:

$$\overline{S}_{j(t)} = S^{c}_{j(t)} + S^{l}_{j(t)} \quad , \quad j = 1,2$$

and

$$\overline{S}_{3(t)} = S^{l}_{3(t)} \quad .$$

Each economic agent is assumed to save a fixed fraction, s, of total disposable income $\overline{Y}_{j(t)}$. Therefore:

$$\overline{S}_{j(t)} = S^{c}_{j(t)} + S^{l}_{j(t)} = s^{c}_{j}\ \overline{Y}^{c}_{j(t)} + s^{l}_{j}\ \overline{Y}^{l}_{j(t)} \tag{32}$$

$$j = 1,2$$

and

$$\bar{S}_{3(t)} = S^{l}_{3(t)} = s_3 \; \bar{Y}_{3(t)} \quad . \tag{33}$$

Disposable income is defined as total income accruing to a person net of taxes. Then, for commercial agriculture, we have:

$$\bar{Y}^{c}_{2(t)} = \left[i_{1(t)} \; x_{1(t)} \; K_{12(t)} + i_{2(t)} \; x_{2(t)} \; K_{22(t)} + q_{(t)} \; R_{(t)} \right] \left[1 - \tau^{c}_{2} \right] \tag{34}$$

$$\bar{Y}^{l}_{2(t)} = \left[W_{2(t)} \; y_{2(t)} \; L_{2(t)} \right] \left[1 - \tau^{l}_{2} \right] \tag{35}$$

where $i_{j(t)}$ are the interest rates which can be derived from equations 1 and 3 as:

$$i_{1(t)} = \left(P_{1(t)} \right) \left(A_{1(t)} \delta_1 \right) \left(x_{1(t)} \right) [\cdots\cdot]^{\frac{1}{\sigma_1 - 1}} \left(x_{1(t)} \; K_{1(t)} \right)^{-\frac{1}{\sigma_1}} \tag{36}$$

and

$$i_{2(t)} = \left(A_{2(t)} \right) \left(\theta_K \right) \left(x_{2(t)} \right) [\cdots\cdot]^{\frac{1}{\sigma_2 - 1}} \left(x_{2(t)} \; K_{2(t)} \right)^{-\frac{1}{\sigma_2}} \tag{37}$$

the rent rates accruing to landlords, $q_{(t)}$, is defined as

$$q_{2(t)} = \left(P_{2(t)}\right)\left(A_{2(t)}\right)\left(\delta_3\right) [\cdot\cdot\cdot\cdot]^{\frac{1}{\sigma_2 - 1}} \left[R_{2(t)}\right]^{-\frac{1}{\sigma_2}} \tag{38}$$

and finally, τ_2^c and τ_2^1 denote tax rates for capital and wage income, respectively.

Similarly, for the industrial sector we have:

$$\overline{Y}_{1(t)}^{c} = \left[i_{1(t)}\ x_{1(t)}\ K_{11(t)} + i_{2(t)}\ x_{2(t)}\ K_{21(t)}\right]\left[1 - \tau_1^c\right] \tag{39}$$

$$\overline{Y}_{1(t)}^{1} = \left[W_{1(t)}\ y_{1(t)}\ L_{1(t)}\right]\left[1 - \tau_1^1\right] \quad . \tag{40}$$

For subsistence agriculture, disposable income is defined as

$$\overline{Y}_{3(t)} = \left[P_{3(t)}\ X_{3(t)}\right]\left[1 - \tau_3\right] \quad . \tag{41}$$

The question of how savings are allocated to each of the sectors in the form of investment has long attracted economists' attention (Kelley, et al., 1972). Since Mexican capital markets bear a considerable degree of imperfection (Solis, 1970), it is not reasonable to adopt a purely neoclassical mechanism. Instead we posit an allocation process which is a mixture of exogenous and market guided decision (Yap, 1976a). Then,

$$\overline{S}_{1(t)}\ \xi_1 = P_{1(t)}\ I_{11(t)} \tag{42}$$

where ξ_1 is given exogenously and takes the value $0 < \xi_1 < 1$. The rest of the funds $(1 - \xi_1)$ are allocated among commercial agriculture or industrial sectors according to the differential in interest rates. Thus,

$$\left(1 - \xi_1\right)\left(i^*_{2(t)}\right) \bar{S}_{1(t)} = P_{1(t)} \, I_{21(t)} \tag{43}$$

where

$$i^*_{2(t)} = \frac{i_{2(t)}}{i_{1(t)} + i_{2(t)}} \; .$$

Similarly:

