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ABSTRACT

OPTIMAL ALLOCATION OF HOUSING INVESTMENT
IN FIVE MEXICAN CITIES, 1960-1970 AND 1970-1985

By

Jesús Yáñez Orviz

In a given year, new construction tends to satisfy the housing needs of only a small proportion of families while old dwellings constitute the chief source of housing for the majority of families. Thus housing programs should consider the effects of new construction on the use of the existing housing stock.

New dwellings are occupied by families who in some cases vacate dwellings which are then transferred to other families. This study is concerned with the transfer or filtering effects of new construction on the entire housing stock. The main objective is to design and apply a model for optimal allocation of housing investment, taking into account the transfer or filtering effects of new construction.

We examine the filtering process in Mexico under two perspectives. First we undertook a vacancy chain survey in the city of Chihuahua. Secondly, we examine the effects of new construction on the allocation of the entire

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housing stock by income group from 1960 to 1970 in five cities and the entire nation. For this purpose we use stock-user matrices which are formed with data from the population and housing census of 1960 and 1970.

The main findings of the vacancy-chain survey were:

i) The average length of the chains of moves was 2.13, which indicates that for each dwelling built there were approximately two households who improved their housing conditions.

ii) On the average, dwellings were filtered from high to lower income families. The chains of moves however, were broken before reaching the lowest fifty percent of the families in Chihuahua.

iii) Dwellings in the middle value range initiated the longest chains of moves. This result, however, was not statistically significant.

We observed one principle filtering pattern in the stock-user matrices from 1960 to 1970. The gap between family formation and housing construction resulted in a proportion of lower-middle and higher income families remaining in the same dwellings even though they had risen in the income scale. This form of upward filtering reduced the possibilities for low income families to improve their housing conditions through the filtering process.

The proposed housing investment strategies seek to improve the quality of the existing housing stock and to reduce the housi

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reduce the housing shortages. Housing conditions are improved as some families move into new dwellings while others receive old, but adequate dwellings through downward filtering.

The model used to evaluate alternative housing investment startegies determines the optimal combination of dwellings to be built, identifies the income groups involved in the filtering process, and estimates the amount of investment required to achieve certain housing goals. In the cities studied, we found that housing conditions could have been improved considerably during 1960-1970, using the actual amount of investment, by allocating the entire investment in the construction of minimum and medium quality dwellings.

Although the model can be applied to any country, it is particularly useful for developing countries where a substantial proportion of the population is ill-housed and the amount of national resources than can be allocated to housing is limited.

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OPTIMAL ALLOCATION OF HOUSING INVESTMENT IN FIVE MEXICAN CITIES, 1960-1970 AND 1970-1985

By

Jesús Yáñez Orviz

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

1976

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I am also grateful to the other members of my dissertation committee, Drs. Hunter, Saks, and Kannappan.

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CHAPTER I

INTRODUCTION

Background

Housing programs in Latin American countries have been based almost exclusively on estimates of the housing deficit.[1] Once the severity of the housing problem is announced, the housing authorities proceed to set a construction goal which is rarely attained. Housing programs are established without considering the interdependence between trends of population growth, migration, income distribution, and housing consumption. Architectural standards are often set unrealistically high for the level of income earned by the majority of families. The capacity of the construction industry and the financial institutions to undertake large housing programs is also ignored. In addition, legal and administrative procedures make it difficult to implement housing policies.

Until recently, housing programs in Mexico consisted of constructing a small number of housing projects

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[1]Charles Frankenhoff, "A Popular Housing Policy," Land Economics, August 1973, page 335.

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chiefly for government employees and the adoption of banking regulations designed to increase the number of low-cost dwellings financed by private banks. This last program not only failed to increase significantly the number of low cost dwellings built, but the dwellings were often occupied by middle instead of low income families. Finally in 1972 the government, trade unions, and the private sector agreed to establish an ambitious housing program to be financed by a five percent payroll tax. A new housing agency -- INFONAVIT -- was created to administer a program in which almost four million workers were registered at the end of 1975. Need for research on housing became apparent.

A comprehensive housing policy requires among other things, to take into account the effects of new construction on the use of the existing housing stock. New dwellings are occupied by families who in some cases vacate dwellings which are then available for other occupants. This process continues until no unit is left empty by the occupants of the last dwelling in the chains of moves. A housing building strategy should consider not only the recipients of new dwellings, but also the number and type of households involved in the chains of moves initiated by new construction.

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[3] Ira S. Low
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page 363.

The filtering process has been defined by Fisher and Winnick[2] and Lowry[3] in terms of changes in the market value and quality of the dwellings involved in the chains of moves. According to this definition, downward filtering occurs when dwellings decline in quality through normal physical deterioration, adverse neighborhood effects, or technological obsolescence. This definition of filtering is based exclusively on the characteristics of dwellings. In this study we will use a definition of filtering based on the income level of the households involved in the chains of moves. This last definition of filtering is more general and relevant in determining whether the poor benefit from new construction through the chains of moves mechanism. Nevertheless, in our survey in the city of Chihuahua, we will examine the physical characteristics of the dwellings involved in the chains of moves. According to the definition of filtering based on the income level of the households, dwellings involved in the chains of moves filter down when they are transferred to successive lower income families. On the other hand, dwellings which do not change occupants can filter up or down if the level of income of the occupants increases or decreases respectively through time.

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[2]Ernest M. Fisher and Louis Winnick, "A Reformulation of the Filtering Concept," Journal of Social Issues, Vol. VII, Nos. 1 and 2, 1951, page 48.

[3]Ira S. Lowry, "Filtering and Housing Standards: A Conceptual Analysis," Land Economics, XXXVI, (November 1960), page 363.

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Purpose of the Study

The final objective of the study is to develop and apply a method to evaluate housing investment strategies. The specific purpose is to estimate the effects which occur through the filtering process of new construction on the utilization of the entire housing stock.

An important policy question to be examined is whether low income families in a developing country improve their housing conditions as a result of the filtering process. If the chains of moves are broken before they reach the lowest income strata, then housing programs should concentrate on the construction of low cost dwellings. However, the housing programs should take into account that low cost dwellings might be bid away after some time by higher income families if no medium and higher quality dwellings are built. In addition, the housing authorities should consider the financial feasibility of the building program. On the other hand, if downward filtering occurs throughout the housing market, incentives might be granted to encourage the construction of middle and higher quality dwellings.

The filtering or transfer effects of new construction will be studied under two perspectives.

i) Through a survey undertaken in 1975 we will examine the chains of moves initiated by new construction in the city of Chihuahua. In order to determine whether the filtering p

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the filtering process operates through the entire housing sector, we study the characteristics of the households and dwellings involved in the chains of moves.

ii) We will study the effect of new construction on the use of the entire housing stock from 1960 to 1970 in five Mexican cities and the entire nation. The allocation of the housing stock by income group is studied through stock-user matrices which are formed with data from the population and housing census of 1960 and 1970.

A model which takes into account the pattern of filtering trends initiated by new construction will be used to evaluate alternative housing investment strategies. The model provides the optimal combination of dwelling types to be built in order to improve the over-all housing conditions with an investment constraint, but without subsidies to households.

The stock-user matrices will also be used to estimate Gini coefficients in order to measure the degree of inequality of the housing stock and family income distributions.

Sequence of Chapters

Chapter II is a general description of the housing sector in Mexico. We describe the over-all physical conditions of the housing stock and some characteristics of the construction industry in Mexico. Secondly, we estimate the housing de

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the housing deficit by conventional physical standards and the housing needs for the near future. We next measure the influence of several variables on the (effective) demand for housing through single and multiple regression techniques. Finally we describe the financial institutions and government agencies involved in the housing sector.

Chapter III presents the results of the filtering survey in the city of Chihuahua. We estimate the length of the chains of moves. We then study characteristics of the dwellings involved in the chains of moves. Finally we seek to determine the extent to which low income families benefit from the filtering process.

Chapter IV evaluates the effect of various housing investment strategies on the allocation of the existing housing stock during 1960-1970. Using the population and housing census data for 1960 and 1970, we apply a model for housing investment to five Mexican cities and the entire nation.

Chapter V presents the results of the housing investment strategies for the projected period 1970-1985.

Chapter VI deals with the relationship between the housing stock and family income distributions. Gini coefficients are calculated to determine whether the housing stock is more unequally distributed in the large industrial cities where

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cities where the level of income inequality is expected to be higher than in the smaller cities.

Chapter VII is a summary of the results of the entire study.

The models used to evaluate housing investment strategies are tentative and should be improved by future research.

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CHAPTER II

THE HOUSING SECTOR IN MEXICO

Introduction

Even before Spanish colonization, Mexico had important urban centers located around administrative facilities. However, it was not until the beginning of the Mexican Revolution (1910) that the process of urbanization really began. While the agricultural sector was losing its economic and political preponderance, people were migrating from the rural to the urban centers. Thus the share of the rural population decreased from 80 percent in 1900 to 68 percent in 1921. However, the share of rural population remained stable from 1920 to 1940, a period of national rehabilitation.

Industrialization was encouraged in the 1940's due to world market conditions and an import-substitution program. As a result, urbanization accelerated in that period. By 1974, 62 percent of the population lived in urban centers as compared with 35 percent in 1940.[1] It

[1] The census considers rural areas those localities having less than 2,500 inhabitants. If the urban-rural dividing line is established at 15,000 inhabitants, only fifty percent of the population can be classified as urban in 1974.

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should also be noted that the rate of population growth which was 3.2 percent between 1950-1970, is one of the highest in the world.

During the last three decades, Mexico has experienced a period of intermittent economic growth. This process has been characterized by three principal types of dislocation: i) the coexistence of a modern agricultural sector and another of subsistence farming where the majority of the rural population lives, ii) the concentration of industrial development in very few urban centers, iii) the chronic maldistribution of wealth and income.

While the emphasis has been placed on growth, several important social problems remain unsolved. The majority of the population is seasonally unemployed or is occupied in low productivity jobs in the subsistence agricultural sector and in services. Although manufacturing has been growing at an annual rate between nine and ten percent, its demand for labor has grown only at the rate of three to four percent per year.

As the cities were expanding rapidly but in a disorderly manner, a large segment of the population has remained badly housed. The housing problem is also present in the rural areas but is more dramatic in large cities which have attracted a steady flow of migrants.

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1960	5,
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This chapter presents the elements needed for a general understanding of the housing sector in Mexico. Section 1 refers to the physical housing conditions and the construction industry. The demand for housing is examined in Section 2, as are the estimates of the housing deficit. Finally, in Section 3 we describe the financial institutions and government agencies engaged in housing operations.

Section 1. Physical Characteristics of the Housing Stock and the Construction Industry in Mexico

This section describes the physical characteristics of the stock, the volume of construction, and the construction industry.

Before describing the physical characteristics of the housing stock, we show in Table II-1 the growth of the housing stock and population since 1930.

Table II-1. Housing Stock, Total Population, and Number of Occupants Per Dwelling

Year	Housing Stock (1) (thousands of dwellings)	Population (2) (thousands)	Occupants Per Dwelling (3 = 2/1)
1930	3,178	16,696	5.25
1940	3,884	19,923	5.13
1950	5,259	25,791	4.90
1960	6,409	34,923	5.48
1970	8,286	48,337	5.83

Source: Dirección General de Estadística, Censos de Población, 1930, 1940, 1950, 1960, 1970. Mexico, D.F.

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Table II-1 shows that the number of occupants per dwelling decreased from 5.25 in 1930 to 4.90 in 1950. During this period, the housing stock increased 65.5 percent while the population increased 54.5 percent. However, from 1950 to 1970 -- the period of fastest economic growth -- the number of occupants per dwelling increased from 4.90 to 5.84. This is due to the fact that population increased more than the housing stock -- 87.4 percent versus 57.6 percent respectively. The increase in the number of occupants per dwelling already suggests the existence of a housing shortage. We will see in Chapter IV that despite an increase in the average size of dwellings and the reduction in the average family size, the number of persons per room increased during 1960-1970.

1.1. Physical Characteristics of the Housing Stock

A. Construction Materials in the Housing Units

The type of materials used in the construction of housing units is the most visible indicator of housing quality. The traditional material of most Mexican houses has been adobe, which is the cheapest and least durable material. The proportion of adobe houses has been decreasing as shown in Table II-2, while the proportion of brick houses has increased. Wood and stones, which are inferior materials in Mexico, have also lost importance as construction materials. However in 1970, half of all dwellings we

materials.

Table II

Year	Adob
1930	46.
1940	52.6
1950	41.6
1960	49.7
1970	30.1

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Table II-2. Share of Dwellings by Type of Construction Materials

(Percentage of the Housing Stock)

Year	Adobe	Bricks	Wood	Stone	Mud and Thatch
1930	46.0	3.0	19.0	8.0	24.0
1940	52.6	5.6	18.7	9.4	13.7
1950	41.6	13.7	19.8	4.8	20.1
1960	49.7	24.1	9.2	3.6	13.4
1970	30.1	44.1	15.9	2.4	7.5

Source: Dirección General de Estadísticas, Censos de Población, 1930, 1940, 1950, 1960 and 1970. Mexico, D.F.

B. Availability of Utilities and Number of Rooms

Another measure of housing quality is the availability of utilities and the number of rooms per dwelling. Unfortunately, this information has only been reported since 1960. Table II-3 shows the number of dwellings with electricity, running water, bathrooms, and the number of rooms.

Table II

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total stock)

Year	Total N of Dwel (millio
1960	6.41
1970	8.28

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Table II-3. Availability of Electricity, Running Water, Bathrooms, and Number of Rooms, 1960-1970

(Figures in parentheses are percentages with respect to total stock)

Year	Total Number of Dwellings (millions)	Running Water (millions)	Electricity (millions)	Bathroom (millions)	Two or more rooms (mill.)
1960	6.41	1.50 (23.4)	1.63 (25.4)	1.33 (20.7)	1.23 (19.2)
1970	8.28	3.21 (38.8)	4.40 (53.6)	2.63 (31.8)	2.56 (30.9)

Source: Dirección General de Estadística, VIII, IX Censo General de Población, 1960 and 1970, México.

In Table II-3 we notice a relative improvement in the housing conditions from 1960-1970. The number of dwellings with running water, bathrooms, and electricity increased by 114 percent, 98 percent and 169 percent respectively during the period. The number of dwellings with more than two rooms increased 108 percent. Nevertheless, of the total 8.28 million existing units in 1970, there were still 5.6 million dwellings without bathrooms, 5.1 million without running water, and 3.7 million lacking electricity.

1.2. Volume of Construction

It should be indicated from the outset that the housing market in Mexico is not homogenous, but is composed of an unorganized sector which accounts for sixty to seventy per

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Year	1940-46
Public	500
Private	19,500
Total	20,000

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to seventy percent of all new construction, and an organized sector. The unorganized sector consists of low and mediocre quality housing units which are usually built in successive steps as the families become larger or earn higher incomes. These dwellings are built without commercial financing on tracts of land which lack utilities. Most of them were built without a building permit. By contrast, the organized sector utilizes financing of private and public banks and the legal ownership of the dwelling is well-defined. The construction industry concentrates its activities in the organized sector. Published information on the volume of housing construction refers only to the organized portion of the housing market. The number of dwellings built in the unorganized sector can only be imputed from the housing censuses of the last decades. Table II-4 shows the number of public and private dwellings built by the organized sector since 1940.

Table II-4. Housing Construction 1940-1973 -- Private and Public Dwellings Built Per Year in the Organized Housing Sector

Year	1940-46	1947-51	1952-58	1959-64	1965-69	1970-72	1973
Public	500	2,500	2,236	4,629	6,043	18,352	23,429
Private	19,500	20,500	33,500	44,700	52,000	60,000	55,000
Total	20,000	23,000	35,736	49,329	58,043	78,352	78,429

Source: Vivienda de Interes Social, IX Convención Union Pan American de Ingenieros, Banco de Mexico, 1966. Private construction data from FOVI, Banco de Mexico. Public construction data is from Subcomisión de la Vivienda, Secretaría de la Presidencia.

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The public units were built or promoted by nine government agencies. Table II-4 indicates that the public sector has increased notably its importance in the organized housing market in the last two decades. While the share of the public sector was less than six percent before 1952, by 1973 it represented thirty percent of new construction. Moreover, the public sector accounts for sixty percent of the low cost dwellings built in the nation.

The data shown in Table II-4 indicate that the number of dwellings built during the period 1940-1950 (212,000 units) in the organized sector (private and public) represented 15.4 percent of the increase in the housing stock (1,375,000 units) reported by the census. For the period 1960-1970 the share of the organized sector represented 29.3 percent (550,000/1,877,000) of the total increase in the housing stock. It is expected that the share of the organized sector will continue to rise with incomes and as the government assumes a more important role in the housing sector.

1.3. The Construction Industry in Mexico

This section is based upon a study by D.A. Germidis[2] on the construction industry in Mexico. Additional data were provided by the national chamber of the

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[2] Dimitrios A. Germidis, The Construction Industry in Mexico, OECD, Paris, 1972, pp. 15-21, 53-57.

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construction industry.

The purpose of this section is to give a general view of the construction industry.

Since 1950, the annual gross production of the construction industry in Mexico has been about 6.6 percent of Gross Domestic Product. Housing construction accounts for approximately forty percent of the total production in the construction sector. In 1970, the industry contributed 50 percent of total fixed-asset formation, and it employed 4.4 percent of the economically active population. In 1955-1964, the construction industry employed 7.2 percent of the labor force in developed countries, and 3.9 percent in developing countries. This share was 3.6 percent in Mexico during the same period.[3]

The proportion of labor of the Mexican construction industry in total employment has continuously risen in the last two decades. It has been the policy of government housing agencies (which have recognized the employment-generating capacity of the industry) to discourage the adoption of capital intensive methods of production. Furthermore, experiments with industrialized systems have

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[3]W.P. Strassmann, "Productivity, Construction and Employment in Developing Countries." International Labor Review, May 1970, pp. 508-510. Data for Mexico from, Cuentas Nacionales y Acervos de Capital, Consolidada, y por Tipo de Actividad Economica 1950-1967 Banco de Mexico, S.A., Mexico 1969.

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not resulted in lower costs of production. Recently, the emphasis has been placed on rationalization and materials standardization, rather than on the use of heavy prefabricated elements.

Data on construction cost trends indicate that the wage index has increased at a higher rate than the construction material index (Table II-5, page 19). Given an elasticity of substitution of materials for labor greater than unity,[4] which is apparently the case, firms tends to employ fewer units of labor as wages increase. The construction wage index however, is based on the legal minimum wage rates rather than on the lower wages actually paid. This suggests that strict enforcement of the minimum wage law could have reduced the demand for labor in the construction industry.

A. Number, Capital, and Location of the Construction Firms

Approximately 3,500 construction firms were registered with the chamber of the construction industry in 1969. Most of the firms are small family businesses with limited amounts of capital. They were concentrated in few urban centers; thus 55 percent were located in Mexico City

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[4]W.P. Strassmann, "The Substitution of Materials or Capital for Labor in Mexican Construction", in Studies on Employment in the Mexican Housing Industry, OECD, Paris, 1973, pages 307-320.

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and their capital represents 78 percent of the total capital of the industry. It should be added that there are no records on the large number of subcontractors employed in the industry.

B. Labor Productivity

Information concerning labor productivity shows that in the construction industry the rate of labor productivity growth has been lower than the average rate for all industries. It is even lower than the growth rate registered in the agriculture and service sectors. While in the construction industry the index rose 18.7 percent from 1950 to 1969, it increased 33.9 percent in agriculture and 37.9 percent in the service sector.

The lower growth rate of labor productivity in the construction industry seems to occur from the high rate of labor turn-over making difficult the improvement of skill level. The construction industry also provides the first job to a large number of unskilled migrants from the rural areas. Furthermore, foremen and union leaders usually keep for themselves a portion (called commission) of the workers' wages -- a practice not contributing to satisfactory working conditions.

C. Construction Cost Trends

Table II-5 indicates the relative changes in labor, material, and average building costs which occurred in the period 1954-1

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Year	Material Cost Index
1954	100.0
1958	133.8
1962	148.8
1966	164.0
1969	184.3
1971	186.3
1972	186.0
1973	226.9
1974	294.9

Sources: Camar
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period 1954-1974 in relation to the workers' cost of living index. The data are based on Mexico City prices which do not adequately represent the cost trends of the entire country. Furthermore, as indicated before, the "labor wage index" does not reflect the wage rates actually paid, but is based on the legal minimum wage rates.

Table II-5. Building Cost and Price Indexes, 1954-1974

Year	Material Cost Index	Labor Wage Index	Total Building Cost Index	Workers' Cost of Living Index
1954	100.0	100.0	100.0	100.0
1958	133.8	144.1	135.6	143.5
1962	148.8	212.7	159.9	158.6
1966	164.0	301.9	187.5	176.4
1969	184.3	328.9	209.0	189.8
1971	186.3	398.6	221.3	207.1
1972	186.0	490.3	246.8	220.4
1973	226.9	520.9	285.7	257.0
1974	294.9	651.1	366.1	308.0

Sources: Camara Nacional de la Industria de la Construccion and Secretaría de Industria y Comercio.

The first trend to note in Table II-5 is that building costs (a weighted average of the materials and labor cost indexes) have risen faster than the workers' cost of living. This trend has accelerated since 1972. While building costs and workers' cost of living rose at an annual rate of 7.1 percent and 6.3 percent respectively in the period 1954-1971, after 1972 these have increased at the rates of 24.2 percent and 19.9 percent. This obviously mean

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obviously means that the workers' financial capacity to acquire housing has been deteriorating in relation to other commodities.

Secondly, the building cost index has been rising chiefly because the labor wage index (based on the legal minimum wage) has increased faster than all other indices. Whereas the wage index increased at an annual rate of 17.5 percent, material costs rose 5.1 percent. However, after 1972 material costs increased almost at the same rate as the cost of labor, at 19.4 percent and 21.1 percent respectively. The announcement by the government of the creation of the INFONAVIT housing program in 1972 had a strong influence on the price of construction materials. Speculative transactions with construction materials were added to the worldwide inflationary pressure from which Mexico did not escape.

Critics of the government housing programs asserted that the new agencies were responsible for the increases in the building costs. Probably the lack of coordination among the government housing agencies and their exaggerated goals contributed more to raise construction costs than the volume of construction, which was much lower than the announced plans. Nevertheless, private developers had to face higher construction costs.

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D. Availability of Construction Materials

A 1973 report prepared by the President's Office of Economic Research[5] indicates that the construction materials industry is capable of producing the volume of construction materials required by the new housing programs. The supply of basic materials such as bricks and reinforced steel already exceeded the national demand. The only deficit foreseen by the 1973 study was in the production of cement. However, the cement industry is currently in a process of expansion.[6] The demand for bricks and other construction materials is adequately satisfied by local producers in each region.

In brief, shortages of construction materials are not likely to appear given that entrance to the industry is not restricted, and large amounts of capital are not required in the production of the most commonly used materials.

E. Construction Costs in Latin America

A comparative study of construction costs in Latin America[7] found that the cost for low income homes was higher

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[5]Secretaría de la Presidencia, unpublished research paper, Mexico, 1973.

[6]In December 1975, Mexico was accused of selling cement in the U.S. at artificially low prices. This probably indicates the existence of a cement surplus in Mexico.

[7]U.S. Department of Housing and Urban Development, Comparison of Construction Costs in Latin American Cities, Washington, 1973.

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in Mexico City than in ten other cities (this comparison included fifteen cities). The construction cost per square meter was 40 dollars in Mexico, whereas the lowest cost was found in Honduras (23 dollars), and the highest was observed in Argentina (62 dollars). At the same time, the cost per square meter for high income homes was lower in Mexico City than for eleven other cities (this comparison included seventeen cities). Costs varied from 60 dollars per square meter in Ecuador, to 225 dollars in Argentina, while the cost in Mexico City was 96 dollars.

According to the study, Mexico City has among the lowest prices for most construction materials. On the other hand, wages of skilled and unskilled labor were higher in Mexico City than in most countries. These comparisons partially explain the relatively higher costs for low income homes in Mexico City, since the share of labor cost in total construction costs is higher for low cost housing than it is for the most luxurious type. These comparisons however, should be taken with caution since construction costs per square meter are likely to vary according to the type of material used, the type of architecture, and the particular standards and regulations of each country.

In conclusion, the main obstacle from the supply side seems to arise from the low rate of growth of labor productivity. However the adoption of more efficient labor practices and the establishment of training programs should contribute t

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contribute to improve the skills and discipline of the workers employed in the construction industry.

Section 2. The Demand for Housing in Mexico

In Section 2.1 we describe the composition and magnitude of the housing needs in Mexico from a normative point of view. In Section 2.2 we deal with such variables as family income, stage in family life cycle, family size, and credit terms -- which determine the effective demand for housing.

2.1. Housing Needs

The study of housing needs is usually based on the estimation of the following four sources:[8]

i) existing quantitative deficit

ii) existing qualitative deficit

iii) housing needs derived from the demographic growth

iv) housing needs derived from the number of dwellings that are replaced

The estimation of these four sources of housing needs indicates the dimensions of the present and future housing problems in Mexico.

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[8] Jesus Puente Leyva, "El Problema Habitactional," El Perfil de Mexico en 1980, Siglo XXI, ed., Mexico, 1970, pages 268-281.

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i) Existing Quantitative Deficit

The number of dwellings available in 1970 was 8.2 million units, of which 5.0 million were located in urban areas and 3.2 million in rural areas, while the number of occupants per room was 2.08 and 2.95 respectively. The quantitative deficit for 1970 is based on the assumption that the desired index of crowding is 1.5 persons per room in the urban areas and 2.5 in the rural areas.[9] This results in a total deficit of 2.1 million dwellings -- approximately 1.4 in the urban and 0.7 in the rural areas.

ii) Existing Qualitative Deficit

The number of dwellings constructed with low quality materials and lacking utilities represents at least 40 percent of the housing stock. The qualitative deficit has been estimated more conservatively as 20 percent in urban areas and 25 percent in rural areas, which amounts to 0.65 million units and 1.26 million units respectively.[10]

In brief, the total existing deficit is 4.0 million dwellings which represents 48 percent of the 1970 housing stock. In order to estimate the number of dwellings that need to be built in the period 1970-1985, we have to take into consideration the demographic growth and the number of units to be replaced during that period.

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[9] Ibid., page 270.

[10] Ibid., page 272.

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iii) Demographic Growth

Assuming a rate of demographic growth of 3.3 percent annually, the population will increase from 48 million in 1970 to 76 million in 1985. This implies an addition of 5.3 million new families (assuming a family average size of 5.3) who will require housing. Assuming that the degree of urbanization will be 75 percent in 1985, the urban area will require 4.0 and the rural 1.3 million dwelling units.

iv) Replacement Needs

In Chapter V the replacement needs for the period 1970-1985 are estimated at 3.2 million units of which 2.4 correspond to urban areas and 0.8 in the rural areas.

In order to satisfy the housing needs due to population growth and dwelling replacement, Mexico will have to build 8.5 million units during the period 1970-1985. This number is in addition to the present housing deficit estimated at 4.0 million units. The elimination of the present deficit and the housing needs in the near future will require the construction of 12.5 million dwelling units. The accomplishment of this goal would require the construction of four times as many dwellings as were built per year during 1960-1970.

The magnitude of the housing deficit is likely to become larger in the future unless the distribution of family income is improved and ambitious housing policies are adopted.

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2.2. Explanatory Variables of the Effective Demand for Housing

Previous studies have found that income is by far the most important explanatory variable on the demand for housing. At the same time, the demand for housing is also influenced by the size of households, the level of education, the age of household heads, and the credit terms of housing mortgages. The purpose of this section is to test the influence of these variables on the demand for housing through the use of single and multiple regressions.

Housing consumption (X). The dependent variable is measured in terms of monthly rent (R) in the case of renters and monthly payments (M) for owner-occupied dwellings. Given that renters can move more easily than homeowners, monthly rent is assumed to reflect more accurately the demand for housing. Moreover, the amount of monthly payments has to be somehow adjusted to include opportunity costs of the income foregone on the downpayment.

We next describe the independent variables.

Income (Y). Based on budget studies, Schwabe concluded that housing is an inferior good, which implies that the proportion of housing expenditures in total expenditures decreases as income rises. However, modern empirical studies undertaken by Reid,[11] Muth,[12] Winger,[13]

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[11]Margaret C. Reid, Housing and Income, (University of

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and Morgan[14] have shown that housing is a normal good whose income elasticity is close to one. Given that housing consumption is more responsive to permanent or long-term expected income than to current income, the coefficient of permanent income elasticity is higher than it is for current income. Averages of observations within and between cities have been used as proxies for permanent income.

Unfortunately we have only a small sample for the city of Chihuahua. The regressions were estimated with the current family income reported in our survey.

Housing expenditures are assumed to be more responsive to the level of income than to any other variable.

Education (E). The level of education reflects the past and current income level and is an indicator of expected future income. Consequently, we expect that housing expenditures are positively correlated to the level of education measured by the years of schooling. However the existence of multicollinearity between education, income, and housing consumption may result in biased estimates of the regression coefficients.

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11 (continued)
Chicago Press), 1962.

[12] Richard F. Muth, "The Demand for Nonfarm Housing," The Demand for Durable Goods, A.C. Harberger, (University of Chicago Press), 1960.

[13] Alan R. Winger, "Housing and Income," Western Economic Journal, Vol. V, No. 3, June 1968, page 229.

[14] James N. Morgan, "Housing and Ability to Pay," Econometrica, XXXIII, April 1965, page 306.

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Stages in Family Life Cycle

The quantity of housing needs depends on the household size (S) and age (A) of the household. Assuming that families have enough income, housing expenditures would increase as the families become larger, and then decrease as some members of the household leave to form new households.

The age of the household head varies with the number of children as well as with the level of income and net worth of the family. It can be expected that housing expenditures will increase with age until the retirement age is reached, after which it will start to decrease. However, age and housing consumption might not be related if income and age are not in turn related. Furthermore, some old households may be reluctant to move into smaller, less expensive dwellings, while others move with relatives and friends. Thus the form of the relation between family life cycle and housing cannot be easily predicted.

The relation between housing expenditures, age, and household size are assumed to be non-linear. A quadratic function is used to test this assumption.

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Credit Terms

Gelfand[15] and Herbolzheimer[16] have found that housing demand is more responsive to changes in downpayment requirements than to any other credit term. The influence of downpayment requirements in Mexico is institutionally determined by the government policy of reducing, and even eliminating, the downpayment of low cost housing. As a result of this policy, low income families have been able to become homeowners. Consequently, low downpayment requirements are associated with low cost dwellings. It is then expected that housing expenditures will be positively related to downpayment requirements. Alternatively, the load to value ration (L/V), which is the inverse form of downpayment requirements, is expected to be negatively related to housing expenditures.

The studies previously mentioned have found housing expenditures and family income to be positively correlated. Double-logarithmic functions have been found to provide a more adequate fit of the housing-income relation than normal linear functions. We will use both normal linear and double logarithmic functions to examine the

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[15] Jack E. Gelfand, "Mortgage Credit and Lower-Middle Income Housing Demand," Land Economics, XLVI, May 1970, page 169.

[16] E.O. Herbolzheimer, Cross Section Analysis for Housing Demand in Venezuela, dissertation, Michigan State University, 1972, page 90.

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relation between housing and the other dependent variables. In addition, we will use a quadratic function to determine whether housing expenditures rise as families get larger and older and then decline as some members leave the household.

Studies of the relation between housing expenditures and income should consider the possible influence of supply factors on housing expenditures. If the supply of housing were completely elastic, then families would be able to consume the amount of housing desired according to their income and preferences. However, if the type and number of dwellings available do not match the consumer's needs and preferences, then the differences observed in housing expenditures might be due to supply rigidities rather than to the level of income. We will assume that the price elasticity of the demand for housing is -1.0, in which case increases in dwelling prices (due to restrictions in the housing supply) would not affect housing expenditures (price increased would be offset by declines in the amount purchased). This assumption should be tested by future research in Mexico.

Monthly payment (M) was adjusted by the opportunity cost of the downpayment. An interest rate of 12 percent per year was used to impute the opportunity cost of the downpayment.

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Table II-6. Regression Results with Housing Expenditures (X), Rent (R), and Monthly Payments (M), as Dependent Variables and Income (Y) as Independent Variable

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Regression	a	bY	Sample Size	R^2
Log X = f(Log Y)	-1.53	1.01 (.02)	53	.97
X = (Log Y)	3.75	.21 (.08)	55	.93
Owners' Adjusted M Log M = f(Log Y)	-1.43	.99 (.04)	27	.95
Renters Log R = F(Log Y)	-1.57	1.00 (.03)	26	.97
Owners' Unadjusted M Log M = F(Log Y)	-1.38	.93 (.02)	27	.95
New Public Units Log M = f(Log Y) (Adjusted)	-1.64	1.08 (.11)	15	.96
New Private Units Log M = f(Log Y) (Adjusted)	-1.52	.90 (.11)	14	.95

Source: The data was obtained from the filtering survey in Chihuahua which is described in Chapter III.

Notes: R^2 is the coefficient of determination.

b denotes the coefficient of the independent variables. In case of logarithmic regressions, b represents the elasticity coefficient.

The numbers in parentheses are the standard error of the regression coefficients.

Housing expenditures (X) include renters and owner-occupied dwellings.

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Table II-6 shows the results of the single regression between housing consumption and family income in Chihuahua. The income elasticity of the demand for housing for all households is 1.01, which means that housing is a normal good. The income elasticity for owners (.99) is not significantly different from the elasticity of renters (1.00). The income elasticity with respect to unadjusted monthly payments (.93) is lower than it is for adjusted monthly payments (.99). It was expected that the adjustment of monthly payments by the opportunity cost of the downpayment would raise the coefficient of income elasticity.

Another difference in the value of income elasticity (with respect to adjusted monthly payments) is observed between new private dwellings (.90) and new public units (1.08). While occupants of new private dwellings seem to allocate a decreasing proportion of income to housing, recipients of public units are not permitted to commit more than 20 percent of income to housing.

All the coefficients of income elasticity are significant at the one percent level of significance. The fit of the regression (R^2) is within the range of .93 to .97.

The value of the income elasticity observed in Chihuahua is consistent with the values estimated in budget surveys[17] und

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surveys[17] undertaken by the Banco de Mexico in urban areas (1.01). The value in rural areas was .925.

The regression results involving income, education, size, age, and loan to value ratio are shown in Table II-7. The multiple regression which includes all the variables indicates that income is the only significant variable on the demand for housing. While R^2 falls from .96 to .65 when income is excluded, R^2 decreases slightly from .96 to .95 when the other variables are omitted from the multiple regression. Furthermore, the coefficients of S, A, E, and L/V are not significant even at a 10 percent level of significance. The strong correlation between housing and income in the multiple regressions prevents other variables from having a significant influence on the demand for housing.

In all multiple regressions the income elasticity for housing is not significantly different from one.

Education and loan to value ratio become significant only when they are regressed separately on housing expenditures. As expected, there is a positive correlation between housing expenditures and education. The education elasticity is .86 (R^2 = .55), which implies that higher levels of education are associated with less than proportional increases in housing expenditures.

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[17] Encuesta Sobre Ingresos y Gastos Familiares en Mexico, 1963, Banco de Mexico, 1966, page 48.

Table II-7. Regression Results with Housing Expenditures (X) as Dependent Variable and Income (Y), Age (A), Size (S), Education (E), and Loan to Value Ratio (L/V) as an Independent Variable

Regressions	a	bY	bA	bS	bE	bL/V	Sample Size	R^2
Log X = f(Log Y,	-1.62	.97						

Table II-7. Regression Results with Housing Expenditures (X) as Dependent Variable and Income (Y), Age (A), Size (S), Education (E), and Loan to Value Ratio (L/V) as an Independent Variable

Regressions	a	bY	bA	bS	bE	bL/V	Sample Size	R^2
Log X = f(Log Y, Log A, Log S, Log E)	-1.62	.97 (.04)	.071 (.05)	.002 (.035)	.037 (.045)		54	.96
Log X = f(Log Y, Log A, Log S, Log E, Log L/V)	-1.31	1.00 (.10)	-.003 (.104)	-.027 (.067)	-.036 (.082)	-.021 (.062)	25	.96
X = f(Y,A,S,E,L/V)	382.57	.18 (.01)	-.52 (2.73)	-.87 (14.88)	-7.56 (6.58)	-1.94 (1.13)	25	.97
Log X = f(Log E)	4.67				.86 (.10)		52	.55
Log X = f(Log L/V)	8.48					.51 (.06)	25	.73

Quadratic Regressions	a	bS	bS^2	bA	bA^2	Sample Size	R^2
$X = f(S,S^2)$	611.22	26.19 (109.83)	2.70 (8.74)			50	.05
$X = f(A,A^2)$	507.58			60.81 (30.17)	-.61 (.35)	54	.09

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The loan to value ratio elasticity is -.51 (R^2 = .73) which confirms the expected negative correlation between housing and L/V. It should be recalled that the L/V elasticity is determined by the government policy of eliminating the downpayment requirements for low income groups.

The regression coefficients of the quadratic function relating housing to age are statistically significant but the fit of the regression (R^2 = .09) is very poor, making it difficult to draw any definite conclusion.

The coefficient for household size is not significant in any regression. Although housing needs increase with family size, housing expenditures do not follow the family life cycle. This is due to the fact that the level of income in the sample is not associated with either family size or age of household head.

We can conclude that the variation in housing consumption is almost entirely explained by changes in the level of income. Education and loan to value ratio have a minor influence on the demand for housing. Age and family size do not seem to have any influence on housing expenditures.

Section 3. Financial Institutions and Public Agencies Engaged in Housing Operations

In this section we describe the activities and policies of the housing institutions established by the governme

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government in the last decades as well as the housing operations of private financial institutions.[18]

Section 3.1 refers to the private banks which provide home financing chiefly to upper-middle and high income families. Section 3.2 describes the government agencies which deal with middle and lower income groups.

3.1. Private Financial Institutions

The private financial institutions engaged in home finance are the mortgage banks, the savings and loan associations, and after the legislative reform of 1962,[19] the savings department of the commercial banks.

i) Mortgage Banks

Before 1962, these banks provided expensive mortgage financing at 18 to 23 percent on the unpaid balance. The amortization period was ten years. The loans granted could not exceed fifty percent of the value of the mortgaged home (including land costs). In addition, mortgages were only given for houses built on land provided with all utilities, including paved streets and sidewalks. As a result of all these requirements, only high income families were able to obtain credit.

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[18] Some of the information used in this section was taken from Oliver Oldman, Henry J. Aaron, Richard M. Bird, and Stephen Kass, Financing Urban Development in Mexico City, Harvard University Press, 1967), pp. 157-173.

[19] The purpose and nature of this reform is described in Section 3.2.

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As a consequence of the 1962 reform, mortgage banks could extend the amortization periods up to twenty years. The maximum interest rates for low cost housing were fixed at nine percent for homeowners and ten percent for developers. The reduction in interest rates is more significant when we consider that in the period 1950-1960 the rate of inflation was around ten percent while during 1960-1970 it was around three percent. Another change in the 1962 reform raised the loan to value ratio to eighty percent (from fifty percent before 1962).

Since there is no market in Mexico for trading home mortgages, mortgage banks issue mortgage bonds and certificates that pay eight percent interest. The funds collected are then available for home financing. It should be added that mortgage banks have not expanded their operations as rapidly as the financial corporations (Sociedades Financeras) which pay up to thirteen percent on certificates of deposit.

ii) Savings and Loan Banks

Credit applicants are required to open a savings account which pays (since 1962) 4.5 percent interst in savings and loan banks. The mortgage credit is granted once the customer has deposited 25 percent of the mortgage value of the house. The loan interest paid by the savings and loan institutions and the contractual nature of their operation has severely limited the extent of home financing offered by these institutions.