$$\bar{S}_{2(t)} \, \xi_2 = P_{1(t)} \, I_{22(t)} \tag{44}$$

where ξ_2 is exogenously given and takes the value $0 < \xi_2 < 1$. The remaining funds $(1 - \xi_2)$, are allocated to either sector by means of:

$$\left(1 - \xi_2\right)\left(i^*_{1(t)}\right) \bar{S}_{2(t)} = P_1 \, I_{12(t)} \tag{45}$$

where

$$i^*_{1(t)} = \frac{i_{1(t)}}{i_{1(t)} + i_{2(t)}} \; .$$

Whatever savings are generated in subsistence agriculture are entirely invested into the same sector. That is:

$$\bar{S}_{3(t)} = P_{1(t)} \, I_{33(t)} \; . \tag{46}$$

At the present stage, the model includes a public sector whose function is to provide one additional source of investment and comsumption demand. By taxing incomes and by consuming, the public sector is in the position of modifying consumption and investment patterns as well as transferring funds from sector to sector and from urban to rural areas or vice versa. The public sector budget equation is expressed as:

$$G_{(t)} = \sum_{i=1}^{2} Y^{c}_{i(t)} \left[1 - \tau^{c}_{i}\right] + \sum_{i=1}^{2} Y^{1}_{i(t)} \left[1 - \tau^{1}_{i}\right] + Y_3 \left[1 - \hat{\tau}_3\right]$$

$$+ \sum_{i}^{4} \sum_{j=1}^{4} \hat{\tau}_i \, P_{i(t)} \, D_{ij(t)} + \sum_{i=1}^{3} i_{i(t)} \, K_{i5(t)}$$

$$- \sum_{i=1}^{3} P_{1(t)} \, I_{i5(t)} - D_{5(t)} \qquad (47)$$

where $\hat{\tau}_i$ are the indirect tax rates on consumption, and $D_{t(t)}$ is the total value of government consumption of goods and services and is assumed to be a function of the rates of growth of total population in both urban and rural areas. Thus,

$$D_{5(t)} = d_0 + d_1 \left(\frac{L_{r(t)} - L_{r(t-1)}}{L_{r(t-1)}} \right) + d_2 \left(\frac{L_{u(t)} - L_{u(t-1)}}{L_{u(t-1)}} \right) \qquad (48)$$

The origin of total government consumption is, in turn, allocated to each one of the sectors in a proportional way

$$p_i \, D_{5(t)} \qquad i = 1,2,3,4$$

where $0 < p_i < 1$ and $\sum_{i=1}^{4} p_i = 1$.

Public investment in Mexico has at times been complementary and at times been a substitute for private investment. Using Hirshman's terminology, the Mexican government has been both a follower and a leader in investment projects. This is captured in the following formulation:

$$P_{1(t)} \; I_{15(t)} = \zeta_{5(t)} + \zeta_6 \left(\frac{I_{11(t-1)} + I_{12(t-1)}}{\sum_{i=1}^{2} \sum_{j=1}^{2} I_{ij(t-1)}} \right) \tag{49}$$

$$P_{1(t)} \; I_{25(t)} = \zeta_{7(t)} + \zeta_8 \left(\frac{I_{21(t-1)} + I_{22(t-1)}}{\sum_{i}^{2} \sum_{j}^{2} I_{ij(t-1)}} \right) \tag{50}$$

$$P_{1(t)} \; I_{35(t)} = \zeta_{9(t)} + \zeta_{10} I_{33(t-1)} + \zeta_{11} \; I_{35(t-1)} \tag{51}$$

where ζ_5, ζ_7, and ζ_9 tend to vary with time, and the rate of variation is given exogenously.

The introduction of these behavioral assumptions on sectoral transferences of capital, allows for one very important way of determining the role of agricultural development on industrialization, to the extent that rural-agricultural profits are channeled to the urban-industrial activities. For the Mexican case, this seems to have been of some importance:

> ...the strategy of agricultural modernization implemented by Post-Cardenas Governments is generally credited with serving industrialization through generating very large profits from farming, which could be transferred out of agriculture toward investment in the secondary and tertiary sectors, through the banking system. According to the findings of the CIDA report, a fifth of all the resources handled by banks between 1942 and 1962 came from the agricultural sector, while amounts equal to or greater than deposits attributable to farming were returned to that sector in only nine of the twenty years studied.
> (Hewitt de Alcantara, 1976, p. 116).

Besides investment demand, the model includes a commodity demand system for each one of the economic agents considered. The demand system used here is the well-known Linear Expenditure System (LES). (See Pollack and Wales, 1969; and Lluch et al., 1977 for an exposition.) This family of demand functions is well suited to the analysis of the Engel's effect which is claimed to take place during the process of development (see Kelley et al., 1972). Demand for each commodity is a function of relative prices and disposable income. The system requires at least the consumption of a bundle of goods which are considered essential. We assume that a minimum amount of small scale agricultural output, b_3, is required as essential.

Expressed in terms of industrial goods, the demands are given by the following eight equations*

$$\hat{\tau}_1 D^c_{1j(t)} = a^c_{1j} \left[\left(1 - s^c_j\right) \bar{Y}^c_{j(t)} - P_{3(t)} b_3 \right] \qquad j = 1,2 \qquad (52)$$

$$\hat{\tau}_1 D^l_{1j(t)} = a^l_{1j} \left[\left(1 - s^l_j\right) \bar{Y}^c_{j(t)} - P_{3(t)} b_3 \right] \qquad (53)$$

$$j = 1,2,3,4$$

$$\hat{\tau}_2 P_{2(t)} D^c_{2j(t)} = a^c_{2j} \left[\left(1 - s^c_j\right) \bar{Y}^c_{j(t)} - P_{3(t)} b_3 \right] \qquad (54)$$

$$j = 1,2$$

$$\hat{\tau}_2 P_{2(t)} D^l_{2j(t)} = a^l_{2j} \left[\left(1 - s^l_j\right) \bar{Y}^l_{j(t)} - P_{3(t)} b_3 \right] \qquad (55)$$

$$j = 1,2,3,4$$

$$\hat{\tau}_3 P_{3(t)} D^c_{3j(t)} = P_{3(t)} b_3 + a^c_{3j} \left[\left(1 - s^c_j\right) \bar{Y}^c_{j(t)} - P_{3(t)} b_3 \right]$$

$$j = 1,2 \qquad (56)$$

*For a mathematical derivation of the demand functions see Appendix C.

$$\hat{\tau}_3 \; P_{3(t)} \; D^{l}_{3j(t)} = P_{3(t)} \; b_3 + a^{l}_{3j} \left[\left(1 - s^{l}_{j}\right) \bar{Y}^{l}_{j(t)} - P_{3(t)} \; b_3\right] \qquad j = 1,2,3,4 \tag{57}$$

$$\hat{\tau}_4 \; P_{4(t)} \; D^{c}_{41(t)} = a^{c}_{41} \left[\left(1 - s^{c}_{1}\right) \bar{Y}^{c}_{1(t)} - P_{3(t)} \; b_3\right] \tag{58}$$

$$\hat{\tau}_4 \; P_{4(t)} \; D^{l}_{4j(t)} = a^{l}_{4j} \left[\left(1 - s^{l}_{j}\right) \bar{Y}^{l}_{j(t)} - P_{3(t)} \; b_3\right] \qquad j = 1,4 \tag{59}$$

where a^{c}_{ij}, and a^{l}_{ij} are parameters associated with the consumption of the i^{th} good by capitalists and workers of the j^{th} sector respectively, and $\hat{\tau}_i$ are the tax rates on consumption.

Observe that the value of the minimum consumption requirement varies as the relative price $P_{3(t)}$ varies through time. For the present, it is assumed that all incomes are greater than the value of this essential requirement.* Also for the present, demand functions for capitalists are specified differently depending on whether they belong to the rural or urban areas. However, this may not be the case, and only one set of parameters are relevant. This factor will be corrected during the implementation of the model. Finally, output of the informal sector is exclusively consumed in urban areas.

*If, when simulating, this proves to be untrue, a mechanism, perhaps a transfer of public funds, will be used as a device for correction.

The specification of the demand functions allows us, finally, to close the system. Thus,

$$X_{1(t)} = \sum_{j=1}^{2} D^{c}_{ij(t)} + \sum_{j=1}^{4} D^{1}_{1j(t)} + \sum_{i=1}^{2} \sum_{j=1}^{2} I_{ij(t)} \quad (60)$$

$$+ I_{33(t)} + \sum_{i=1}^{3} I_{i5(t)} + P_1 D_5(t)$$

$$X_{2(t)} = \sum_{j=1}^{2} D^{c}_{2j} + \sum_{j=1}^{4} D^{1}_{2j} + p_2 D_5(t) \quad (61)$$

$$X_{3(t)} = \sum_{j=1}^{2} D^{c}_{3j(t)} + \sum_{j=1}^{4} D^{1}_{2j} + p_3 D_5(t) \quad (62)$$

$$X_{4(t)} = D^{c}_{41} + D^{1}_{41} + D^{1}_{44} + p_4 D_5(t) \quad . \quad (63)$$

Model Extensions

Although our model-economy highlights the main aspects of the Mexican economy, there is still room for some extensions which could help us in getting closer to Mexican economic reality. Some of these extensions are listed in what follows.