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iii) Commercial Banks

Commercial banks are required to channel thirty percent of the deposits in their savings accounts for low cost home financing. Depositors receive 4.5 percent annual interest in addition to a free life insurance policy of 4,000 dollars. These depositors have priority in obtaining mortgage loans with interest rates of nine percent. The required downpayment is twenty percent of the house price. Amortization periods vary from ten to fifteen years.

Commercial banks can obtain loans from a trust fund (FOVA) established by the government to finance low cost housing projects at six percent interest. The required downpayment in home loans is guaranteed by the government in case of default. Nevertheless, commercial banks have been reluctant to participate extensively in low cost housing operations. They prefer to invest their reserve in government securities (risk-free) which pay eight percent interest instead of granting nine percent home loans. At the same time, the government encourages these placements in order to cover its budget deficits.

In the period 1960-1970, the total number of houses financed by private banks represented approximately 25 percent of the houses annually built in the nation, while the government agencies built approximately four percent. The remainder consisted of low quality houses built in the unorganized sector and luxury dwellings financed by their own occupants.

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The private bank operations that are involved in low cost housing are regulated by two government trust funds -- FOVI and FOGA. They are described in the following section.

3.2. Government Housing Agencies

Regulatory Agencies

The banking laws were reformed in 1962 with the purpose of increasing the amount of funds available for home financing. Commercial banks were authorized to grant home loans. These banks were required to allocate thirty percent of the deposits in saving accounts for low cost housing projects. The savings and loan banks were authorized to establish home loan contracts with organized groups. As previously mentioned, the maximum interest rate was fixed at nine percent and the credits could be extended for a maximum of eighty percent of the dwelling value for a period of ten to fifteen years. In order to implement these regulations, the federal government established the following agencies in 1963:

i) The Operational and Bank Discount Housing Fund (FOVI)

This agency was created to supervise, promote, and approve the low cost housing projects presented by the private banks which in turn could receive credits at six percent interest from the agency. FOVI was established as a trust fund i

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trust fund in the Central Bank, authorized to provide financial support to the private banks.

The program is intended for families whose monthly income (in 1975) does not exceed 6,900 pesos ($552). The maximum value for the homes was set at 117,000 pesos ($9,360). In areas with a higher cost of living, the values were set at 8,600 pesos ($688) and 160,000 pesos ($13,120) respectively. The minimum monthly income required was 617 pesos ($49). However, a survey undertaken in the city of Monterrey[20] indicates that families earning less than 1,900 pesos ($152) -- which are almost 50 percent of the Monterrey families -- received only eleven percent of the total credits granted under the program. Furthermore, 48 percent of the credits were granted to families whose monthly income exceeded the maximum level authorized by FOVI. Private banks seem to distrust low income credit applicants and to ignore the fact that higher income families understate their income in the credit applications. As a result, a substantial proportion of low income families remain unable to obtain home loans.

ii) Guarantee and Support Fund for Housing Loans (FOGA)

FOGA was established in order to assure the liquidity of private banks in low cost housing operations when

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[20] I.T.E.S.M. and Camara de la Industria de la Construccion, Experiencia Sobre Vivienda Popular en el Area Metropolitana de Monterrey, unpublished paper, 1971, page 14.

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Source: Fond
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borrowers are unable to advance the full, required down-payment (20 percent of the house price). This difference, advanced by the banks, is guaranteed by FOGA in case of subsequent default. Since foreclosure procedures are lengthy and expensive in Mexico, FOGA also guarantees the payment of the installments for one and one half years after the fourth monthly default. Private banks receive one percent interest from FOGA as an incentive to grant low cost home loans in addition to the nine percent interest paid by customers.

Finally, FOGA established a compulsory insurance policy which covers life, disability, and property risks to the recipients of home credits.

Table II-8 shows the number of dwellings financed under the FOVI and FOGA programs.

Table II-8. Number of Dwellings Financed by FOVI and FOGA 1963-1974

Year	Number of Dwellings	Year	Number of Dwellings
1963	41	1969	13,500
1964	7,558	1970	19,500
1965	11,800	1971	17,900
1966	12,000	1972	13,200
1967	24,500	1973	29,200
1968	10,700	1974	17,700

Source: Fondo de Operacion y Descuento Bancario a la Vivienda.

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During the period 1964-1974, a total of 177,599 dwellings was built under the FOVI-FOGA programs. This volume of construction represents less than ten percent of the total number of dwellings built during the same period. The disappointing results of this program led the government to establish a new housing agency, the INFONAVIT, which is next described.

Government Agencies Engaged in Dwelling Construction

i) The Institute of Social Security and Services for State Workers (ISSTE)

ISSTE was established in 1925 as the Office of Civil Pensions and Retirement. It was the first public agency to finance and build housing units, and until 1958, the most important one. From 1925 to 1972, ISSTE financed or built approximately 35,000 dwellings for the employees of the federal government. Since 1972 the housing activities of ISSTE are realized through a trust fund called FOVISSTE. The federal government contributes five percent of its monthly payroll which encompasses 800,000 employees and deposits the amount in the FOVISSTE fund. In 1973, FOVISSTE financed 4,000 dwellings. FOVISSTE has adopted the INFONAVIT credit terms which are described later in the section.

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ii) The National Bank of Public Works and Services (BNHOP)

This bank was established in 1933 to finance the urban infrastructure works undertaken by the municipalities. Since 1946 it has also financed the construction of approximately 22,000 low cost homes. Home loans are granted under favorable credit terms. The downpayment does not exceed ten percent of the value of the house, amortization periods vary from ten to twenty years, and the interest rates range between eight and ten percent. The bank has participated in the financing and management of large housing complexes built in Mexico City.

iii) The National Housing Institution (INV)

INV was established in 1954 to serve as a coordinating agency for all government housing programs. Unfortunately, INV was not provided with enough capital and legal authority to fulfill its functions. From 1954 to 1964 INV financed the construction of 10,000 low cost dwellings. Since then it has been engaged in some housing rehabilitation projects and in the elaboration of housing studies.

iv) Department of the Federal District (DDF)

Since 1950 the Department of the Federal District has been engaged in the construction of low cost housing for its employees and for families whose homes have been demolished during the construction of public works. In the period 1

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the period 1970-1973 the DDF promoted the construction of 27,080 units, which represents 36 percent of the total number of public housing units built in the nation.[21] Until 1972, the activities of all public housing agencies were chiefly concentrated in the metropolitan area of Mexico City where political power resides. Despite these efforts, the housing shortage in Mexico City is larger than in other cities in the nation due to the rapid growth of the population which increased from 3.05 million in 1950 to 6.87 million in 1970.

v) National Institute for the Development of Rural Communities and Low Cost Housing (INDECO)

Created in 1972, INDECO represents the first effort to solve the housing problems in the rural areas. It has plans to build 8,000 houses per year with funds allocated by the federal government.

INDECO is also authorized to undertake housing projects in the outskirts of the cities where private developers cannot easily operate because Mexican agrarian laws restrict, or forbid in some cases, the sale of agricultural land for urban projects. For example, the land occupied by ejidos (collective farms) according to the law, cannot be sold, leased or mortgaged without government approval.

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[21]Refer to Table II-9.

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In addition to the five housing agencies already mentioned, there are other public organizations involved in the construction of low cost housing units such as The National Institute of Social Security (IMSS), the petroleum and electric power enterprises, (PEMEX and CFE), and some state governments. Unfortunately, the activities of all housing agencies have not been coordinated by the government. Furthermore, the investment plans of the existing housing agencies have been periodically interrupted by the creation of new agencies. It appears that the government housing plans will continue to fail unless long term investment goals are adopted and implemented.

The number of dwellings built by the various government agencies is summarized in Table II-9. During the period 1953-1973, the number of public housing units was 150,147, of which 54 percent were built since 1970.

The Mexican Constitution of 1917 states that enterprises employing more than one hundred workers must provide them with adequate housing. In reality, few firms complied with this constitutional mandate. An agreement was reached in 1972 between the government, trade unions, and the private sector which resulted in the creation of a new housing organism, the INFONAVIT (National Housing Fund for Workers). Under the new housing laws, all firms are obligated to contribute an amount equal to five percent of wage payments to the INFONAVIT.

Table II-9.

Year	1953-1958
Agency	
ISSTE	2,931
BNHOP	2,106
INV	688
DDF	444
IMSS	2,433
PEMEX	2,100
CFE	2,719
INDECO	
INFONAVIT	
Total	13,421

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Table II-9. Number of Dwellings Built by Government Housing Agencies 1952-1973

Year / Agency	1953-1958	1959-1964	1965-1969	1970-1972	1973
ISSTE	2,931	4,713	4,934	5,184	4,003
BNHOP	2,106	8,000	9,385	3,333	4,232
INV	688	2,924	1,827	2,400	
DDF	444	1,486	14,321	19,887	8,093
IMSS	2,433	5,939			
PEMEX	2,100	2,000			
CFE	2,719	2,712			
INDECO				15,000	243
INFONAVIT				9,252	6,858
Total	13,421	27,774	30,467	55,056	23,429

Note: Some housing projects promoted by government agencies but which were financed by private banks are not included in this table.

The housing policies adopted by INFONAVIT are subsequently described.

A. Credit Policy

INFONAVIT home loans are granted for a maximum amortization period of twenty years at 4 percent annual interest. No downpayment is required. The amount of monthly installment is determined by the wages earned by the workers. For example, workers earning less than 1.25

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times the minimum wage[22] pay 14 percent of their salaries as installments. Those workers earning between 1.25 and 5 times the minimum wage pay 18 percent. Under this system, the amount of monthly payments rises as the workers' salaries increase. During the amortization period, 2 percent out of the 5 percent payroll tax paid by the firms is credited to the workers' account. It should be noted that the enterprises continue to pay the five percent payroll tax even after the recipients of INFONAVIT homes have paid their loans.

Credits are assigned under a "lottery" system which favors workers who earn less than twice the minimum wage. In 1973, 76 percent of the credits were granted to this group of workers. At the same time, the contributions paid by the firms for this group of workers represented approximately 40 percent of the total contributions. Consequently, funds are transferred from workers earning more than twice the minimum wage to workers who earn less.

INFONAVIT housing projects are built by private developers who receive "bridge" loans at eight percent interest from the institute. This type of loan is not easily obtained from private banks which often require that dwellings be sold before the projects begin.

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[22] The minimum wage in Mexico City was approximately 2,000 pesos ($160) per month in 1975.

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B. Resources

The INFONAVIT is funded through firms who pay the five percent payroll tax and the installment payments made by the recipients of home loans. From 1972-1975 INFONAVIT received 800 million dollars.

The INFONAVIT has invested 110 million dollars in the acquisition of land reserves for its housing programs for the next five years. In this way the institute expects to protect its program from land speculation and inflationary pressures.

C. Number of Workers

In April 1975 there were 3.75 million workers employed by 229,000 firms registered with INFONAVIT. It should be noted that while there are approximately sixteen million people in Mexico who earn less than the minimum wage, the INFONAVIT had only one million of these people registered with the institution. The INFONAVIT program only covers workers employed under an explicit or implicit contract. Consequently, seasonal workers, those who are self-employed, and peasants are excluded from the INFONAVIT.

D. Construction Goals

INFONAVIT planned to build 100,000 dwellings per year, but this goal proved to be unrealistically high. Projections for 1980 have estimated that 85,000 credits will be granted

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will be granted per year. Eighty percent will be accorded for the acquisition of INFONAVIT dwellings. Twenty percent will be used as credits to rehabilitate or improve old dwellings and pay workers' home loans that have been contracted with other financial institutions.

In its first three years of operation the INFONAVIT has promoted the construction of 55,000 dwellings, at an average price of 100,000 pesos (8,000 dollars).

The INFONAVIT represents the most ambitious and best organized program undertaken in Mexico. The compulsory nature of the contributions paid by enterprises assures an increasing flow of resources to the institute. However, a substantial segment of the population will still remain outside the organized housing sector.

Summary

The purpose of this chapter was to describe some general aspects of the housing sector in Mexico.

We observed that while the over-all quality of the housing stock has improved through time, there remains a substantial portion (around 40 percent) of dwellings that do not meet a minimum standard of quality. Furthermore, the number of persons per dwelling has been rising in the last two decades because the housing stock has increased at a lower rate than the population. The present housing deficit was estimated at 4 million dwellings, and the housing needs fo

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housing needs for the period 1970-1985 were calculated at approximately 8.5 million units.

The construction industry seems capable of meeting the demand for housing in the organized part of the housing sector, including the housing programs initiated by the government. The most serious problem on the supply side seems to be the low growth rate of labor productivity in the construction industry.

Family income was the most important variable on the demand for housing in Chihuahua. Education and down-payment requirements (loan to value ratio) exerted some influence on housing when income was excluded from the regressions. Household age and family size were statistically unrelated to housing consumption. The income elasticity of the demand for housing was not significantly different from one.

Finally we described the financial institutions and the government housing agencies. Despite the increasing participation of the government and the banking reforms, the volume of low cost housing construction has remained at relative low levels. The agency established in 1972 (INFONAVIT) is the best financed (through a five percent payroll tax) and designed housing program ever initiated -- yet a large segment of the population remains outside the private and public housing plans.

CHAPTER III

SURVEY ON THE FILTERING PROCESS IN THE CITY OF CHIHUAHUA

Introduction

While new construction tends to satisfy the housing needs of a small segment of the population, old dwellings are the chief source of housing for the majority of families. New construction represents only a small fraction of the housing stock, and the price of new dwellings is often beyond the financial capacity of most people. It is important to know how the construction of dwellings affects the supply of old dwellings for all income groups.

The process of household moves begins when new dwellings are occupied by families who vacate their homes which are then made available for other occupants. Downward filtering is said to occur when dwellings are transferred to families of lower income levels. However the existence of housing shortages at certain income levels may prevent the chains of moves from reaching the lowest income families. Furthermore, the construction of an insufficient number of units for the rich can result in upward filtering trends which aggravates the housing conditions of the poor if it is not anticipated.

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Initial vacancies are created by the construction of new dwellings and through emigration and death of households. We limited the survey of Chihuahua to the household moves that originated with new construction. The survey produced information on the direction and length of the chains of moves as well as on the characteristics of the households and dwellings involved.

The filtering process has been studied using two approaches.[1] One approach is based on the analysis of a set of dwelling units whose values and quality are recorded through time. Under this method, reductions in value and quality indicate downward filtering trends. The other approach is based only on the characteristics of the households involved in the chains of moves. Under this approach, filtering is defined in terms of the level of income of the occupants. In our survey, a combination of both approaches is adopted. Dwellings and their occupants are examined simultaneously from the beginning to the end of the chains of moves.

Since we are interested in discovering whether poor families benefit from the sequences of moves, our criterion of filtering is essentially based on the income level of the households involved in the chains of moves.[2]

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[1] J.B. Lansing, C.W. Clifton, and J.N. Morgan, New Homes and Poor People -- A Study of Chains of Moves, (ISR, Ann Arbor), 1969, pages 2-4.

[2] The same criterium will be used in the application of a linear programming model in Chapters IV and V.

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The Survey Sample

The sample was taken in Chihuahua, a city of 300,000 (in 1975) inhabitants located in northern Mexico. The average monthly family income in Chihuahua was 2,478 pesos (199 U.S. dollars) in 1970 as compared with 1,948 pesos (155 U.S. dollars) for the nation. The population of Chihuahua grew at an annual rate of 4.28 percent from 1960 to 1970. The proportion of the labor force employed in manufacturing in 1970 was 25.5 percent as compared with 16.4 percent for the nation as a whole.

The number of households interviewed was sixty-four, of which thirty had moved to new dwellings. The sample of new dwellings was restricted to the organized housing sector since we were interested in determining whether poor families improve their housing conditions by moving into dwellings filtered down from the organized sector. In addition, a housing program can control only the volume and type of dwellings built in the organized sector. Dwellings built by the INFONAVIT represent one-third of the sample of new dwellings. The rest were built by private developers. INFONAVIT dwellings are over-represented in the sample, given the relatively small number of dwellings built (about ten percent for the nation) by this institution in 1975. However, INFONAVIT is expected to build an increasingly larger number of dwellings in the future.

The sample of dwellings built by the INFONAVIT and private developers were randomly chosen. The dwellings were located throughout the entire city.

Purpose of the Survey

The purpose of the survey is to quantify the indirect (transfer) effects induced by new construction. The length of the chains of moves will indicate the number of families who indirectly benefitted from new construction. At the same time we will examine the level of income reached by the chains of moves to determine whether the poor benefit from new construction.

Another objective is to determine which type of dwelling (in value terms) initiates more household moves. Thus housing programs could promote the dwelling type whose construction would benefit the greatest number of families.

In addition, the survey provides information to determine the influence of several variables such as income, age, education, familiy size, and family preference on the demand for housing.

Section 1. Characteristics of the Chains of Moves

The occupation of new dwellings represents the first position in the chains of moves. However the chains of moves will not extend beyond the first position if new dwellings are occupied by households who do not leave any unit vacant. T

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Since the survey was restricted to the city of Chihuahua, a chain is terminated by the emigration of households to other cities.

Finally, some chains cannot be followed to their conclusion due to the impossibility of establishing contact with the households.

1.1. The Length of the Chains of Moves

The first measure of the length of the chains of moves is given in the ratio of total number of households interviewed to the number of new dwellings:

$$\frac{\text{Total number of interviews}}{\text{Total number of new dwellings}} = \frac{64}{30} = 2.13$$

The ratio 2.13 means that for each new dwelling built, there are approximately two vacant units which are subsequently occupied.

We estimated the percentage of dwellings "lost" at each position based on the number of dwellings whose disposition was known from interviews or from information supplied by neighbors.

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[3] This method

pages 12-16.

The loss rates shown in Table III-1 were estimated from the data presented in Table III-2. The loss rate represents the number of dwellings that are withdrawn definitely from the chains of moves in each position. For example, of the thirty dwellings in the first position, only twenty of these initiated chains of moves. Consequently ten dwellings were occupied by households who did not leave any unit vacant. However, three out of the ten dwellings were still vacant at the time of the survey or we could not contact the occupants. Since these three dwellings could initiate chains of moves once occupied, the net number of dwellings withdrawn is only seven. Thus the loss rate is 23.3 percent (7/30). In Table III-1 we present the number of dwellings at each position estimated by the loss rate method.[3]

Table III-1. Number of Dwellings in Each Position in the Chains of Moves

Position	Number of Dwellings (1)	Estimated Loss Rates (percent) (2)	Dwellings Lost (3) = (1)×(2)
1	30	23.3	7
2	23	50.0	12
3	11	50.0	5
4	6	75.0	5
5	1	75.0	1
Total	72		30

Note: The figures in column 3 were rounded off.

[3]This method is proposed by Lansing, et al., op. cit., pages 12-16.

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The average length of the chains is 2.4 (72/30) calculated from the data shown in Table III-1. This implies that the construction of one hundred dwellings resulted in the improved accommodation of 240 families, of which 140 families moved to old dwellings.

The average length found in Chihuahua (2.4) is within the range estimated in similar studies: 1.5 in Detroit (Committee for Community Renewal, 1971), 2.05 in Tunis (R. Ferchiou, 1974), 2.4 in New York (Kristof, 1965), and 2.52 in Mexico City (C. Prentice, 1975). The longest average length of 3.5 was recorded in a survey produced by Lansing, Clifton, and Morgan which covered all geographical areas of the United States. It is expected that the average length of chains will be longer when families can be followed through an entire nation.

1.2. Reasons for the Ending of the Chains of Moves

Sequences of household moves come to an end because of two "justifiable" reasons: i) when the dwellings in the last position of a sequence are occupied by people who do not leave any vacancy, ii) when the dwelling in the last position is removed from the housing stock.

Alternately, the failure to establish contact with a household and the fact that a dwelling remains empty during the survey period are considered to be "unjustifiable" reasons for the ending of a sequence. The loss rates shown in Table

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Table III-

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Total number of interviews	
Sequences known to continue	
Moves without vacancies	
Recent migrants	
Recently formed households	
Dwellings removed	
Dwellings temporarily vacant	
No contact possible	

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shown in Table III-1 were based exclusively on the "justifiable" reasons.

Table III-2. Reasons for the Ending of the Chains of Moves

	Position I	Position II	Position III	Position IV	Total
Total number of interviews	30	20	10	4	64
Sequences known to continue	20	10	4		34
Moves without vacancies	10	10	6	4	30
Recent migrants	4	6	3	2	15
Recently formed households	1	1	1	1	4
Dwellings removed	2	3	1		6
Dwellings temporarily vacant	2				2
No contact possible	1		1	1	3

Since economic opportunities in Chihuahua attract families from other parts of the state, it is not surprising that recent migrants constitute the most important reason (50%) for the ending of sequences. Although the occupation of dwellings by migrants resulted in the end of the sequences of moves in Chihuahua, we found that twenty two percent of the migrants left houses vacant which initiated new sequences

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in other cities. We also noted that the migrants belonged to all income groups.

The removal of a dwelling from the housing stock constitutes the second reason why the sequences of moves ends. Destruction by rain floods accounted for half of all removals. These dwellings were made of low-quality materials which suggests that the sequences were moving, in these cases, toward lower income families. The other dwellings that were removed from the housing stock were converted into boarding houses and commerical stores.

The occupation of dwellings by newly-married couples constitutes the third reason for the ending of sequences. Since they were usually living in their parents' homes, no unit was left vacant.

The final reason sequences were ended was the impossibility of locating householders or the fact that the dwellings were still vacant. These "unjustifiable" reasons are more important in studies covering larger geographical areas because it is more difficult to locate the households.

In Section 2 we shall determine if the length of the chains depends on the value of the initial dwelling in each sequence.

Section 2. Characteristics of the Dwellings

Section 2 examines the value, rent, and quality of the dwellings involved in the sequences of moves.

2.1. Dwelling

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Dwelling Type	Value Dwell
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II	100,00 125,0
III	125,000 175,00
IV	175,000 250.0
V	More t 250,C
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2.1. Dwelling Values in Relation to the Length of Chains of Moves

Are sequences initiated by the most expensive dwellings longer than those starting with lower value dwellings? This would be expected in cities where there are no acute housing shortages and the housing market is homogenous. The relation of the length of chains and the value of new dwellings is shown in Table III-3.

Table III-3. Length of Sequences and Value of New Dwellings

(1975 Pesos)

Dwelling Type	Value of new Dwellings	Total number of new dwellings (1)	Total number of moves (2)	Length of chains (3)=(2)/(1)
I	75,000-100,000	7	13	1.86
II	100,000-125,000	12	22	1.83
III	125,000-175,000	6	16	2.67
IV	175,000-250.000	3	7	2.33
V	More than 250,000	3	6	2.00
Total		30	64	2.13

The length of sequences rises as the dwellings become more expensive, reaches a maximum value at 2.67, and then decreases.

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As found in other studies, inexpensive houses initiate short sequences in Chihuahua. Contrary to surveys carried out in the United States, the longest sequence in Chihuahua was not initiated by the most expensive dwellings. Dwellings in the middle value range (125,000-175,000 pesos) resulted in the longest sequence (2.67 moves) in Chihuahua. However the t-test for differences between means[4] revealed that the differences in the average lengths were not significant at the 5 (and 10) percent levels of significance.

The cost per unit filtered and built which is estimated by dividing the amount invested in new construction by the total number of families benefitted, is 47,000 pesos for Dwelling Type I (the least expensive in the survey), 61,500 pesos for Dwelling Type II, 56,179 pesos for Type III, 91,200 pesos for Type IV, and 200,000 pesos for Type V. According to this criterium, Dwelling Type I results in the lowest cost (47,000 pesos) per family benefitted, followed by Dwelling Type III (56,200 pesos).

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[4]The t-test for differences between means when the population variances are unequal and the subsample sizes are different are based on:

$$t = \frac{(X1 - X2) - (U1 - U2)}{\left(\frac{S1^2}{N1} + \frac{S2^2}{N2}\right)^{\frac{1}{2}}}$$

The null hypothesis is $X1 = X2$. The alternative hypothesis is $X1 > X2$ where X_i = subsample means

U_i = population mean = 0

S_i = variances

N_i = size of the subsamples

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However it should be noted that the INFONAVIT (which builds Dwelling Type I) transfers some of the financial and urbanization costs of this type of dwelling to more expensive dwellings that are built by them. Thus, the estimated cost per unit filtered and built of Dwelling I might be slightly underestimated.

2.2. Dwelling Rent at Each Position in the Sequences of Moves

The first evidence of the direction of the filtering trends is given through the difference between the rent paid at the first and last dwelling of a sequence of moves. Downward filtering is likely to occur if the rent of the initial dwelling is higher than the rent paid for the last dwelling in the sequence.

Table III-4. Rent Paid in the First and Last Dwelling in the Sequences of Moves

(1975 Pesos)

Number of Moves	Average rent of the first dwelling (1)	Average rent of the last dwelling (2)	Percentage decrease between (1) and (2)
2	930	555	40.3
3	1,000	550	45.0
4	1,350	540	60.0
Averages	1,093	548	49.9

Note: Average rent refers either to rent paid or monthly payment.

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As shown in Table III-4, rents decreased from the first to the last position in all sequences. The average reduction in rent is 49.9 percent which makes it possible for some dwellings to filter down to lower income families. However, the over-all average rent in the last position (548 pesos) is excessive for families earning less than 2,192 pesos.[5] This fact implies that approximately fifty percent of the families in Chihuahua will not be affected by the chains of moves (see Distribution of Households by Income Level in the Appendix of this chapter).

We also notice that the longest sequences (those involving four moves) results in the greatest reduction (60.0) in the rent paid for the first and last dwellings (from 1,350 to 540 pesos). However, the average rent paid in the last position is approximately the same in all the chains irrespective of their length. It appears that even relatively long chains of moves (4 moves) fail to reach the lowest income strata.

According to the laws and commercial customs of Mexico, landlords cannot force tenants out of dwellings unless they are granted a three to six month period to find another place to live.[6] Rents tend to remain unchanged

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[5]Assuming that families do not spend more than twenty five percent of their income on housing.

[6]This period is not granted in most cases to poor families who are subject to landlord abuses.

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or are slightly increased during the period that a dwelling is continuously occupied; however, rent increases when a tenant moves out. In Chihuahua we found that on the average, rents increased 18 percent after households moved to another dwelling. Rents increased in 58 percent of all cases, while they decreased in 11 percent of all cases. They remained fixed in 31 percent of the cases.

Given that housing shortages are larger at the bottom than at the top of the income scale, it was not unexpected that rent increases were larger for low cost than for higher quality dwellings. Rents increased 31 percent for dwellings valued at less than 100,000 pesos, 12 percent in the range of 100,000 to 250,000, and 10 percent for dwellings above 250,000 pesos ($20,000). It was also expected that high income families would resist large rent increases since they can afford to move into new homes, while low income families do not have the financial capacity to acquire new homes.

It is observed everywhere that rents tend to decline in real terms during an unanticipated inflationary period. Since 1973, the consumer price index has increased at an annual rate of 20 percent, while we found in Chihuahua that rents increased 18 percent on the average. However, rent increases for low cost dwellings exceeded the rate of inflation. Low income families are even worse off since workers' earnings have declined in real terms since 1973.

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Even the minimum wage rates, which most workers do not receive, have increased at a lower rate than the consumer price index since 1973.

2.3. Physical Characteristics of Successive Dwellings

Direction of the filtering trends can also be inferred by examining the quality of the dwellings involved in the chains of moves. We gathered information about the number of rooms and the availability of utilities, which indicate the quality of the dwellings.

New dwellings are provided with complete facilities and are larger than those occupied by poor families. We can expect that downward filtering is taking place if the quality of the dwellings decreases as sequences become longer.

A. Number of Rooms per Dwelling

Table III-5. Number of Rooms at each Position (kitchens and bathrooms excluded)

Number of Rooms	1	2	3	4	5	6	7 or more	Average number of rooms/dwelling
Position								
I				3	12	10	5	5.57
II			2	8	7	3		4.55
III			1	4	3	2		4.60
IV		2	1	1				2.75

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As shown in Table III-5, the average size of dwellings declines along the chains of moves. Given that the size and the value of the dwellings are positively correlated, we can expect that the chains move in the direction of lower value homes as indicated in Sections 2.1 and 2.2.

The average size of dwellings in the last position (2.75 rooms) is larger than the size of the dwellings occupied by the lowest income families who usually live in one and two room houses. The stock-user matrix for 1970[7] shows that the lowest 2.7 percent of families (F_0 and F_1) live in low quality dwellings which have one and two rooms (H_0 and H_1). The matrix appears in the Appendix of this chapter.

Finally, it should be added that 80 percent of the sequences involved less than four moves and ended with dwellings having 4.6 or more rooms.

B. Availability of Housing Facilities

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[7]The stock-user matrix illustrates the distribution of the housing stock by family income levels.

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Table III-6. Housing Facilities at Each Position in the Chains of Moves (Number of Dwellings)

Position	Electricity Have	Electricity Lack	Running Water Have	Running Water Lack	Bathroom Have	Bathroom Lack	Toilet Have	Toilet Lack	Percentage of dwelling with all facilities
I	30		30		30		30		100%
II	20		18	2	15	5	14	6	80%
III	10		9	1	8	2	7	3	80%
IV	3	1	3	1	3	1	2	2	63%

As expected, the availability of housing facilities decreases as the sequences come to an end. The percentage of dwellings provided with all facilities decreased from 100 percent in the first position to 63 percent in the last position.

Low quality dwellings which accounted in 1970 for 46.8 percent of the housing stock in Chihuahua,[8] were not affected by the chains of moves. The chains of moves remained within the organized housing sector.

Section 3. The Characteristics of the Families in the Chains of Moves

The sequences of moves were analyzed in the previous section in terms of the dwelling characteristics. We now examine the characteristics of the households involved. As

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[8]Dwelling types H_0 and H_1 are not provided with electricity and other utilities. See the stock-user matrix at the end of this chapter.

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previously stated, the chief interest in studying the filtering process is to discover which families indirectly benefit from new construction.

In Section 3.1 we present the reasons for household moves. These reasons reflect the families' tastes and preferences in housing. Sections 3.2 and 3.3 are concerned with the level of income and the stage in the family life cycle, which represent respectively the financial capacity and the need to change houses.

3.1. Reasons for Household Moves

Table III-7. Reasons for Household Moves at Each Position in the Sequences

(In Percentages)

Position	I	II	III	IV	Averages
Reasons					
To become homeowners	57.9	20.5	50.0	33.3	40.4
More space needed	15.8	46.8	12.5	16.7	22.9
Access to place of employment	13.2	15.8	20.5	16.3	16.5
Better neighborhood	10.5	5.3		16.9	10.9
Other reasons	2.6	11.6	17.0	16.8	12.0

The first reason why people move is due to the desire to become homeowners. Families were especially interested in acquiring INFONAVIT dwellings whose credit terms

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are affordable for even the lowest income groups. Furthermore, in the absence of a developed stock market, housing ownership is the preferred form of investment for most Mexicans.

The desire to live in a more spacious home constitutes the second reason for moving.

Since the dwellings surveyed were located near employment centers, the desire to be closer to the place of employment was not viewed as an important reason for moving.

It should be indicated that the reasons shown in Table III-7 are those given by order of importance.

A small number of households were motivated to move by the wish to live in a better neighborhood. These results are not surprising since there are no signs of urban decay in Chihuahua and the population is ethnically homogenous.

Another indicator which illustrates the importance of housing ownership is seen in the proportion of homeowners at each position in the sequences.

As shown in Table III-8 the proportion of homeowners increases from the last (24%) to the first position (76.7%) while the proportion of renters decreases. The higher proportion of homeowners in Position I is largely explained by the favorable credit terms granted by the INFONAVIT and the Office of Civil Pensions in the state of Chihuahua, whereas

Table III-8. Proportion of Owners and Tenants in the Sequences of Moves

(In Percentages)

Tenure	Homeowners	Renters	Total
Position			
I	76.7	23.3	100
II	50.0	50.0	100
III	30.0	70.0	100
IV	24.0	76.0	100

the increasing proportion of renters in Positions II, III, and IV suggests that the level of family income decreases as the sequences become longer and that mortgates for old houses are hard to obtain.

3.2. Stage in the Family Life Cycle

Family needs for housing depend on the number of children, age of household heads, and family size. The need for housing space increases as families grow, and then decreases when the children move out of their parents' homes. Since we already know that the dwelling size decreases along the sequences of moves (Table III-5), we might expect that small families live in the dwellings found in the last positions of the sequences. However, the level of income may prevent the families from moving to the type of dwelling required by their stage in the family life cycle.

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Table III-9. Stage in the Family Life Cycle at Successive Positions

Position	Age of Head of Household	Number of Children	Household Size
I	40.6	3.97	5.99
II	38.0	3.67	5.48
III	50.0	3.38	5.43
IV	39.3	4.67	6.74

Table III-9 suggests that the age of the head of the household is not related to the number of children or to the family size. The only clear relation we can detect is that the last dwellings in the sequences are occupied by the largest families. That is, they live in the smallest and least expensive dwellings. Although large families have the greatest need for space, they cannot afford larger dwellings. The level of income is more important in determining the type of dwelling demanded than is the stage in the family life cycle as was shown in Section 3.2 of Chapter II.

We also noted in the survey that the size of the households differ only in the number of children. However, in addition to the number of children, low income households also offer their homes to relatives and friends who lack housing. The chains did not include households who maintained an extended family.

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3.3. Income of the Households Involved in the Sequences of Moves

Table III-10 shows the level of household income at successive positions in the sequence of moves.

Table III-10. Household Income at Different Positions (1975 Pesos)

Positions	Average income per month	Range	Standard deviation	Percentage Decrease from Position I
I	5,703	1,800-14,500	3,269	
II	3,520	1,000- 7,400	1,872	34.7
III	2,650	1,200- 5,000	1,338	51.6
IV	2,600	1,800- 3,100	560	52.5

Downward filtering is indeed taking place in Chihuahua since the households involved in the chains of moves are characterized, on the average, by successive levels of income.

The F-test revealed that only the differences between the first and second, first and third, and first and fourth positions were significantly different. We then conducted a t-test which revealed that average income in the first position was significantly higher (at the 5 percent level) than average income at the second position of the chains. The t-test also indicated that income in the second and third positions was not significantly higher (even at the ten percent level) than income in the third and fourth

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positions respectively. The results of these tests indicate that the chains of moves remained in the middle income group. It appears that housing shortages in the middle of the income scale prevented the chains from reaching the lowest income strata. In addition imperfections in the financial market prevent low income families from acquiring old dwellings.

The lowest level of income reached by filtering trends (2,600 pesos) is above the income earned by approximately fifty percent of the families in Chihuahua (see stock-user matrix for Chihuahua). Consequently, poor families in Chihuahua do not benefit from the filtering process. However, the poor will face less competition from higher income groups in the housing market.

The survey registered upward filtering trends in 26.5 percent of the household moves. In these cases the dwellings were occupied by families who had higher incomes than the previous occupants. It is obvious that the number of low income families involved in the sequences could have been larger if all dwellings had filtered down. In 20.6 percent of the moves, dwellings were transferred among families of the same level of income. In 55.9 percent of the moves downward filtering occurred.

It should be noted that the disappearance of households (by death or migration) may result in chains of moves of differing lengths as compared to those that originated from new construction. Although we did not investigate the first case, it is possible that the disappearance of high income households might reduce the number of units filtered up.

Using the data on household income and average rent we estimated the rent-income ratios at each position in the sequences.

Table III-11. Rent in Relation to Family Income at Each Position

(1975 Pesos)

Position	Average Rent	Average Income	Rent-Income Rate
I	1,110	5,703	19.5%
II	696	3,520	19.8%
III	575	2,650	21.7%
IV	540	2,600	20.8%

Note: In the case of owner-occupied dwellings, the monthly payment includes the opportunity cost of the down-payment. The opportunity cost is based on the rate of interest paid on time deposits -- twelve percent per year.

The rent-income ratios shown in Table III-11 indicate that the proportion of income allocated for housing is approximately the same at all income levels. This suggests that the coefficient of income elasticity is close to one. As a result, the level of income decreases at the same rate as the average rent along the sequences of moves.

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The ratios shown in Table III-11 also indicate that families living in new dwellings (Position I) allocate approximately the same percentage (about twenty percent) of income for housing than do families living in old dwellings (Positions II, III, and IV). The average proportion of income spent in Position I (all new dwellings) could have been higher if INFONAVIT[8] had not restricted the monthly payments to an average of eighteen percent of family income.

3.4. Level of Education at Each Position

The level of education attained by the household head is an indicator of the social status of families. It is also a proxy variable for the level of income. Since we already found that the level of income decreases as the sequences become longer, we can expect that the level of education also decreases along the sequences of moves.

Table III-12. Education of Household Head

Position	Number of Years of Schooling
I	13.7
II	9.6
III	8.8
IV	6.7

[8]INFONAVIT dwellings represented thirty percent of the new dwellings in the sample.

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As shown in Table III-12, the level of education decreased from 13.7 years in the first position to 6.7 in the last. As in the case of income, the largest reduction in the level of education is found between the first and second moves of the chains. Based on the decreasing level of education along the sequences of moves we can conclude that the dwellings filter down in the social scale.

It should be noted that while the household heads in the last position of the chains had 6.7 years of schooling, according to the 1970 census only fifty six percent of the adult population in Chihuahua had completed six years of school. This confirms that the uneducated poor were not reached by the sequences of moves.

Section 4. Average Length of the Sequences of Moves in the Dwellings Built by INFONAVIT

In this section we compare the sequences of moves initiated by INFONAVIT dwellings in relation to the sequences initiated by private developers.

Since INFONAVIT builds less expensive dwellings than other developers, we can expect, in accordance with our previous findings, that INFONAVIT dwellings initiate shorter sequences. This is examined in the next table.

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Table III-13. Average Length of Chains of Moves Initiated by INFONAVIT and Other Developers

Dwelling Values (1975 Pesos)	Length of Sequences INFONAVIT	OTHERS
75,000 - 100,000	1.86	
100,000 - 125,000	1.50	1.90
125,000 - 175,000	2.00	2.80
175,000 - 250,000		2.33
More than 250,000		2.00
Total number of moves	18	46
Total new dwellings	10	20
Average length of chains	1.8	2.3

Table III-13 shows that the average length of INFONAVIT chains (1.8) is shorter than non-INFONAVIT chains (2.3). Therefore the chains initiated by non-INFONAVIT dwellings benefit a larger number of families through the filtering process. The t-test however, revealed that non-INFONAVIT chains were not significantly longer on the average than INFONAVIT chains.

The longest chains (2.8) are initiated by non-INFONAVIT dwellings whose value is between 125,000 and 175,000 pesos. The shortest sequences were initiated by INFONAVIT dwellings valued at less than 125,000 pesos (10,000 dollars).

Besides building a larger number of low cost dwellings, INFONAVIT provides more housing units to lower inc

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income families than other developers through the sequences of moves. While 70 percent of INFONAVIT dwellings were assigned to families earning less than 2,500 pesos per month, only 5 percent of the dwellings built by other developers were sold to this income group.

The average income of families in the last position in INFONAVIT chains was 2,200 pesos (2,800 pesos for non-INFONAVIT chains), whereas the income of the occupants in the first position was 2,640 pesos (7,325 pesos for non-INFONAVIT). This suggests that families earning less than 2,200 pesos ($178) will not benefit from the filtering process unless a larger number of low cost dwellings is built. In 1975, INFONAVIT should have increased construction of dwellings valued at less than 75,000 pesos ($6,000), instead of the 100,000 pesos dwellings that are currently built, in order to reach the lowest 50 percent income strata.

Summary

This survey was undertaken with the purpose of measuring the filtering trends initiated by the construction of new houses. We wished to discover who benefits indirectly from new construction through the filtering process. We also wanted to find the type of dwelling that initiated the longest sequences of moves.