Skilled versus unskilled labor

At the present stage, the model includes only one homogeneous labor factor. However, in order to capture some of the income distribution effects associated with economic development one should have at least two categories of labor, that is, skilled and unskilled labor. These two types of labor should enter the production process as different factors with different remuneration. This division should enrich our understanding of the rural-urban migration process as well as the functioning of the urban dual labor market.

Public Services

Activities pertaining to the public sector in our model are restricted to taxation, consumption, and investment. However, the production of public services such as education and health, are important government activities as well. These could be represented in our model-economy by specifying another production function using similar factors of production and different possibilities of substitution. The introduction of public services could provide us with the opportunity of endogenizing some of the technological progress accruing to labor.

International Trade

Our model of the Mexican economy is a closed model, where all prices of goods are determined endogenously within the system. This was chosen to simplify our first approximation of the problem. However, Mexico belongs to a large set of economies that export raw materials and import manufacturing goods. As such, Mexico (at least until very recently) has been a "price taker" and has been unable to influence international prices of the goods that are exported or imported. For our purpose, this would imply that the price of agricultural goods in terms of manufacturing goods are given exogenously. This can be captured by opening the model to international trade.

Energy Sector

The future exploitation of recent oil reserve discoveries in Mexico will undoubtedly affect the pattern of development and urbanization. State-owned oil resources can be channelled through investment, subsidies, and consumption to different sectors and regions of the Mexican economy. The model can be extended to include an energy sector by specifying another production function and using the same inputs under different technological constraints. Another way in which our model-economy will be altered is by including the output of this energy sector as one more input in the production process of other sectors.

CONCLUSIONS

Based on the historical analysis of the Mexican economy, we have been able to construct what we call a basic Model of Urbanization and Economic Development. The model belongs to the general equilibrium type of models, where production as well as demand aspects are highlighted. However, our model-economy includes several market imperfections and theoretical concepts peculiar to the Mexican case, such as agricultural duality; an explicit migration process; an active public sector; and an imperfect capital market.

Nevertheless, we are aware of the fact that the basic model is susceptible to various modifications and extensions such as the division between skilled and unskilled labor; the production of public goods; the inclusion of international trade; and the specification of an energy sector. This will enrich the model and add more realism to our analysis.

Notwithstanding, the model at its present stage is a convenient framework for the evaluation of various policies. In particular, we are able to determine what the effects are on the overall economic development of changes in population growth; rural-urban migration; public investment; public consumption; terms of trade between sectors; pricing systems; and taxation patterns. It is also possible to detect in a general way the effects of international migration on the Mexican economic development. Although we do not include a foreign sector demanding labor, the problem can be analyzed as an alternative scenario where inmigration to the cities is reduced or increased exogenously.

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APPENDIX A

APPENDIX A

Table A.1. Mexican Total, Urban, and Rural Population (Thousands).

YEAR	TOTAL POPULATION	URBAN POPULATION	%	RURAL POPULATION	%
1900	13607	1434	10.5	12173	89.5
1910	15160	1783	11.7	13337	88.3
1921	14335	2100	14.7	12335	85.3
1930	16553	2891	17.5	13662	82.5
1940	19649	3928	20.0	15721	80.0
1950	25779	7210	28.0	18569	72.0
1960	34923	12747	36.5	22176	63.5
1970	49050	22004	44.9	27046	55.1

Source: Unikel, L. et al. (1976) p. 27.

Table A.2. Annual Average Rate of Population Growth (Percentages).

YEARS	TOTAL POPULATION	URBAN POPULATION	RURAL POPULATION
1940-1950	2.8	6.3	1.7
1950-1960	3.1	5.9	1.8
1960-1970	3.5	5.6	2.0
1940-1970	3.1	6.0	1.8

Source: Table A.1.

Table A.3. Gross Domestic Product Per Capita.