The average length of the chains of moves was 2.13, which means that for each dwelling built there were

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approximately two households who improved their housing conditions.

We found that downward filtering took place in 55.9 percent of the household moves. In 26.5 percent of the moves we observed that the dwellings were transferred to higher income families, while in 20.6 percent the dwellings remained in the smae income group. Since INFONAVIT dwellings were occupied by relatively lower income families, we observed a net over-all transfer of dwellings from high to lower income families.

The results showed that dwellings were transferred, on the average, to lower income families as indicated by the fact that the level of income decreased along the sequences of moves. The average family income decreased from 5,703 pesos in the first position to 2,600 pesos in the last position of those sequences involving four moves. In the chains of moves involving three moves, the average income declined from 5,703 pesos in Position I to 2,650 in Position III.

In the cases of downward filtering, the level of income reached by the chains was above the income earned by approximately fifty percent of the families in Chihuahua. It is therefore necessary for housing programs to expand the construction of lower cost houses.

The process of downward filtering was verified by the rent or monthly payment of the dwellings involved in

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the chains of moves. Families in the first position paid an average of 1,110 pesos while families in the last position paid 540 pesos. The quality of the dwellings as measured by the number of rooms and the availability of utilities also decreased along the sequences of moves.

INFONAVIT houses were found to initiate shorter sequences than other developers. At the same time, being less costly to begin with, INFONAVIT chains reached lower income groups by building a larger number of low cost houses.

The length of the chains depended on the value of the initial dwellings. Dwellings in the middle value range (125,000 to 175,000 pesos) initiated the longest chains of moves. The construction of middle value dwellings will benefit the largest number of families per dwelling, though not per peso invested. The construction of the least expensive dwelling seems to result in the lowest cost per dwelling filtered and built.

In Chapter VII we will explain the relation between the findings of the filtering survey in Chihuahua and the model for optimal allocation which is applied in Chapters IV and V.

APPENDIX I

Chihuahua 1970 Stock-User Matrix

APPENDIX I

Chihuahua 1970 Stock-User Matrix

Table III-IV. Chihuahua 1970 Stock-User Matrix (Units)

Households / Dwellings	H_0	H_1	H_2	H_3	H_4	H_5	F	F_i% Households
(income per mo. in 1975 pesos)								
F_0 (0 - 882)	2,292						2,292	4.7
F_1 (883 - 1,841)	9,542	1,675					11,217	23.0
F_2 (1,842 - 3,841)		9,300	10,257				19,557	40.1
F_3 (3,842 - 7,971)			3,943	7,030			10,973	22.5
F_4 (7,972 - 16,680)				1,270	1,997		3,267	6.7
F_5 (more than 16,681)					571	896	1,467	3.0
H Dwellings	11,834	10,975	14,200	8,300	2,568	896	48,773	
H_j%	24.3	22.5	29.1	17.0	5.3	1.8		
Dwelling Values (1975 pesos)	Less than 19,845	19,846 41,422	41,423 86,422	86,423 179,347	179,348 375,321	More than 375,322		

Notes: See Chapter IV for the procedure used to form stock-user matrices.

The Dwelling values shown in this table include construction and land costs in 1975 pesos.

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CHAPTER IV

APPLICATION OF A FILTERING MODEL TO MONTERREY, PUEBLA, CHIHUAHUA, MORELIA, MEXICO CITY (FEDERAL DISTRICT), AND THE NATION DURING 1960-1970

The filtering or transfer effects initiated by new construction were studied in Chapter III through a vacancy chain survey. This type of survey registers the household moves which take place during a short period of time.

Since filtering trends are influence by long-term demographic and economic changes, it is important to know the effects of new construction on the entire housing stock over long periods of time. In this chapter we apply a filtering model using the population and housing census data collected in 1960 and 1970.

The purpose of the model is to determine the type of dwellings whose construction will maximize the combined amount of downward filtering and new construction subject to an investment budget constraint. Housing conditions will be improved as some households move into new dwellings, while other will receive old but adequate dwellings through filtering.

Once the pattern of housing transfers is anticipated, the government can promote the construction of

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the optimal selection of dwelling types through monetary and financial policies. Redistribution of the housing stock is then left to the market forces.

The allocation of the housing stock among income groups is presented in this chapter in a stock-user matrix using data from housing censuses and family income surveys. The matrix classifies households by level of income in rows and type of dwellings in columns. It allows us to trace the net movement of households in the housing stock as it is changed by construction and removal of dwellings. We can then determine the volume and direction of the housing transfers which result from various housing strategies.

The model is applied to five Mexican cities (Chihuahua, Mexico City, Monterrey, Morelia, and Puebla) and to the country as a whole during the period 1960-1970.

The filtering model is presented in Section 1. The economic characteristics of the cities and housing topology are described in Section 2. The allocation of the housing stock by income level during 1960-1970 is discussed in Section 3. The results of the model are examined in Section 4. In Section 5 we compare the results among the cities.

Section 1. The Filtering Model

In this section we discuss the assumptions, the structure, and the investment strategies of the model.

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Introduction to the Model

Housing units are constantly being transferred among households of similar or different levels of income. These filtering trends are defined here, as in Chapter III, in terms of the relative income of the occupants of dwelling units. Dwellings are said to filter down when they are transferred to households whose income is lower than the income of the previous occupants. On the other hand, upward filtering occurs when a dwelling is transferred to a household whose income is higher than the income of the previous occupants. It should be noted that dwellings are also transferred among households of the same income group. This is called lateral filtering.

In a market system, dwellings are distributed in a way that allows the highest income groups to occupy the best housing available. Remaining dwellings are occupied by households of lower income levels. Thus a housing strategy which only attempts to correct the deficit of low cost dwellings would fail to improve housing conditions of low income families since many dwellings would be bid away by higher income families.

Alternatively, the construction of high quality dwellings may result in chains of moves that do not reach low income families as we have found in the filtering survey in Chihuahua (see Chapter III). Housing shortages at any income level reduces, or even eliminates, the number

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of dwellings that can be transferred among income groups. Even if the proportion of well-housed families were the same at all income levels, the possibilities of upward or downward filtering would be different at each level since higher income groups have the financial capacity to bid away dwellings from lower income groups. For instance, chains of moves originating in the middle of the income scale may end at higher levels of income (via upward filtering) even if housing shortages were larger at the bottom than at the top of the income scale.

A housing strategy which seeks to maximize the number of units that filter downwards must at the same time minimize the possibilities of upward filtering. It is obvious that the construction of a sufficient number of good and high quality dwellings would eliminate the possibilities of upward filtering. This building strategy however may not be financially feasible given a limited investment constraint. Therefore, the exact proportion of dwelling types to be built will vary according to the amount of funds available for housing.

Given the initial housing conditions and the distribution of households by income level during a certain period of time, it is possible to trace in a stock-user matrix the impact of a building strategy on the distribution of the housing stock. The optimal building strategy is based on the selection of the types of dwellings whose

construction will directly and indirectly benefit (through filtering) the largest possible number of families. This goal is accomplished when the number of dwellings built and the existing units transferred downwards is maximized.

The assumptions on which the filtering model is based follow.

1.1. Assumptions

a. The allocation rule in the model is that the highest income groups have priority in choosing the best dwellings. Successive lower income groups obtain the remaining dwellings.

b. Families are assumed to be well-housed when they occupy a dwelling located on or above the diagonal of the stock-user matrix, which is symmetrical. Below the diagonal, families consume less than their optimum. Lack of a sufficient number of adequate houses for a given income level has raised rents and housing prices.

Since households are found to be in equilibrium when they occupy a dwelling on or above the matrix diagonal, monetary measures of well-being are not required in the model. Consequently, the construction of D5 (the most expensive dwelling) for an F5 (a rich family) is equally desirable as a D1 (the least expensive dwelling) for an F1 (a poor family). The social preference for a certain dwelling type is based only on the amount of net filtering induced by its construction and the total number of units built. Housing conditions are improved most when all households are located on or above the diagonal of the stock-user matrix. This criterion is not based on absolute physical standards of housing but it related the level of income to the amount of housing services consumed by each household.

c. A household of income level i has the financial capacity to buy either a new dwelling of quality j or an old dwelling of the next highest quality, j + 1. Alternatively, a new dwelling such as D3 cannot be bought by a household of income group F2 but only by a household from income group F3. This assumption seeks to assure the financial solvency of the housing building program since no subsidies will be granted to any income group.

This assumption implies that only old dwellings can filter down since a new dwelling (Dj) cannot be afforded by a member of the next lower income group (Fi - 1). The value of old dwellings, however, will decrease in real terms through time only if there are no housing shortages. Otherwise, the market price will tend to increase in real terms as we found in Chihuahua (see Chapter III) for low cost dwellings.

d. The government is assumed to have some control over the types of dwellings built. This can be accomplished through financial regulations which require the bank to grant loans for a certain range of dwelling values and levels of family income.

Home financing is already regulated in Mexico through an agency of the Central Bank (FOVI, which was described in Chapter II). Additionally, the government housing agency can adopt the optimal selection of dwelling types in their construction programs. Building and zoning regulations can also be designed to achieve the desired goal.

e. The model is based on the principle that the long-run demand for housing is determined by family formation, family income, and dwelling replacement needs. The rate of family formation and the growth of family income determines the distribution of households by level of income which, in addition to the replacement needs, indicates the number of dwellings that will be demanded at each level of income. Other variables such as the stage in family life cycle and dwelling location are not taken into account in the model.

f. The model also requires that the recipients of new dwellings have long-term financing. It would not be realistic to design a housing program where new dwellings are assigned to families who could not obtain and repay home loans. Consequently, the application of the model is restricted to the organized part of the housing sector (see Chapter II) in which the dwellings meet a set of minimum standards of quality and are occupied by households capable of obtaining home financing. Nevertheless, the unorganized sub-sector is affected through filtering by new construction in the organized sector.

g. The boundaries of the income groups are kept constant in real terms through time and we assume that the value of new dwellings remains constant in real terms. Thus a high quality dwelling (D5) is intended to be bought only by a rich family (F5). The size of households is also assumed to remain constant during the period under consideration. Anyhow, household size was found to be statistically unrelated to housing consumption (see Chapter II).

1.2. Structure of the Model

The following symbols are used in the model.

i = subscript for any income level.

$i-1$ = subscript for the next lower income level.

j = subscript for any housing type.

H_{jo} = the housing stock in the base year.

H_{jt} = the housing stock in the base year.

D_j = new construction of dwelling type j.

R_j = dwellings of type j to be replaced.

F_i = number of households of income group i.

ΔF_i = net addition of households in income group i.

T_j = number of dwellings that are transferred among income groups.

If positive ($+T_j$), it represents the number of dwellings that are filtered down from any income group (F_i) to the next lower income group (F_{i-1}).
If negative ($-T_j$), it represents the number of dwellings that are filtered up from any income group (F_i) to the next higher income group (F_{i+1}).

Dwellings are transferred from the highest to the next lower income group when the number of units built exceeds the number of new households and dwellings to be replaced at the highest income groups.[1]

In symbols, for the highest income level, n:

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[1]This model is a modified version of the one developed by Ridha Ferchiou. We have revised the objective function and some of the constraints. Ridha Ferchiou, New Construction, Subsidies, and Filtering of Dwellings in Tunisia: A Vacancy-Chain and Linear Programming Analysis, dissertation, Michigan State University, East Lansing, 1975, pages 99-115.

The use of a stock-user matrix to study the filtering process was illustrated by Wallace F. Smith, Filtering and Neighborhood Change, Chapter 3, (Berkeley, University of California, Center for Real Estate and Urban Economics, Research Report 24), 1964, reprinted in Matthew Edel and Jerome Rothenberg, Readings in Urban Economics, (New York, MacMillan Press), 1972, pages 193-204.

(1) $T_n = D_n - \Delta F_n - R_n$

$T_n > 0$, if $D_n > \Delta F_n + R_n$

$T_n = 0$, if $D_n = \Delta F_n + R_n$

It should be noted that even if there are no dwellings transferred to the next income group, there may be housing transfers among members of the same income group. These transfers cancel out within each income group and they do not affect the results of the model.

For the second highest income level:

(2) $T_{n-1} = D_{n-1} - \Delta F_{n-1} - R_{n-1} + T_n$

Replacing T_n by its value in 1.

$$T_{n-1} = (D_{n-1} - \Delta F_{n-1} - R_{n-1})$$

$$+ (D_n - \Delta F_n - R_n)$$

$T_{n-1} > 0$, if $D_{n-1} > \Delta F_{n-1} + R_{n-1} - T_n$

Notice that a sufficient number of dwellings transferred ($T_n > 0$) from the highest to the second highest group will in turn increase the number transferred ($T_{n-1} > 0$) from the second to the third highest income group.

For the third highest income level:

(3) $T_{n-2} = (D_{n-2} - \Delta F_{n-2} - R_{n-2})$

$$+ (D_{n-1} - \Delta F_{n-1} - R_{n-1}) + (D_n - \Delta F_n - R_n)$$

Adding the number of dwellings transferred among all income groups:

(4) $\sum_{j-1}^{n} T_j = n(D_n - \Delta F_n - R_n)$

$$+ (n-1)(D_{n-1} - \Delta F_{n-1} - R_{n-1}) + \ldots + (D_1 - \Delta F_1 - R_1)$$

Collecting terms:

$$(5) \quad \sum_{j-1}^{n} T_j = nDn + (n-1)\, D_{n-1} + \ldots + D_1$$

$$- n[(\Delta F_n + R_n) + (n-1)(\Delta F_{n-1} + R_{n-1})$$

$$+ \ldots + (\Delta F_1 + R_1)]$$

We treat the number of new households (ΔF) and the number of units to be replaced (R_j) as exogenously given in the model. The sum of ΔF_i and R_j is called A.

$$(6) \quad \Sigma T_j = nDn + (n-1)D_{n-1} + \ldots + D_1 - A$$

Housing conditions improve the most when the largest possible number of households receive a new dwelling (D_j) or an old dwelling (H_{j+1}) through downward filtering. Thus, the model seeks to maximize both the number of dwellings transferred downwards (ΣT_j) and the number of dwellings built (D_j). The existence of an investment constraint implies that new construction (ΣD_j) is maximized by building low-cost dwellings. However, the maximization of downward filtering (ΣT_j) may require the construction of higher cost dwellings to minimize upward filtering. The exact proportion of dwelling types to be built which maximizes net filtering will be determined by the initial housing conditions, the distribution of households by income level, and the investment constraint. Linear programming techniques are used to select the optimal level of dwelling types (D_j).

Objective function:

$$(7) \quad \text{Max } Z = \text{Max} \sum_{j=1}^{n} T_j + \text{Max} \sum_{j=1}^{n} D_j$$

where $\Sigma D_j = Dn + Dn\text{-}1 + \ldots + D_1$

and $\Sigma T_j = nDn + n\text{-}1\ Dn\text{-}1 + \ldots + D_1 - A$

The number of units built is subject to an investment constraint which represents the share of GNP that a society is willing to spend on housing or the amount needed to achieve a certain target such as having some income groups on the diagonal (well-housed) of the stock-user matrix.

Investment constraint:

$$(8) \quad \sum_{j=1}^{n} D_j C_j \leq I_t$$

where C_j is the construction cost of one dwelling unit.

Maximum Number of New Dwellings Constraint

This constraint is needed to assure that the number of new dwellings in each category does not exceed the number of households who can afford them. For instance, a new dwelling D_n (the most expensive) built for an F_n could not be afforded by a household of the next lower level (F_{n-1}). It is already assumed that only old dwellings can filter down from a given income level (F_i) to the next lower one (F_{i-1}).

For the highest income group:

(9) $D_n \leq F_n + \Delta F_n$

If $D_n = F_n + \Delta F_n$, then all the remaining dwellings ($H_{n0} - R_n$) can then be transferred to the second highest income group (F_{i-1}).

For the first and second highest levels:

$$D_{n-1} + D_n \leq F_{n-1} + \Delta F_{n-1} + F_n + \Delta F_n - (H_{n0} - R_n)$$

The second highest income group in term can transfer the remaining dwellings ($H_{n-1,0} - R_{n-1}$) of category H_{n-1} to the next lower level.

For all income levels:

$$D_1 + \ldots + D_n \leq F_1 + \Delta F_1 + \ldots + F_n + \Delta F_n + (H_{10} - R_1)$$

$$+ \ldots + (H_{n0} - R_n)$$

This constraint is written in its cumulative form ($D_1 + \ldots + D_n$) to allow the maximum freedom in selecting the dwelling types (D_j) to be built.

The constraint for the maximum number of new dwellings can be substituted by the following constraint:

$$T_j \leq H_{j0} - R$$

This constraint directly states that only the remaining old dwellings at each level can filter downwards.

Special Constraints

A housing strategy can be formulated in terms of a minimum number of dwellings to be built per year for a given income group.

(10) $\Sigma D_j > N$

This type of constraint prevents the free transfer of housing units among income groups since the type and number of dwellings to be built are chosen in advance. As a result, the number of units transferred downward may not reach its maximum level.

1.3. Housing Investment Strategies

The model is applied to simulate the impact of several housing investment strategies on the over-all housing conditions. The objective function in all strategies is to maximize the combined amount of filtering and the volume of dwelling construction, both in terms of physical units. The constraint concerning the maximum number of new dwellings is also incorporated in all options. The strategies differ on the amount of investment allocated to housing and building priorities.

We next describe the different housing investment strategies. They will be applied to five cities and to the entire country, as alternatives to what actually happened.

Strategy If: Optimal Building Strategy, Actual Investment

This strategy seeks to determine the type of dwellings which maximize the volume of filtering and new construction subject to the actual investment of the period 1960-1970. The types and volume of dwellings to be built are not subject to any predetermined quantitative target.

The actual number of dwellings built during the period 1960-1970 is obtained from:

$$\Sigma D_{ja} = \Sigma H_{j1970} - \Sigma H_{j1960} + R_j$$

where ΣD_{ja} = actual number of dwellings built

ΣH_{j1970} = housing stock in 1970

ΣH_{j1960} = housing stock in 1960

ΣR_j = number of units replaced

The actual investment (I_a) is calculated from:

$$\Sigma D_{ja} \cdot C_j \leq I_a$$

Strategy II: Adequate Housing for All New Households

This strategy assures that all households that appear in the period under consideration (1960-1970) will have their housing demand satisfied. Consequently, the number of new dwellings has to be at least equal to the number of new families plus replacement. Unlike Option If, we set a minimum number of units of each type to be built.

The special constraint required is derived from:

$$D_j^* \geq \Delta F_i + R_j$$

The investment constraint is the amount of funds needed to build the required number of dwellings (D_j^*) for all new households.

$$\Sigma D_j^* \cdot C_j \leq I$$

Recalling the equation concerning the amount of net filtering ($T_n = D_n - \Delta F_n - R_n$), we can see that this option produces no filtering among income groups. It is interesting to examine the housing conditions when filtering is completely avoided.

Strategy IIf: Optimal Building Strategy, Investment as in II

This strategy seeks to determine the type of dwellings which maximize the volume of filtering and new construction subject to the investment constraint estimated in Option II (Adequate Housing for all New Households).

Strategy III: Adequate Housing for All Middle and Upper Households: F3, F4, and F5.

This strategy concentrates all the building activity on the upper economic strata -- F3, F4, and F5. They will all receive new or old dwellings located on the diagonal of the stock-user matrix. Lower income groups can receive old dwellings through downward filtering.

The number of dwellings to be built is obtained from:

$$D_j^* \geq F_i + \Delta F_i - [H_j - R_j]$$

The investment constraint is the amount of funds needed to provide adequate dwellings to F3, F4, and F5. $\Sigma D_j^* \cdot C_j = I$.

Strategy IIIf: Optimal Building Strategy, Investment as in III

Using the investment constraint estimated in Option III, this option seeks to allocate the same funds to maximize the amount of filtering and new construction. This option (or strategy) is similar to Options If and IIf. They differ only by the investment constraint.