Year	Gross Domestic Product Millions of 1960 Pesos	Population (000)	Gross Domestic Product Per Capita	Annual Average Rate of Growth of GDP/PC
1940	46693	19653	2376	---
1945	62608	22283	2810	3.4
1950	83304	25791	3230	2.8
1955	111671	30011	3721	2.9
1960	150511	34994	4301	2.9
1965	212320	41358	5134	3.6
1970	296600	49090	6042	3.3

Source: Banco de Mexico (1978) p. 31.

Table A.4. Sectoral Distribution of Production (Millions of 1960 Pesos).

	1940	1945	1950	1955	1960	1965	1970
Gross Domestic Product	46693	62608	83304	111671	152030	214604	300167
SECTOR I	9057	11211	15968	20841	23970	30222	34535
Agriculture	4672	6152	9673	13562	14790	19921	21140
Livestock	3703	4254	5104	6180	7966	9008	11848
Forestry	626	702	913	889	882	955	1149
Fishing	56	103	188	210	332	338	398
SECTOR II	11705	15746	22097	30093	43933	66508	102154
Mining	1736	1767	1739	2011	2306	2429	2859
Petroleum	1253	1411	2467	3379	5089	7525	11295
Petrochemical	---	---	---	---	39	490	1380
Manufacturing	7193	9985	14244	19589	28892	44761	67680
Construction	1169	2153	3028	4133	6105	8534	13583
Electrical Industry	354	430	619	981	1502	2769	5357
SECTOR III	25931	35651	45239	60737	84127	117874	163478
Commerce	14439	20383	26300	34832	46880	67368	94491
Transport	1187	1822	2728	3917	4996	6443	9395
Government	3348	4530	4824	5964	7399	11834	17097
Other Services	6957	8916	11387	16024	24852	32229	42495

Source: Banco de Mexico (1978) p. 28.

Table A.5. Sectoral Distribution of Production (Percentages).

	1940	1945	1950	1955	1960	1965	1970
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SECTOR I	19.4	17.9	19.1	18.6	15.8	14.1	11.5
Agriculture	10.0	9.8	11.6	17.1	9.7	9.3	7.0
Livestock	8.0	6.8	6.2	5.5	5.2	4.2	4.0
Forestry	1.3	1.1	1.1	0.8	0.6	0.4	0.4
Fishing	0.1	0.2	0.2	0.2	0.2	0.2	0.1
SECTOR II	25.1	25.2	26.5	27.0	28.9	31.0	34.0
Mining	3.7	2.8	2.1	1.8	1.5	1.1	1.0
Petroleum	2.7	2.8	2.1	1.8	1.5	1.1	1.0
Petrochemical	---	---	---	---	0.03	0.2	0.4
Manufacturing	15.7	16.0	17.1	17.5	19.0	20.9	22.5
Construction	2.5	3.4	3.6	3.7	4.0	4.0	4.5
Electrical Industry	0.8	0.7	0.7	0.9	1.0	1.3	1.8
SECTOR III	55.5	36.9	54.4	54.4	55.3	54.9	54.5
Commerce	30.9	32.6	31.6	31.2	30.8	31.4	31.5
Transport	2.5	2.9	3.3	3.5	3.3	3.0	3.1
Government	7.2	7.2	5.8	5.3	4.9	5.5	5.7
Other Services	14.9	14.2	13.7	14.4	16.3	15.0	14.2

Source: Table A.4.

Table A.6. Gross Domestic Product and Economically Active Population by Sector.

	1940	1950	1960	1970
PRIMARY SECTOR				
Output[1]	9054	15968	23970	34535
Labor Force[2]	3832	4867	5048*	5329
Output Per Worker	2364	3281	4748	6481
SECONDARY SECTOR				
Output[1]	11705	22097	43993	102154
Labor Force[2]	826	1490	2175*	3198
Output Per Worker	14171	14830	20199	31943
TERTIARY SECTOR				
Output[1]	25931	45239	84127	163478
Labor Force[2]	1200	1988	2990*	4428
Output Per Worker	21609	22756	28136	36919
GROSS DOMESTIC PRODUCT				
Output[1]	46693	83304	152030	300167
Labor Force[2]	5858	8345	10213*	12955
Output Per Worker	7971	9983	14886	23170

[1] Millions of 1960 Pesos

[2] Thousands of Persons

* Figures adjusted by Oscar Altimir as cited in Alba-Hernandez Francisco (1976).

Source: Elaborated from figures in Table A.7 and labor force figures from Unikel et al., (1976) Statistical Appendix.

Table A.7. Sectoral Productivity Growth.

YEAR	TOTAL	PRIMARY SECTOR	SECONDARY SECTOR	TERTIARY SECTOR
1940	100.0	100.0	100.0	100.0
1950	125.2	138.8	104.7	105.3
1960	186.8	200.8	142.5	130.2
1970	290.7	274.2	225.4	170.9

Source: Table A.6.

Table A.8. Average Annual Rate of Growth of Sectoral Gross Domestic Output Per Worker.

YEAR	TOTAL	PRIMARY SECTOR	SECONDARY SECTOR	TERTIRAY SECTOR
1940/1950	2.3	3.3	0.5	0.5
1950/1960	4.1	3.8	3.1	2.1
1960/1970	4.5	3.2	4.7	2.8
1940/1970	3.6	3.4	2.7	1.8

Source: Table A.6.

Table A.9. Gross Fixed Investment in Mexico (Current Prices/Millions of Pesos).

YEAR	TOTAL	PUBLIC	%	PRIVATE	%
1940	591	290	49.0	301	51.0
1945	1696	848	50.0	848	50.0
1950	5385	2672	49.6	2713	50.4
1955	13926	4408	31.7	9518	68.3
1960	25507	8376	32.8	17131	67.2
1965	44295	16301	36.8	27994	63.2
1970	82300	30582	37.2	51718	62.8

Source: Banco de Mexico S.A. (1978) p.

Table A.10. Gross Fixed Investment as a Percentage of GDP (%).

YEAR	TOTAL	PUBLIC	PRIVATE
1940	7.6	3.7	3.9
1945	8.8	4.4	4.4
1950	13.5	6.7	6.8
1955	16.4	5.2	11.2
1960	17.0	5.6	11.4
1965	17.6	6.5	11.1
1970	19.7	7.3	12.4

Source: Banco De Mexico (1978) p.

Table A.11. Public Investment by Sector of Destination
(Millions of Pesos).

YEAR	TOTAL	AGRICULTURAL DEVELOPMENT	%	INDUSTRIAL DEVELOPMENT	%	SOCIAL WELFARE	%	OTHERS*	%
1940	290	44	15	60	21	29	10	157	54
1945	848	144	17	132	15	91	11	481	57
1950	2672	515	19	796	30	256	10	1105	41
1955	4408	605	14	1738	39	597	14	1468	33
1960	8376	580	7	2610	31	1885	23	3301	39
1965	16301	1524	10	7253	44	2763	17	4761	29
1970	29205	3921	13	11097	38	7919	27	6268	22

*Includes Administration, Defense and Communications

Source: Banco de Mexico (1978) p. 38.

Table A. 12. Economically Active Population by Sector.

YEAR	TOTAL	%	PRIMARY SECTOR	%	SECONDARY SECTOR	%	TERTIARY SECTOR	%
1940	5858	100.0	3832	65	826	14	1200	21
1950	8345	100.0	4867	58	1490	18	1988	24
1960	10213	100.0	5048	50	2175	21	2990	29
1970	12955	100.0	5329	41	3198	25	4428	34

Source: Table A.6.

Table A.13. Annual Rate of Employment Growth by Sector (Percentages).

PERIOD	PRIMARY SECTOR	SECONDARY SECTOR	TERTIARY SECTOR
1940-1950	2.4	6.1	5.2
1950-1960	0.3	3.8	4.2
1960-1970	0.5	3.9	4.0

Table A.14. Mexican Gross Domestic Product per Economically Active Person in Rural and Urban Areas (Indices Countrywide Productivity = 100).

YEAR	RURAL AREAS (A)	URBAN AREAS (B)	B/A
1940	0.30	2.33	8
1950	0.33	1.94	6
1960	0.32	1.66	5
1970	0.30	1.50	5

Source: Table A.6.

Table A.15. Distribution of Household Income in Mexico (Percentage).

	1950		1958		1963		1969	
DECILE	BY DECILE	ACCUMU-LATIVE	BY DECILE	ACCUMU-LATIVE	BY DECILE	ACCUMU-LATIVE	BY DECILE	ACCUMU-LATIVE
I	2.7	2.7	2.2	2.2	2.0	2.0	2.0	2.0
II	3.4	6.1	2.8	5.0	2.2	4.2	2.0	4.0
III	3.8	9.9	3.3	8.3	3.2	7.4	3.0	7.0
IV	4.4	14.3	3.9	12.2	13.7	11.1	3.5	10.5
V	4.8	19.1	4.5	16.7	4.6	15.7	4.5	15.0
VI	5.5	24.6	5.5	22.2	5.2	20.9	5.0	20.0
VII	7.0	31.6	6.3	28.5	6.6	27.5	7.0	27.0
VIII	8.6	40.2	8.6	37.1	9.9	37.4	9.0	35.0
IX	10.8	51.0	13.6	50.7	12.7	50.1	13.0	49.0
X	49.0	100.0	49.0	100.0	51.0	100.0	51.0	100.0

Source: Gollas (1978) p. 77.