Strategy IV: Optimal Building Strategy, Investment 4.5% of GNP (or GCP)

This strategy maximizes the amount of filtering and new construction subject to an investment constraint which represents 4.5 percent of Gross National Product (or Gross City Product). Taking a fixed share of GCP as the investment constraint facilitates the comparison among cities.

Strategy V: No Investment Constraint for the Rich (F5), Investment 3.0% of GNP (or GCP)

Since the wealthiest families always have had the financial means to acquire their desired dwellings in Mexico, we have excluded them from the investment constraint used in this option. As a result, the most expensive dwelling (D5) is eliminated from the objective function. This option seeks to maximize the amount of filtering and new construction of dwellings below the highest category (D5), subject to an investment constraint which represents 3.0 percent of GNP (or GCP). The number of dwellings of type D5 to be built corresponds to the actual number built during 1960-1970.

Strategy VI: No Investment Constraint for the Rich (F5), Investment 4.5% of GNP (or GCP)

This strategy is identical to Option V, except for the higher investment constraint (4.5 percent of GNP or GCP).

Section 2. Economic Characteristics of the Cities Studied and Housing Typology

The model is applied to five cities which have reached different degrees of economic development. Monterrey, Mexico City, and Puebla are large dynamic cities with an important industrial base. They account for at least half (56.4 percent in 1965) of industrial production of the nation. Chihuahua is a medium-sized city which serves as a trading center for minerals and livestock. Morelia is a poor city located in a region with a backward agricultural base. While Monterrey, Mexico City, and Puebla represent the modern sector of the Mexican economy, Morelia represents the traditional sector. Chihuahua is changing from an economy based on agricultural and mineral products to an industrially based economy.

Occupations of the Labor Force by Sector of Activity

The data presented in Table IV-1 indicate the occupational structure in each city and the proportion of the population economically active.

Table IV-1. Proportion of the Population in the Labor Force and Occupation by Sector

1960-1970

City	Proportion of the Population in the Labor Force (percent) 1960	1970	Occupation by Section in 1970 (Percent) Manufacturing	Services	Agriculture
Mexico City (Federal District)	33.0	32.3	29.9	57.2	2.0
Monterrey	32.6	28.2	35.7	48.0	2.2
Puebla	31.4	27.2	30.5	51.2	6.3
Chihuahua	30.8	26.7	25.5	46.7	11.0
Morelia	30.0	25.8	15.2	47.0	21.7
Mexico (nation)	28.3	25.6	16.4	31.8	40.9

Source: Dirección General de Estadística, VIII, IX Censo General de Población, 1960, 1970, Mexico, D.F.

Notes: Services include personal services, trade, government and transportation.

Nonmanufacturing industries (electricity, gas, mining and construction) and nonspecified occupations are excluded from the table.

Table IV-1 shows that the proportion of the labor force in the total population has decreased in the cities and in the nation as a whole. It decreased from 28.3 percent in 1960 to 25.6 percent in 1970 for the nation while the largest reduction occurred in Monterrey from 32.6 percent to 28.2 percent. The relative reduction in the size of the labor force is attributed to both demographic and economic factors. First, the increasing proportion of persons under 14 years of age (44.2 percent in 1960 versus 46.2 percent in 1970) has reduced the relative number of persons capable of working. Secondly, rural migrants seem to have more difficulties finding jobs in the cities. According to C. Stern[2] the level of education of migrants in Mexico City has declined from 1935 to 1970 because they tend to migrate from increasingly backward areas. Thus recent migrants are more likely to be unemployed or excluded from the labor force for longer periods of time. Finally, on the demand side of the labor market, manufacturing firms are said to adopt the most modern capital intensive methods of production, Thus for the nation as a whole the demand for labor in manufacturing increased at a lower rate (3.6 percent per year) than the volume of manufactured goods (9.6 percent per year) during the period 1960-1970.

Table IV-1 also shows the occupations of the labor force by sector of activity. The proportion of the labor

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[2] Claudio Stern, "Migracion, Educacion, y Marginalidad en la Ciudad de Mexico,: in Demografia y Economia, Vol. VIII, Num. 2, El Colegio de Mexico, 1974, page 172.

force employed in manufacturing varies from 15.2 percent in Morelia, 16.7 percent for the nation, to 35.7 percent in Monterrey. At the same time, agriculture employs 39.4 percent of the labor force in the nation, 21.7 percent in Morelia, 11.0 percent in Chihuahua, and less than 2.5 percent in Monterrey and Mexico City.

In all cities under consideration the service sector employes the largest proportion of the economically active population. Salaries and level of productivity tend to be lower in the service sector.

In industrial countries the service sector absorbs the largest proportion of the labor force. This pattern however, is taking place in the Mexican cities before industrialization has reached its maximum level.

Population and Family Income

Table IV-2. Population, Monthly Family Income, and Rates of Population and Family Income Growth

1960-1970

City	Population (thousands) 1960	1970	Rate of Growth	Average Family Income per Month (1968 pesos) 1960	1969	Rate of Growth
Mexico City (Federal District)	4,870	6,874	3.70%	2,542	3,501	3.58%
Metropolitan Area of Mexico City	5,564	8,605	4.70%	n.a.	n.a.	n.a.
Monterrey	596	918	4.65%	2,199	2,987	3.43%
Puebla	289	532	6.64%	2,047	2,848	3.69%
Chihuahua	186	277	4.28%	1,759	2,478	3.56%
Morelia	134	191	3.77%	1,298	1,712	3.09%
Mexico (Nation)	34,923	48,337	3.48%	1,426	1,943	3.49%

Sources: Population data from: Dirección General de Estadística, VIII, IX, Censo General de Población, 1960, 1970, Mexico, D.F.
Income data from: Secretaria de Industria y Comercio, Ingresos y Egresos de las Families de la República Mexicana 1969-1970, Mexico, D.F., 1971, La Distribución del Ingreso en Mexico, Encuesta Sobre Los Ingresos y Gastos de Las Familias, 1968, Banco de Mexico, F.C.E., Mexico, D.F., 1974 and Secretaria de Industria y Comercio, Departmento de Muestreo, Las 16 Eiudades Principales de la República Mexicana: Ingresos y Egresos Familiares (Mexico, D.F., 1962).

Notes: The population growth rates were calculated over a period of 9.5 years, since the 1960 census was finished in June of 1960, while the 1970 census was completed in January of 1970. The income growth rates were calculated over a period of 9 years (1960-1969).

Table IV-2 shows that the rate of population growth has been higher in the cities (4.81 percent on the average) than in the nation as a whole (3.48 percent). The rapid growth of the cities is attributed to the rural-urban migration. Puente-Leyva[3] found that the proportion of the population born outside (a proxy for the migration rate) the city of Monterrey was 32.2 percent in 1960. C. Stern[4] estimated this ratio at 36.0 percent (which represented half of the adult population) for Mexcio City in 1970. Thus, migration seems to account for approximately one-third of the population growth in the cities.

The population of Mexico City at the end of this century may well be 20 million (34 million for the metropolitan area, which would be the largest urban center in the world) if the past growth rates are maintained in the future. A city of that size would undoubtedly experience external diseconomies in the form of pollution and time lost in transportation, as well as diseconomies of scale in the provision of public services. Fortunately, according to urban experts,[5] the urban growth rate will decline after 1980 due to an older population structure.

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[3]Jesus Puente-Leyva, Distribución del Ingreso en un Area Urbana: El Caso de Monterrey, Ed. Siglo XXI, 1969, page 66.

[4]Claudio Stern, op. cit., page 172.

[5]Luis Unikel, among others, "El Proceso de Urbanizacion," in El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, 1970, page 235.

Table IV-2 also shows the average monthly family income. In 1969, Mexico City had the highest level of family income -- 3,501 pesos ($280), followed by Monterrey, Puebla, Chihuahua, and Morelia. The national average was 1,948 pesos ($156). It is not surprising that the most industrialized cities (Monterrey, Mexcio City, and Puebla) had the highest income, followed by Chihuahua and Morelia (where agriculture is more important). The rate of growth of family income in the cities was similar to that of the nation (around 3.5 percent), except for Morelia (3.1 percent). Average family income would have grown at a higher rate in the cities than in the nation if the cities had not received a large influx of migrants from the rural areas.

Since data on income distribution is not available for metropolitan areas, we have restricted the study to the census boundaries of each city. For instance, the population, housing, and income data for Mexcio City refer only to the federal district, but the metropolitan area of Mexico City includes sections located outside the federal district. As Table IV-2 indicates, the proportion of the population of Mexcio City metropolitan area living in the federal district decreased from 87.5 percent in 1960 to 79.9 percent in 1970. Thus the stock-user matrices for Mexico City do not represent the entire area of the city.

Finally, Table IV-2 shows that the rate of population growth is higher in Puebla than for any other city. This is partially explained by the fact that the 1960 census did not include the entire urban area of the city; whereas the 1970 census covers a larger geographical area.

Housing Typology

Through the housing census and some construction studies we could distinguish six types of dwellings using an index[6] composed of three indicators: number of rooms, type of construction materials, and type of utilities available. Dwelling values (in 1968 pesos) exclude land costs, which tend to vary from one city to another and within each city. It is recalled that dwelling location is not included in the model nor in the census data. The following typology includes all housing types found in Mexico.

H0: Temporary: These dwellings are made of adobe, mud, sticks, or thatch and lack all public services. In general, these dwellings have only one room where people sleep and cook. They are found in rural areas and urban slums. The value is less than 9,000 pesos ($720).

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[6]The index and dwelling values observed in Mexico by several construction studies are shown in Appendix I of this chapter.

H1: Substandard: These are also built with adobe and other inferior materials, but have communal facilities and rudimentary water and sewage disposal. The average size is two rooms. The value is around 15,000 pesos ($1,200).

H0 and H1 constitute the unorganized (self-help. non-commercial) part of the housing sector. They represent approximately seventy percent of the housing stock in the nation and about fifty five percent in the cities. Usually they are built by families who earn less than 1,100 pesos per month ($88) and who lack banking credit. They are built on land of uncertain legal tenure.

H2 Minimum: This type is the least expensive dwelling that meets a minimum standard of quality. Units have running water, sewage disposal, and electricity. The walls are made of brick and the roof of asbestos or reinforced wood. They have three rooms (two bedrooms and a living room) and a separate kitchen. The price is between 30,000 and 40,000 pesos ($1,600-$3,200). INFONAVIT was the first financial institution (public or private) to grant long-term loans for the construction of this type of dwelling.

H3 Medium: These correspond to what the government calls "housing of social interest." They have two three bedrooms, kitchen, fully-equipped bathroom, and a living room. They are made of brick and have concrete panels on the roof. The price varies from 40,000 to 80,000 pesos ($3,200 to $6,400).

Before the establishment of INFONAVIT the government housing agencies promoted the construction of medium-quality dwellings (H3) exclusively. Private financial institutions have also granted long-term loans guaranteed by the government (see Fovi program in Chapter II) for this type of dwelling which is affordable only by middle and upper income families. The higher quality dwellings (H4 and H5) are also built with long-term financing; even though the most luxurious type (H5) is occupied by wealthy families who do not usually need mortgage finance.

H4 Good: These dwellings usually have six or seven rooms including four bedrooms. They all have concrete roofs. The price varies from 80,000 to 170,000 pesos ($6,400-$13,600).

H5 Luxury: These usually have more than eight rooms in one or two floors. They have a servant's room, inside garage, two or more bathrooms. The average price is approximately 290,000 pesos ($23,200) Due to the labor intensity of residential construction, such a house would cost two or three times as much in the United States.

Dwelling Values and Family Income Brackets

The distribution of the housing stock by family income level is represented in the stock-user matrices. Dwelling values were set in the matrices according to the level of family income to assure that the value of a given dwelling (Hj) is within the financial means of a household (F_i).

Households are assumed to spend 22.5 percent[7] of their income on housing at all income levels. This implicitly assumes that the income elasticity on the demand for housing is 1.0.[8] Land costs are assumed to account for 20.0 percent of total dwelling costs.[9] Dwelling values (excluding land costs) are then calculated to be equal to eighty monthly payments.[10] For example, a household earning

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[7]We found in Chihuahua (c.f. Chapter III) that households spend 20.1 percent of their income on housing. This share was estimated at 20.2 percent in Mexico City and 25.2 percent in Puebla, by P. Strassmann in "Employment and Financial Alternatives in Mexican Housing," pages 269-271 in Studies on Employment in the Mexican Housing Industry, OECD, Paris, 1973.

[8]For Chihuahua (Chapter II) we estimated that the coefficient of income elasticity is not significantly different from 1.0. This coefficient was estimated at 1.01 in cities having 150,000 to 500,000 inhabitants and 1.02 in Mexico City, in Encuesta Sobre Ingresos y Gastos Familiares en Mexico, 1963, (Mexico, D.F., Banco de Mexico, 1966), quoted in P. Strassmann, op. cit., page 279.

[9]The share of land costs in dwelling values was estimated at 22.4 percent by Christian Araud, "Direct and Indirect Employment Effects of Eight Types of Housing in Mexico," in Studies on Employment in the Mexican Housing

(footnotes continued)

10,000 pesos per month will spend 2,250 pesos on housing (22.5 percent of monthly income) and it will occupy a dwelling valued (land excluded) at 180,000 pesos (2,250 × 80) or 225,000 pesos if land is included. This is equivalent to stating that monthly payments represent 1.0 percent of the total dwelling value (2,225 = .01 × 225,000)

The income and dwelling values that are used in the stock-user matrices are shown in Table IV-3. Dwelling values are estimated by the procedure described above. These values correspond approximately to the values estimated in the index (shown in Appendix I), which is based on construction cost studies. It is recalled that the objective function (maximum filtering + building) and the special constraints of the model are defined in physical terms (number of dwelling units). Dwelling values are used to estimate the investment constraint of each housing strategy.

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footnotes continued

Industry, op. cit., page 90.

[10] Dwelling values (land excluded) were estimated to represent 76.9 monthly payments in Puebla and 84.3 in Mexico City, in P. Strassmann, op. cit., pages 269-292.

Table IV-3. Family Income Levels and Dwelling Values

(1968 Pesos)

Family Income Groups			Dwelling Average Values		
Fi	Family Income Per Month	Average Income	Hj	Dwelling Values	Dwelling Average Values
F0	0- 529	406.0	H0	0- 9,539	7,308
F1	530-1,104	846.5	H1	9,540-19,889	15,237
F2	1,105-2,303	1,764.9	H2	19,890-41,471	31,769
F3	2,304-4,779	3,679.9	H3	41,472-86,399	66,239
F4	4,800-9,999	7,672.7	H4	86,400-179,999	138,108
F5	10,000 or more	16,000.0	H5	180,000 or more	288,000

Notes: Dwelling values increase at the same rate as income levels assuming a coefficient of income elasticity equal to 1.0. Income and dwelling values are set in a logarithmic progression which corresponds approximately with the observed values in Mexico. The values increase at the rate (b) of 2.085 in accordance with the following formula:

$$b = \frac{\text{Highest Value}}{\text{Lowest Value}} \frac{1}{m-1}$$ where "m" is the number of categories

From the data shown in Appendix I we calculated the lowest (H1) dwelling value at 15,258 pesos and the highest (H5) dwelling value at 288,161 pesos. From the data shown in Appendix II we calculated the lowest (F1) income level at 833 pesos and the highest (F5) income level at 15,828 pesos.

Replacement of Dwellings

The rate of annual replacement for each dwelling type was calculated with the following formula:

$$r = [L(1 + g)^L]^{-1}$$

where r = rate of annual replacement

L = average life expectancy

g = past growth of the housing stock

Each dwelling type as assumed to have the following life expectancy: 20 years for H1, 25 for H2, 30 for H3, 35 for H4, and 40 years for H5. The past growth rates for all dwelling types (H0 is excluded) were set at 5.0 percent for the nation and 5.5 percent for the cities. Since the estimated life expectancy exceeds 15 years in all cases, dwellings built during the period under consideration (1960-1970) will not need to be replaced. The estimated replacement rates are shown in Table IV-4.

Table IV-4. Replacement Rates for Each Dwelling Type (H1...H5)

	Sub-Standard H1	Minimum H2	Medium H3	Good H4	Luxury H5
Life Expectancy (Years)	20	25	30	35	40
Annual Replacement Rate (Nation)	1.88%	1.18%	0.76%	0.52%	0.36%
Annual Replacement Rate (Cities)	1.72%	1.05%	0.67%	0.44%	0.30%

We did not calculate the replacement rates for temporary dwellings (H0) whose absolute number declines in some cities, in which case the relevant coefficient would be the rate of abandonment rather than the rate of replacement. Furthermore, a proportion of temporary dwellings

(H0) is actually upgraded when a separate kitchen is built or sewage disposal is made available. Temporary dwellings (H0) then become substandard dwellings (H1). Although we suspect that the rate of upgrading is very high for temporary dwellings (H0), it does not affect the results of the model which is restricted to the organized housing sector. Thus we apply the model to dwellings in the range of H2 (minimum) to H5 (luxury). Long term financing is only available to dwellings built in the organized sector (H2, H3, H4, and H5).

Section 3. Allocation of the Housing Stock by Income Level in 1960 and 1970

In this section we present the allocation of the housing stock by level of family income in 1960 and 1970. The stock-user matrices shown in the following pages classify households by level of income in the rows and type of dwellings in the columns. The housing stock is divided into six dwelling types (H0 to H5) according to the number of rooms, type of construction materials, and availability of utilities which are reported in the census. A housing quality index (shown in Appendix I) composed of the three indicators was used to distinguish the types of dwellings. Using data collected by family income surveys,[11] we

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[11]The family income surveys were conducted in 1958, 1963, and 1968 by the Banco de Mexico for the nation.

footnote continued

distinguish six family income groups (F0 to F5) which correspond to the six types of dwellings (H0 to H5). Dwelling values match income levels (see Table IV-3) assuming that the income elasticity for housing is equal to 1.0. Finally, the housing stock is allocated according to the principle that the highest income group (F5) occupies all the luxury dwellings (H5) available, and also some of the next lower quality if there is not a sufficient number of H5's. Successive lower income groups obtain the remaining dwellings.

It is recalled that families are assumed to be well-housed when they occupy dwellings located on the diagonal of the stock-user matrix. Households to the left of the diagonal (for example, an F3 household living in an H2 dwelling) consume less housing than they wish. In order to compare the allocation of the housing stock through time and among cities, we use an index which gives a weight of 1.00 to households on the diagonal, .48 to those one cell to the left of the diagonal, and .23 to those two cells to

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11 (continued)

The Secretaria de Industria y Comercio undertook similar surveys in the cities in 1960 and 1969 (see sources of Table IV-2). The sample size in the cities represented about 0.5 percent of the total number of families. According to the Banco de Mexico, the sample for the nation (6,000 households) is statistically significant at the 3 percent level of significance.

the left of the diagonal.[12] We have excluded the lowest income families (F0) from the weighted average index since they are all on the stock-user matrix diagonal (in H0's) which would produce a misleading higher index. The index is shown in the last column in the stock-user matrices.

The index gives a weight of 1.00 to households on the diagonal of the stock-user matrix. This indicates that households on the diagonal are consuming the minimum amount of housing services which is "adequate" for their level of income. It does not mean, however that families are necessarily well-housed from a normative point of view.

Tables IV-5 to IV-16 show the 1960 and 1970 stock-user matrices for the five cities studied and for the entire nation.