Table A.16. Components of Countrywide Inequalities of "Household" Expenditures as Measured by Theil Index.

Countrywide Inequality	Inequality between Rural and Urban Areas	Inequality within Urban Areas	Inequality within Rural Areas
100.0	29	60	11

Source: van Ginneken (1976) p. 29.

APPENDIX B

APPENDIX B

The technique used in the estimation of the output growth's share of population mobility is very simple but helpful in indicating what the contribution of rural-urban migration has meant in the development of Mexico.*

Define:

Y_{ij} : Value added in sector i at period j

N_{ij} : Employment in sector i at period j

A : Primary sector

M : Secondary Sector

S : Tertiary Sector

$$Y_T = Y_A + Y_M + Y_S \qquad \text{(B.1)}$$

where Y_T is Gross Domestic Product for the whole economy. Then, product per capita is defined as:

$$\frac{Y_T}{N_T} = \frac{Y_A}{N_A}\frac{N_A}{N_T} + \frac{Y_M}{N_M}\frac{N_M}{N_T} + \frac{Y_S}{N_S}\frac{N_S}{N_T} \qquad \text{(B.2)}$$

Define also:

$$A = \frac{Y_A}{N_A} \qquad a = \frac{N_A}{N_T}$$

$$M = \frac{Y_M}{N_M} \qquad m = \frac{N_M}{N_T}$$

$$S = \frac{Y_S}{N_S} \qquad s = \frac{N_S}{N_T}$$

---

*This technique was used by Reynolds (1970) p. 67. Here we reproduce it using the recently revised data of the Banco de Mexico presented in Table A.6.

Then,

$$\frac{Y_T}{N_T} = Aa + Mm + Ss \tag{B.3}$$

such that:

$$\frac{Y_{T(t+n)}}{N_{T(t+n)}} = Aa + A\Delta a + \Delta Aa + \Delta A\Delta a + Mm + \Delta mM$$

$$+ \Delta Mm + \Delta M\Delta m + Ss + s\Delta S + S\Delta s + \Delta S\Delta s$$

Therefore:

$$\frac{Y_{T(t+n)}}{N_{T(t+n)}} - \frac{Y_T}{N_T} = \Delta Aa + \Delta Mm + \Delta Ss \quad \} \text{ Sectoral factors}$$

$$+ \Delta aA + \Delta mM + \Delta sS \quad \} \text{ Shift factors}$$

$$+ \Delta a\Delta A + \Delta m\Delta M + \Delta s\Delta S \quad \} \text{ Combined factors}$$

Table B.1. Shares of income and labor force by sector

	1940	1950	1960	1970
$A \equiv \frac{Y_A}{N_A}$	2364	3281	4748	6481
$a \equiv \frac{N_A}{N_T}$	0.64	0.50	0.49	0.41
$M \equiv \frac{Y_M}{N_M}$	14171	14830	20199	31943
$m \equiv \frac{N_M}{N_T}$	0.14	0.18	0.22	0.25
$S \equiv \frac{Y_S}{N_S}$	21609	22756	28136	30919
$s \equiv \frac{N_S}{N_T}$	0.21	0.24	0.29	0.34

Source: Table A.6.

Table B.2. Variations of shares of income and labor force by sector

	1940-1950	1950-1960	1960-1970
ΔA	917	1467	1733
Δa	-0.07	-0.09	-0.08
ΔM	659	5369	11744
Δm	0.04	0.04	0.03
ΔS	1147	5380	8783
Δs	0.03	0.05	0.05

Source: Table A.1.

Estimation of Productivity Changes 1940-1950

Real Total Productivity Change 2012

Primary Sector			
ΔAa	596.0		
ΔaA	- 165.50		
$\Delta a \Delta A$	- 64.20	366.30	0.18
Secondary Sector			
ΔMm	92.26		
ΔmM	566.80		
$\Delta m \Delta M$	26.40	685.46	0.35
Tertiary Sector			
ΔSs	240.90		
ΔsS	648.30		
$\Delta s \Delta S$	34.41	923.61	0.47

Estimated Total Change in Productivity: 1957.37

Estimated Change in Productivity with no Shift in Labor Force: 596 + 92.26 + 240.90 = 929.16

Share of Change in Productivity Attributed to Shift Factor: $\frac{1957.37 - 929.16}{1957.37} = 0.53$

Estimation of Productivity Changes 1950-1960

Real Total Productivity Change 4903

Primary Sector			
ΔAa	850.86		
ΔaA	- 295.30		
$\Delta a \Delta A$	- 132.03	423.53	8.7
Secondary Sector			
ΔMm	966.42		
ΔmM	593.20		
$\Delta m \Delta M$	214.76	1774.38	36.2
Tertiary Sector			
ΔSs	1291.20		
ΔsS	1137.80		
$\Delta s \Delta S$	269.00	2698.00	55.1

Estimated Total Change in Productivity: 4895.91

Estimated Change of Productivity with no Shift in Labor Force: 850.86 + 966.42 + 1291.20 = 310.48

Share of Change in Productivity Attributed to Shift Factor: $\frac{4895.91 - 3108.48}{4895.91} = 0.37$

Estimation of Productivity Changes 1960-1970

Real Total Productivity Change 8284

Primary Sector		
ΔAa	849.17	
ΔaA	- 379.84	
$\Delta a \Delta A$	- 138.64	330.69
Secondary Sector		
ΔMm	2583.68	
ΔmM	605.97	
$\Delta m \Delta M$	352.32	3541.97
Tertiary Sector		
ΔSs	2547.07	
ΔsS	1406.80	
$\Delta s \Delta S$	439.15	4393.02

Estimated Total Change in Productivity: 8265.69

Estimated Change in Productivity with no Shift in Labor Force: 849.17 + 2583.68 + 2547.07 = 5979.92

Share of Change in Productivity Attributed to Shift Factor: $\frac{8265.68 - 5979.92}{8265.68} = 0.28$

APPENDIX C

APPENDIX C

$$\text{Max } U = \sum_{k=1}^{n} a_k \log (D_k - b_k) \tag{C.1}$$

$$\text{S.t.} \sum_{k=1}^{n} P_k D_k = \bar{Y} \tag{C.2}$$

where, U denotes utility; D_k the amount of good k consumed; and a_k and b_k are parameters. The assumption made is that,

$$0 < a_i > 0 \ ; \quad \sum_{k=1}^{n} a_k = 1 \ ; \quad (D_i - b_i) > 0 \quad .$$

For the solution to the problem, consider the following Lagrange function:

$$\underset{\{D_k\}}{L} = \sum_{k=1}^{n} a_k \log (D_k - b_k) + \lambda \left[\sum P_k D_k - \bar{Y} \right] \quad . \tag{C.3}$$

Then, the first order conditions are given by:

$$L_{D_i} : \frac{a_i}{(D_i - b_i)} + \lambda P_i = 0 \tag{C.4}$$

and

$$L_{\lambda} : \sum_{k=1}^{n} P_k D_k - \bar{Y} = 0 \quad . \tag{C.5}$$

From (C.4) we obtain

$$D_i = -\frac{a_i}{\lambda P_i} + b_i \quad , \tag{C.6}$$

which, substituted in (C.5) yields

$$\sum_{k=1}^{n} P_k \left[-\frac{a_k}{\lambda P_k} + b_k \right] - \overline{Y} = 0 \quad .$$

Therefore,

$$-\frac{1}{\lambda} + \sum_{k=1}^{n} P_k b_k - \overline{Y} = 0 \quad . \tag{C.7}$$

From (C.6) we obtain:

$$-\frac{1}{\lambda} = \frac{P_k (D_k - b_k)}{a_k} \quad . \tag{C.8}$$

Combining (C.7) and (C.8) gives us

$$\frac{P_k}{a_k} (D_k - b_k) + \sum_{k=1}^{n} P_k b_k - \overline{Y} = 0 \quad . \tag{C.9}$$

Then,

$$D_k = \frac{a_k}{P_k} \overline{Y} - \frac{a_k}{P_k} \sum_{k=1}^{n} P_k b_k + b_k \quad .$$

Therefore:

$$D_k = \frac{a_k}{P_k} \left(\overline{Y} - \sum_{k=1}^{n} P_k \, b_k \right) + b_k \qquad (C.10)$$

or

$$P_k \, D_k = P_k \, b_k + a_k \left(\overline{Y} - \sum_{k=1}^{n} P_k \, b_k \right) \qquad (C.11)$$

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