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[12]These weights increase at the same rate (2.085) as the value of dwellings and level of incomes which are shown in Table IV-2. Although a diminishing marginal utility of housing seems plausible, in the absence of data, we assume that housing construction cost and utility are proportional. We also assume implicitly that the construction cost is proportional to the amount of housing services which a new dwelling produces

Table IV-5. Monterrey 1960 Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	8,545						8,545	8.0	
F1	23,824	7,867					31,511	29.5	.61
F2		21,703	13,012				34.715	32.5	.68
F3			12,472	8,998			21,470	20.1	.70
F4				4,443	3,141		7,584	7.1	.70
F5					1,273	1,719	2,922	2.8	.78
Hj	32,269	29,390	25,484	13,441	4,414	1,719	106,817	100.0	.68
Hj%	30.3	27.5	23.8	12.6	4.1	1.6	100.0	Index F2-F5	.69

Table VI-6. Monterrey 1970 Stock-User Matrix

Actual Allocation (1960-1970) H2-H5 3.8%, H1 0.3% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	10,616						10,616	7.2	
F1	32,980	10,221					43,201	29,3	.60
F2		25,183	11,383				36,566	24,8	.64
F3			19,762	14,888			34,650	23.5	.70
F4				6,820	8,517		15,337	10.4	.77
F5					2,965	4,112	7,077	4.8	.78
ΣHj	43,596	35,404	31,145	21,708	11,482	4,112	147,447	100.0	.66
Hj%	29.6	24.0	21.1	14.7	7.8	2.8	100.0	Index F2-F5	.69
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		12,007	8,747	9,462	7,426	2,480	40,122		

Table IV-7. Puebla 1960 Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	7,274						7,274	13.8	
F1	12,754	4,904					17,658	33.5	.62
F2		6,744	7,751				14,495	27.5	.76
F3			3,217	4,953			8,170	15.5	.80
F4				1,064	2,520		3,584	6.8	.85
F5					320	1,210	1,530	2.9	.89
ΣHj	20,028	11,648	10,967	6,017	2,840	1,210	52,711	100.0	.72
Hj%	38.0	22.1	20.8	11.4	5.4	2.3	100.0	Index F2-F5	.79

Table IV-8. Puebla 1970 Stock-User Matrix

Actual Allocation (1960-1970) H2-H5 4.6%, H1 0.7% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	9,850						9,850	10.3	
F1	19,011	10,348					29,359	30.7	.66
F2		16,223	5,963				22,186	23.2	.62
F3			11,289	8,602			19,891	20.8	.70
F4				4,398	4,973		9,371	9.8	.76
F5					2,202	2,773	4,975	5.2	.77
ΣHj	28,861	26,571	17,252	13,000	7,175	2,773	95,632	100.0	.68
Hj%	30.2	27.8	18.0	13.6	7.5	2.9	100.0	Index F2-F5	.68
Remaining Hj		8,113	9,431	5,371	2,615	1,150	26,680		
Build, Dj		18,458	7,821	7,629	4,560	1,623	40,091		

Table IV-9. Chihuahua 1960 Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	3,379						3,379	9.8	
F1	6,967	4,067					11,034	32.0	.67
F2		5,618	6,413				12,031	34.9	.76
F3			2,499	3,124			5,623	16.3	.77
F4				743	914		1,657	4.8	.77
F5					321	437	758	2.2	.78
ΣHj	10,346	9,685	8,912	3,867	1,235	437	34,482	100.0	.73
Hj%	30.0	28.1	25.8	11.2	3.6	1.3	100.0	Index F2-F5	.77

Table IV-10. Chihuahua 1970 Stock-User Matrix

Actual Allocation (1960-1970) H2-H5 4.3%, H1 0.2% (Investment percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	2,292						2,292	4.7	
F1	9,542	1,675					11,217	23.0	.56
F2		9,300	10,257				19,557	40.1	.75
F3			3,943	7,030			10,973	22.5	.81
F4				1,270	1,997		3,267	6.7	.80
F5					571	896	1,467	3.0	.80
ΣHj	11,834	10,975	14,200	8,300	2,568	896	48,773	100.0	.72
Hj%	24.3	22.5	29.1	17.0	5.3	1.8	100.0	Index F2-F5	.77
Remaining Hj		7,774	7,653	3,454	1,150	417	20,448		
Build, Dj		3,201	6,547	4,846	1,418	479	16,491		

Table IV-11. Morelia 1960 Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	5,986						5,986	23.3	
F1	6,012	4,290					10,302	40.1	.70
F2		2,855	3,516				6,371	24.8	.77
F3			157	1,924			2,081	8.1	.96
F4				182	486		668	2.6	.86
F5					79	205	284	1.1	.86
ΣHj	11,998	7,145	3,673	2,106	565	205	25,692	100.0	.75
Hj%	46.7	27.8	14.3	8.2	2.2	0.8	100.0	Index F2-F5	.82

Table IV-12. Morelia 1970 Stock-User Matrix

Actual Allocation (1960-1960) H2-H5 4.2%, H1 0.8% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	3,157						3,157	8.9	
F1	7,906	4,935					12,841	36.2	.68
F2		5,803	7,003				12,806	36.1	.76
F3			1,034	4,145			5,179	14.6	.89
F4				26	967		993	2.8	.99
F5					117	382	499	1.4	.88
ΣHj	11,063	10,738	8,037	4,171	1,084	382	35,475	100.0	.75
Hj%	31.2	30.3	22.6	11.8	3.0	1.1	100.0	Index F2-F5	.81
Remaining Hj		5,491	3,034	1,893	528	197	11,143		
Build, Dj		5,247	5,003	2,278	556	185	13,269		

Table IV-13. Mexico City (Federal District) 1960
Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	67,656						67,656	7.5	
F1	207,035	45,548					252,583	28.0	.57
F2		172,156	105,685				277.841	30.8	.68
F3			97,830	87,999			185,829	20.6	.73
F4				31,575	49,612		81,187	9.0	.80
F5					11,729	25,258	36,987	4.1	.84
ΣHj	274,691	217,704	203,515	119,574	61,341	25,258	902,083	100.0	.68
Hj%	30.5	24.1	22.6	13.2	6.8	2.8	100.0	Index F2-F5	.72

Table IV-14. Mexico City (Federal District) 1970 Stock-User Matrix

Actual Allocation (1960-1970) H2-H5 3.5%, H1 012% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	29,266						29.266	2.4	
F1	247,542						247,542	20.3	.48
F2	32,873	257,342	110,973				401,188	32.9	.60
F3			181,993	139,933			321,926	26.4	.71
F4				49,993	103,653		153,646	12.6	.83
F5					17,069	48,782	65,851	5.4	.87
ΣHj	309,681	257,342	292,966	189,926	120,722	48,782	1,219,419	100.0	.65
Hj%	25.4	21.1	24.0	15.6	9.9	4.0	100.0	Index F2-F5	.69
Remaining Hj		173,763	176,456	109,051	57,245	24,148	540,663		
Build, Dj		83,579	116,510	80,875	63,477	24,634	369,075		

Table IV-15. Mexico (Nation) 1960 Stock-User Matrix

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	2,095,774						2,095,744	32.7	
F1	1,472,855	590,873					2,063,728	32.2	.63
F2		969,058	229,442				1,198,500	18.7	.58
F3			416,977	332,887			749,864	11.7	.71
F4				91,837	138,890		230,727	3.6	.79
F5					24,299	46,204	70,503	1.1	.82
ΣHj	3,568,629	1,559,931	646,419	424,724	163,189	46,204	6,409,096	100.0	.64
Hj%	55.7	24.3	10.1	6.6	2.6	0.7	100.0	Index F2-F5	.65

Table IV-16. Mexico (Nation) 1970 Stock-User Matrix

Actual Allocation (1960-1970) H2-H5 3.3%, H1 0.7% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
Fo	1,425,255						1,425,255	17.2	
F1	1,901,265	385,772					2,287,037	27.6	.57
F2		2,010,144	426,048				2,436,192	29.4	.57
F3			828,195	696.496			1,524,691	18.4	.72
F4				219,194	228,273		447,467	5.4	.75
F5					77,727	88,000	165,727	2.0	.76
ΣHj	3,326,520	2,395,916	1,254,243	915,690	306,000	88,000	8,286,369	100.0	.62
Hj%	40.1	28.9	15.1	11.1	3.7	1.1	100.0	Index F2-F5	.64
Remaining Hj		1,155,051	528,198	372,046	150,756	43,792	2,249,843		
Build, Dj		1,240,865	726,045	543,644	155,244	44,208	2,710,006		

Interpretation of the Stock-User Matrices

The first pattern we observe in all the stock-user matrices is that a proportion of households at all levels of income occupy dwellings located to the left of the stock-user matrix diagonal. Although some households may choose to spend a smaller proportion of their income on housing than is needed (22.5 percent) to occupy a dwelling located on the stock-user matrix diagonal, it is likely that housing shortages at all levels of income force households to spend 20-25 percent for dwellings which initially cost less. It is not surprising that households consume less than the optimum or desired level of housing when the housing stock grows at a lower rate than either population or family formation as is the case in Mexico (see Table IV-17).

T.H. Lee[13] has estimated that it would take the U.S. seven years to close 90 percent of the initial gap between the desired and the actual level of housing stock per family. Using time series data from 1920 to 1941, he estimated the adjustment coefficient at 28.5 percent which is the rate at which the gap between desired and actual

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[13]Tong Hun Lee, "The Stock Demand Elasticities of Non-Farm Housing," The Review of Economics and Statistics, February 1964, page 88. Note: It would take 23 years to close 100 percent of the initial gap at the annual rate of 28.5 percent.

stock tends to be closed. E.H. Oksanen[14] estimated the coefficient at 23.0 percent for Canada. Although we do not have the required data to estimate the adjusted coefficient, it is plausible that given the rapid population growth in Mexico, it takes a longer period of time to close the gap between the desired and the actual stock of housing. Furthermore, the construction industry in Mexico is restricted to the organized housing sector which includes only 30 to 40 percent of the housing stock in terms of units. Therefore the lack of financial and technical means in the unorganized housing sector (H0 and H1) makes it more difficult to expand the housing stock.

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[14]Ernest H. Oksanen, "Housing Demand in Canada, 1947 to 1962: Some Preliminary Experimentation," The Canadian Journal of Economics and Political Science," August 1966, page 315.

Table IV-17. Rates of Growth of the Housing Stock, Family Formation, and Population; Family Size and Number of Persons Per Dwelling

(1960-1970)

City	Growth Rates (Percentages) Housing Stock 1	Population 2	Family Formation	Difference 3=2-1	Average Family Size 1960	1970	Persons Per Household 1960	1970
Monterrey	3.45	4.65	4.70	1.25	5.43	5.41	5.58	6.23
Puebla	6.41	6.64	7.04	.63	5.31	5.17	5.48	5.56
Chihuahua	3.72	4.28	4.30	.58	5.24	5.23	5.39	5.68
Morelia	3.46	3.77	3.87	.41	5.15	5.11	5.24	5.40
Mexico City (Federal District)	3.22	3.70	3.78	.56	5.17	5.13	5.40	5.64
Mexico (Nation)	2.74	3.48	3.70	.96	5.43	5.32	5.48	5.83

Source: Dirección General de Estadisticas, VIII, IX, Censo General de Población, 1960, 1970, Mexico, D.F.

Table IV-17 shows that population growth and family formation exceeded the expansion of the housing stock in the period 1960-1970 in all cases considered. Family formation exceeded the growth of the housing stock by 0.41 percent per year in Morelia (the most backward city) and by 1.25 percent per year in Monterrey (the most industrialized city). This suggests that migration to the relatively rich industrial cities widens the gap between family formation and housing construction. Thus migrants might earn a higher level of income in the large industrial cities but their housing conditions are likely to be worse than in small towns. For the whole nation net family formation was 280,000 per year during 1960-1970, but only 190,000 dwellings were added per year to the housing stock in both the organized and unorganized housing sectors. Given the discrepancy between family formation and the growth of the housing stock, it is not unusual that a substantial proportion of households occupy "inappropriate" (for their income level) dwellings located to the left of the matrix diagonal. Under these circumstances, the housing stock is in a permanent state of disequilibrium since the desired housing stock (all households on the diagonal) exceeds the actual stock at any point in time.

A major obstacle in residential construction during 1960-1970 was a lack of long-term home financing. Despite the efforts of the government, long-term financing was restricted by private banks to middle and upper income groups (F3, F4, F5) which accounted for only 25 percent of the families in the nation and 40 percent in the cities.[15] Long-term financing for lower-middle

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[15] Oliver Oldman, et al., Financing Urban Development in Mexico City, (Harvard University Press), 1967, pages 192-186. They found that private bankers considered that home loans to F2 households involved excessive risk despite government guarantees (see Chapter II). Mortgage banks also complained about "the complexity and the amount of information" requested by the government in considering approval of low-cost housing projects.

income families (F2) was available only in housing projects built by the government.

The rapid population growth in Mexico has also resulted in an increase in the number of persons per dwelling. Despite the decline in the size of the average family from 5.43 in 1960 to 5.32 in 1970, the number of persons per dwelling increased from 5.48 to 5.83 in the same period. Thus the lack of a sufficient number of dwellings may have forced some newly married couples and poor recent migrants to live in relatives' homes.

On the other hand, dwellings on the average become larger during 1960-1970 since the proportion of one-room dwellings (H0) declined in all cases. At the same time the average number of persons per room increased from 2.36 in 1960 to 2.58 in 1970. The number of persons per room in temporary dwellings (H0) increased from 5.01 in 1960 to 5.41 in 1970, while it decreased from 1.28 to 1.08 in medium and higher quality dwellings (H3, H4 and H5).

Table IV-18. Relative Size of the Unorganized Housing Sector (H0+H1), and of the Low-Income Group (F0+F1) in 1960 and 1970

(In Percentages)

City	1960 H0+H1	1960 F0+F1	1970 H0+H1	1970 F0+F1
Monterrey	57.8	37.5	53.6	36.5
Puebla	60.1	47.3	58.0	41.0
Chihuahua	58.1	41.8	46.8	27.7
Morelia	74.5	63.4	61.5	45.1
Mexico City (Federal District)	54.6	35.5	49.5	22.7
Mexico (Nation)	80.0	64.9	69.0	44.8

Source: Stock-user matrices shown in Tables IV-5 to IV-16.

Table IV-18 shows how the relative size of the unorganized housing sector (H0 temporary and H1 sub-standard dwellings) changed in relation to the relative size of the lowest income groups (F0 and F1) who earned less than 1,100 pesos ($88). First we observe that the largest relative reduction of poor families occured in the nation as a whole (64.9 percent in 1960 to 44.8 percent in 1970). This income group did not decline as rapidly in the cities due to the influx of migrants. The largest relative decrease in the cities took place in Morelia (63.4% to 45.1%), while it decreased slightly in

Monterrey (37.5% to 36.5%). Despite the influx of migrants, the relative number of poor families is lower in the cities than in the nation as a whole. This is due in part to the higher participation of low-income women in the labor force (especially in personal services) in the cities.[16]

We also notice in Table IV-18 that the relative number of temporary and substandard dwellings (H0 + H1) did not decline as rapidly (except in Monterrey) as the relative number of poor families (F0 + F1). Alternatively, we can say that the increase of middle and upper income groups (F2 to F5) exceeded the increase of dwellings in the organized housing sector (H2 to H5). This is another indication of the lag between the demand for housing and residential construction. Thus in addition to the rapid rate of family formation, the relative changes in the distribution of income groups makes more difficult the adjustment of the actual to the desired housing stock.

The transfer of households from low to higher income groups could be expected to improve the housing conditions of the poor (F0 and F1), as some low-quality dwellings (H0 and H1) are left vacant by former poor families. However, the lack of a sufficient number of

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[16] United Nations, "Income Distribution in Selected Major Cities of Latin America and in Their Respective Countries," Economic Bulletin for Latin America, Vol. XVIII, No. 1, New York, 1973, page 31.

higher quality dwellings (H2 to H5) force a proportion of higher income households (F2 to F5) to obtain dwellings which otherwise would have been occupied by lower income families. For instance, we can notice in all stock-user matrices (Tables IV-5 to IV-16) that a proportion of F2 households occupy substandard dwellings (H1) because income group F3 has in turn bid away H2 dwellings from income group F2.

It appears that housing conditions would be easier to improve if the relative size of all income groups remained unchanged through time. For example, in Morelia, a city with a low population growth rate (3.77) the number of middle and upper income families (F3, F4, F5) increased from 3.033 in 1960 to 6,671 in 1970 at the annual rate of 8.6 percent, while the number of medium and higher quality dwellings (H3, H4, H5) rose from only 2,876 to 5,637 at an annual rate of 7.4 percent. The upward movement of families in the income scale was accompanied by a less than proportionate expansion of residential construction.

During 1960-1970, the result of the discrepancy between family formation, social mobility, and residential construction caused an increasing proportion of households to live in "inappropriate" dwellings located to the left of the matrix diagonal. Table IV-19 shows how the indices of "housing adequacy" changed from 1960 to 1970. A maximum index of 1.0 indicates that all families are "adequately housed" on the diagonal of the stock-user matrix.

Table IV-19. Index of Housing Adequacy and Investment Allocated to Housing Construction as a Share of Gross National Product (GNP) or Gross City Product (GCP)

City	Index of Housing Adequacy 1960 F1-F2	F3-F5	F1-F5	1970 F1-F2	F3-F5	F1-F5	Investment in H1-H5 1960-1970 (Percentage of GNP or GCP)
Monterrey	.65	.71	.68	.62	.73	.66	4.1
Puebla	.68	.82	.72	.64	.73	.68	5.3
Chihuahua	.72	.77	.73	.68	.81	.72	4.5
Morelia	.73	.92	.75	.72	.90	.75	5.0
Mexico City (Federal District)	.63	.76	.68	.55	.76	.65	3.7
Mexico (Nation)	.61	.73	.64	.57	.73	.62	4.0

Note: National Family Income computed from the Family Income Survey accounted for 61.2 percent of GNP in 1969. The same percentage is used to estimate Gross City Product, which allows us to compare investment in residential construction among cities. See Appendix II of this chapter.

The indices of housing adequacy shown in Table IV-19 indicate that housing conditions are better in the smaller cities (Morelia and Chihuahua) than in the larger industrial cities (Puebla, Monterrey and Mexico City). The indices for the lowest income groups (F1, F2) show that their housing conditions worsened during 1960-1970 in the large industrial cities (Monterrey, Mexico City and

Puebla) and in the medium-sized city of Chihuahua. In contrast, in the smaller city of Morelia the index for the lowest income groups (Fl, F2) declined insignificantly (from .73 to .72) during the same period. It appears that the influx of migrants in the more industrialized cities results in increasingly worse housing shortages as measured by the index. Moreover, Morelia is the only city where both the number and the proportion of temporary (HO) houses and poor families (HO) declined during 1960-1970.

Table IV-19 also shows that middle and upper income groups (F3, F4, F5) are better-housed than low income groups (Fl, F2). In all cities (in 1970) the index for middle and upper income groups is around .78, while the index for lower income groups is about .65. It is not surprising that middle and upper income groups who are able to obtain long term financing from private banks occupy dwellings located closer to the optimum level on the diagonal of the stock-user matrix. Furthermore, high income groups have the financial capacity to bid away dwellings from lower income groups.

Table IV-19 shows that the weighted average index for Fl-F5 declined in all cases from 1960 to 1970, with the exception of Morelia, where it remained the same (.75). The largest decline in the index took place in Puebla (.72 to .68) and Mexico City (.68 to .65), while the smallest reduction occurred in Chihuahua (.73 to .72). The deterioration of the housing conditions as measured by the "adequacy" index is consistent with the fact that during 1960-1970 the housing stock expanded at a lower rate than family formation and population growth (IV-17).

The over-all index of housing adequacy does not decline significantly in cities other than in Puebla. Only the low income groups (F1, F2) seem to have experienced a substantial deterioration in their housing conditions. As Table IV-19 shows, the index declined in all cases for low income groups (F1, F2), while the index for middle and upper income groups (F3, F4, F5) declined only in Puebla, and Morelia. The average for the five cities suggests that the index for low income groups (F1 + F2) experienced a larger reduction (from .68 in 1960 to .64 in 1970) than for middle and upper income groups (.80 in 1960 to .78 in 1970).

Table IV-19 also indicates the investment allocated to residential construction as a share of Gross National Product and Gross City Product. The nation as a whole invested 4.0 percent of GNP in residential construction. This share is similar to the estimates for other Latin American countries -- 3.76 percent in Colombia, 4.32 percent in Venezuela, and 4.44 percent in Panama.[17]

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[17] United Nations, World Housing Survey, January 1974, New York.

The share of housing construction in Gross City Product varies from 3.7 percent in Mexico City, 4.5 percent in Chihuahua, to 5.3 percent in Puebla. The share of GCP allocated to residential construction is lower in Mexico City because a substantial proportion of new private housing developments have taken place outside the boundaries of the federal district.[18] Furthermore, a rent control decree issued in 1943 has discouraged new construction in a section of Mexico City (known as "Old Mexico") which accounts for approximately 20 percent of the population of the federal district.[19] While the occupants of buildings under rent control have benefitted from relatively low rents, the supply of housing has been restricted for new families of the city.

In the next section we shall study how the housing conditions as measured by the adequacy index and by the proportion of temporary dwellings (HO) could have been improved during 1960-1970 using the same and different shares of GCP (of GNP) allocated for residential construction.

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[18] Oliver Oldman, et al., Financing Urban Development in Mexico City, op. cit., page 181.

[19] Ibid., pages 137-141.

Section 4. Results of the Filtering Model for Each City and the Nation During 1960-1970

In this section we present the results of the filtering model for the period 1960-1970. Taking the actual distribution of families by level of income in 1960 and 1970, we will seek to determine the volume and type of dwellings which could have been built under various investment constraints to improve the housing conditions for the maximum number of families. The aim is to design a solvent building strategy which produces both the highest percentage of families adequately housed (on the diagonal of the stock-user matrices) and the lowest percentage of families living in temporary dwellings. This is accomplished by selecting the dwelling types whose construction maximizes the amount of downward filtering and construction.

The objective function (Max $\Sigma Tj + \Sigma Dj$) in all strategies seeks to maximize both downward filtering and new construction. A constraint based on the assumption that new dwellings cannot filter down ($Tj \leq HJ0 - R$) is incorporated in all strategies and assures financial solvency by limiting the number of dwellings that can be built for each income group. Strategy If (optimal building strategy) is limited to the actual investment on residential construction during 1960-1970. Strategies II and III seek respectively to provide adequate housing for all new families and for middle and upper income groups. Strategies

IIf and IIIf (optimal building strategies) are subject respectively to the investment constraints required in strategies II and III. Strategy IVf is subject to an investment constraint which is 4.5% of GNP or GCP. In Strategies V and VI (no investment constraint for F5), high quality dwellings (H5) are excluded from the investment constraint which represent 3.0% and 4.5% of GNP or GCP, respectively.

Table IV-20 to IV-27 show the hypothetical stock-user matrices for Monterrey that result from each investment strategy. These matrices are shown in order to illustrate the application of the model. The results for all cities are summarized in Tables IV-28 to IV-33. The investment constraint is restricted to dwellings built in the organized sector (D2-D5), which are the only types that are subject to government control through financial and (zoning) regulations. The index of housing adequacy, which measures the position of households in the stock-user matrix, is also restricted to lower-middle and upper income groups (F2-F5).

Tables IV-28 to IV-33 also show the net number of dwellings transferred to lower income families (downward filtering) or to higher income families (upward filtering). Upward filtering also includes those dwellings whose original occupants have risen in the income scale. It is recalled that dwellings can filter downwards only if the number of dwellings built exceeds the number of new families and the units that need to be replaced at each income level.

$$\text{In symbols: } Tj = Dj - Fj - Rj \quad \text{(Equation 1)}$$

$$Tj \geq 0 \quad \text{if} \quad Dj \geq Fj + Rj$$

Since we already know that during 1960-1970 the rate of family formation exceeded the growth of the housing stock in all cities studied, it is expected that a new number of dwellings were transferred upward. Further, the relative increase of middle and upper income families suggests that upward filtering took place as households remained in the same dwellings while their income rose. This form of upward filtering would occur in the long run even in the absence of housing shortages because it is inconvenient and costly for families to move into higher quality dwellings every time their income increases. The actual amount of new filtering during 1960-1970 can be compared in Tables IV-28 to IV-33 with the amount of filtering produced by each strategy.

Table IV-20. Monterrey 1970 Strategy If

Optimal Building Strategy -- Actual Investment
H2-H5 3.8%, H1 0.3% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	0	10,616					10,616	7.2	
F1		20,803	22,398				43,201	29.3	1.56
F2			36,566				36.566	24.8	1.00
F3			32,126	2,524			34,650	23.5	.52
F4				15,337			15,337	10.4	.48
F5				1,389	4,056	1,632	7,077	4.8	.56
ΣHj	0	31,419	91,090	19,250	4,056	1,632	147,447	100.0	.97
Hj%	0.0	21.3	61.7	13.1	2.8	1.1	100.0	Index F2-F5	.70
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		8,022	68,945	7,004	0	0	83,718		
Historical Comparison		-3,985	+59,945	-2,458	-7,426	-2,480			

Table IV-21. Monterrey 1970 Strategy II

New Families Well-Housed
H2-H5 4.9%, H1 0.3% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	10,616						10,616	7.2	
F1	29,500	13,701					43.201	24.3	.66
F2		21,703	14,863				36.566	24.8	.69
F3			12,472	22,178			34,650	23.5	.81
F4				4,443	10,894		15,337	10.4	.85
F5					1,273	5,804	7,077	4.8	.91
ΣHj	40,116	35,404	27,335	26,621	12,167	5,803	147.447	100.0	.74
Hj%	27.2	24.0	18.5	18.1	8.3	3.9	100.0	Index F2-F5	.78
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		12,007	4,937	14,375	8,111	3,172	43,602		
Historical Comparison		same	-3,180	+4,913	+ 865	+1,692			

Table IV-22. Monterrey 1970 Strategy IIf

Optimal Building Strategy -- Investment as in II
H2-H5 4.9%, H1 0.3% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	0	10,616					10,616	7.2	
F1		20,803	22,398				43,201	29.3	1.56
F2			24,320	12,246			36,566	24.8	1.36
F3			21,625	13,025			34,650	23.5	.68
F4				15,337			15,337	10.4	.48
F5				1,389	4,056	1,632	7,077	4.8	.56
ΣHj	0	31,419	68,343	41,997	4,056	1,632	147,447	100.0	1.11
Hj%	0.0	21.3	46.3	28.5	2.8	1.1	100.0	Index F2-F5	.90
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		8,022	45,945	29,751	0	0	83,718		
Historical Comparison		-3,895	+37,198	+20,289	-7,426	-2,480			

Table IV-23. Monterrey 1970 Strategy III

F3, F4, F5 Well-Housed
H3-H5 6.5%, H1-H2 0.7% (Investment as percentage of (GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	10,616						10,616	7.2	
F1	13,218	29,983					43,201	29.3	.84
F2		5,421	31,145				36,566	24,8	.92
F3				34,650			34,650	23.5	1.0
F4					15,337		15,337	10.4	1.0
F5						7,077	7,077	4.8	1.0
ΣHj	23,834	35,404	31,145	34,650	15,337	7,077	147,447	100.0	.93
Hj%	16.2	24.0	21.1	23.5	10.4	4.8	100.0	Index F2-F5	.97
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,728		
Build, Dj		12,007	8,747	22,404	11,281	5,445	59,884		
Historical Comparison		same	same	+12,942	+3,855	+2,965			

Table IV-24. Monterrey 1970 Strategy IIIf

Optimal Building Strategy -- Investment as in III
H2-H5 6.5%, H1 0.3% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	0	10,616					10,616	7.2	
F1		20,803	22,398				43,201	29.3	1.56
F2			24,320	12,246			36,566	24,8	1.36
F3				34,650			34,650	23.5	1.00
F4				10,646	4,688		15,337	10.4	.64
F5					5,445	1,632	7,077	4.8	.60
ΣHj	0	31,419	46,718	57,545	10,133	1,632	147,447	100.0	1.21
Hj%	0.0	21.3	31.7	39.0	6.9	1.1	100.0	Index F2-F5	1.05
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,279		
Build, Dj		8,022	24,320	45,299	6,077	0	83,718		
Historical Comparison		-3,895	+15,573	+38,837	-1,349	-2,480			

Table IV-25. Monterrey 1970 Strategy IVf

Optimal Building Strategy Investment 4.5%
H2-H5 4.5%, H1 0.3% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	0	10,616					10,616	7.2	
F1		20.803	22,398				43,201	29.3	1.56
F2			36,566				36,566	24.8	1.00
F3			16,954	17,696			34,650	23.5	.75
F4				15,337			15,337	10.4	.48
F5				1,389	4,056	1,632	7,077	4.8	.56
ΣHj	0	31,419	75,918	34,422	4,056	1,632	147,447	100.0	1.03
Hj%	0.0	21.3	51.5	23.3	2.8	1.1	100.0	Index F2-F5	.78
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		8,022	53,691	22,005	0	0	83,718		
Historical Comparison		-3,895	+44,944	+12,543	-7,426	-2,480			

Table IV-26. Monterrey 1970 Strategy V

No Investment Constraint for F5
H2-H4 3.0%, H1 0.3%, H5 1.0% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	2,688	7,928					10,616	7.2	
F1		27,476	15,725				43,201	24.3	1.39
F2			36,566				36,566	24.8	1.00
F3			34,650				34,650	23.5	.48
F4			2,000	12,246	1,091		15,337	10.4	.48
F5					2,965	4,112	7,077	4.8	.78
ΣHj	2,688	35,404	88,941	12,246	4,056	4,112	147,447	100.0	.92
Hj%	1.8	24.0	60.3	8.3	2.8	2.8	100.0	Index F2-F5	.71
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		12,007	11,543	0	0	2,480	81,030		
Historical Comparison		same	+57,796	-9,462	-7,426	same			

Table IV-27. Monterrey 1970 Strategy VI

No Investment Constraint for F5
H2-H5 4.5%, H1 0.3%, H5 1.0% (Investment as percentage of GCP)

	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0	0	10,616					10,616	7.2	
F1		20.803	22,398				43,201	29.3	1.56
F2			26,566				36,566	24.8	1.00
F3			12,167	22,483			24,650	23.5	.82
F4				14,246	1,091		15,337	10.4	.52
F5					2,965	4,112	7,077	4.8	.78
ΣHj	0	31,419	71,131	36.729	4,056	4,112	147,447	100.0	1.07
Hj%	0.0	21.3	48.2	24.9	2.8	2.8	100.0	Index F2-F5	.84
Remaining Hj		23,397	22,398	12,246	4,056	1,632	63,729		
Build, Dj		8,022	48,733	24,483	0	2,480	83,718		
Historical Comparison		-3,985	+39,986	+15,021	-7,426	same			

Table IV-28. **Monterrey (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, Amount of Net Filtering, and Number of Dwellings Built for Various Housing Strategies**

Housing Strategies	Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	Index of Housing Adequacy F2-F5	Proportion of Temporary Dwellings (%, HO)	Amount of Net Filtering (-up, +down) Units	Dwellings Built (Units)
Actual Allocation	3.8%	.66	.69	29.6%	-23,397	40,122
If Optimal Building Strategy, Actual Inv.	3.8%	.97	.70	0.0%	+42,432	83,718
II All new households well-housed	4.9%	.74	.78	27.2%	- 5,676	43,602
IIf Optimal Building Strategy, Inv. as II	4.9%	1.11	.90	0.0%	+65.179	83,718
III F3, F4, F5 well-housed	6.5%	.93	.97	16.2%	+45,076	59,884
IIIf Optimal Building Strategy, Inv. as III	6.5%	1.21	1.05	0.0%	+92,881	83,718
IVf Optimal Building Strategy 4.5%	4.5%	1.03	.78	0.0%	+56,433	83,718
V No investment constraint for F5, 3.0%	3.0%	.92	.71	1.8%	+33,507	81.030
VI No investment constraint for F5, 4.5%	4.5%	1.07	.84	0.0%	+67,046	83,718

Note: Additional investment on luxury dwellings (D5) in strategies V and VI; 1.0 percent of GCP.

Table IV-29. Puebla (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, AMount of New Filtering and Number of Dwellings Built for Various Housing Strategies

Housing Strategies		Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	F2-F5	Proportion of Temporary Dwellings (%, H0)	Amount of Net Filtering (-up, +down) Units	Dwellings Built (Units)
Actual Allocation		4.6%	.68	.68	30.2%	-29,024	40,091
If	Optimal Building Strategy, Actual Inv.	4.6%	.94	.73	3.4%	+10,335	65,475
II	All new households well-housed	7.4%	.87	.90	20.7%	+ 3,122	49,570
IIf	Optimal Building Strategy, Inv. as II	7.4%	1.13	1.02	3.4%	+36,703	65,475
III	F3, F4, F5 well-housed	7.5%	.92	.95	18.4%	+11,443	51,380
IIIf	Optimal Building Strategy, Inv. as III	7.5%	1.14	1.03	3.4%	+37,315	65,475
IVf	Optimal Building	4.5%	.93	.72	3.4%		65,475
V	No investment constraint for F5, 3.0%	3.0%	.80	.70	11.8%	-10.593	57,681
VI	No investment constraint for F5, 4.5%	4.5%	.97	.77	3.4%	+15,446	65,475

Note: Additional investment on luxury dwellings (D5) in Strategies V and VI; 1.2 percent of GCP.

Table IV-30. Chihuahua (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, Amount of Net Filtering and Number of Dwellings Built for Various Housing Strategies

	Housing Strategies	Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	F2-F5	Proportion of Temporary Dwellings (%, HO)	Amount of Net Filtering (-up, +down) Units	Dwellings Built (Units)
Actual Allocation		4.3%	.72	.77	24.3%	- 8,481	16,491
If	Optimal Building Strategy, Actual Inv.	4.3%	.94	.78	0.0%	+ 8,077	28,325
II	All new households well-housed	5.5%	.83	.86	16.7%	+ 1,107	20.173
IIf	Optimal Building Strategy, Inv. as II	5.5%	1.10	.90	0.0%	+17,229	30,243
III	F3, F4, F5 well-housed	5.4%	.86	.92	16.2%	+ 5,189	20,434
IIIf	Optimal Building Strategy, Inv. as III	5.4%	1.10	.80	0.0%	+16,959	30,243
IVf	Optimal Building Strategy 4.5%	4.5%	.97	.78	0.0%	+ 9,677	28,325
V	No investment constraint for F5, 3.0%	3.0%	.78	.76	11.5%	- 3,747	22,699
VI	No investment constraint for F5, 4.5%	4.5%	1,00	.80	0.0%	+12,072	29,008

Note: Additional investment on luxury dwellings (D5) in Strategies V and VI; 0.7 percent of GCP.

Table VI-31. Morelia (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, Amount of Net Filtering and Number of Dwellings Built for Various Housing Strategies

	Housing Strategies	Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	F2-F5	Proportion of Temporary Dwellings (%, H0)	Amount of Net Filtering (-up, +down) Units	Dwellings Built (Units)
Actual Allocation		4.2%	.75	.81	31.2%	- 5,601	13,269
If	Optimal Building Strategy, Actual Inv.	4.2%	.89	.86	15.2%	+ 2,102	19,093
II	All new households well-housed	5.3%	.87	.90	22.9%	+ 1,054	16,217
IIf	Optimal Building Strategy, Inv. as in II	5.3%	1.06	.93	6.3%	+ 8,824	22,106
III	F3, F4, F5 well-housed	3.5%	.81	.88	28.2%	- 2,358	14,303
IIIf	Optimal Building Strategy, Inv. as in III	3.5%	.81	.80	21.1%	- 2,370	16,857
IVf	Optimal Building Strategy 4.5%	4.5%	.93	.86	12.1%	+ 3,988	20,036
V	No investment constraint for F5, 3.0%	3.0%	.77	.77	25.5%	- 4,947	15,290
VI	No investment constraint for F5, 4.5%	4.5%	.95	.88	11.6%	+ 4,913	20,221

Note: Additional investment on luxury dwellings (D5) in Strategies V and VI; 0.5 percent of GCP.

Table IV-32. Mexico City-Federal District (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, Amount of New Filtering and Number of Dwellings Built for Various Housing Strategies

	Housing Strategies	Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	Index of Housing Adequacy F2-F5	Proportion of Temporary Dwellings (%, H0)	Amount of Net Filtering (-up, +down) Units	Dwellings Built (Units)
Actual Allocation		3.5%	.65	.69	25.4%	-299,358	369,075
If	Optimal Building Strategy, Actual Inv.	3.5%	.93	.72	0.0%	+277,405	752,167
II	All new households well-housed	4.8%	.79	.83	15.7%	+ 44,679	487,133
IIf	Optimal Building Strategy, Inv. as II	4.8%	1.11	.93	0.0%	+521,823	752,167
III	F3, F4, F5 well-housed	5.6%	.90	.94	10.5%	+313,683	551,068
IIIf	Optimal Building Strategy, Inv. as III	5.6%	1.17	1.01	0.0%	+711,974	752,167
IVf	Optimal Building Strategy, 4.5%	4.5%	1.08	.89	0.0%	+494,416	752,167
V	No investment constraint for F5	3.0%	.94	.75	0.0%	+216,982	689,370
VI	No investment constraint for F5, 4.5%	4.5%	1.12	.95	0.0%	+591,029	752,167

Note: Additional investment on luxury dwellings (D5) in Strategies V and VI; 1.0 percent of GCP.

Table IV-33. Mexico (1960-1970) Investment Constraint, Index of Housing Adequacy, Proportion of Temporary Dwellings, Amount of New Filtering and Number of Dwellings Built for Various Housing Strategies

Housing Strategies		Investment Constraint (% of GCP)	Index of Housing Adequacy F1-F5	F2-F5	Proportion of Temporary Dwellings (%, HO)	Amount of Net Filtering (-up, +down) Units)	Dwellings Built (Units)
Actual Allocation		3.3%	.62	.64	40.1%	-2,061,499	2,710,006
If	Optimal Building Strategy, Actual Inv.	3.3%	.77	.70	22.5%	- 116,225	4,176,201
II	All new households well-housed	5.6%	.82	.82	25.9%	+ 612,676	3,892,092
IIf	Optimal Building Strategy, Inv. as II	5.6%	1.02	.90	9.5%	+2,905,106	5,248,348
III	F3, F4, F5 well-housed	5.4%	.83	.86	30.1%	+ 720,007	3,538,201
IIIf	Optimal Building Strategy, Inv. as III	5.4%	1,01	.89	9.5%	+2,757,596	5,248,348
IVf	Optimal Building Strategy 4.5%	4.5%	.92	.76	9.7%	+2,006,445	5,234,356
V	No investment constraint for F5, 3.0%	3.0%	.74	.69	25.2%	- 621,638	2,947,400
VI	No investment constraint for F5, 4.5%	4.5%	.94	.77	9.5%	+2,221,485	5,278,564

Note: Additional investment on luxury dwellings (D5) in Strategies V and VI; 0.5 percent of GCP.

Evaluation of Alternative Housing Investment Strategies

Tables IV-28 to IV-33 show in the first row the information concerning the actual allocation of the housing stock in all cities during 1960-1970. As expected, the insufficient number of dwellings built and the upward movement of households in the income scale during the period resulted in a net amount of upward filtering. This does not mean that all those dwellings involved in upward filtering were actually transferred from low to higher income families, but that a proportion of households remained in the same dwellings while their income was rising. Although some families might have chosen to remain in the same dwellings throughout their life cycle in any case, it is likely that the lack of sufficient dwellings forced families to stay in the same houses. As a result, low income families were unable to obtain dwellings through downward filtering from higher income groups. We will show how different building strategies could have resulted in a net amount of downward filtering, or at least in a lower amount of upward filtering.

We next describe the results of each building strategy using the stock-user matrices for Monterrey shown in Tables IV-20 to IV-27.

Strategy If - Optimal Building, Actual Investment

Strategy If is subject to the investment actually allocated (3.8% of GCP) to residential construction in the organized sector (H2-H5) during 1960-1970. This strategy results in the elimination of all temporary dwellings (H0) as better dwellings are filtered downwards. This is accomplished by allocating the entire investment constraint in the construction of minimum (D2) and medium (D3) quality dwellings. Under strategy If, 83,718 dwellings could have been built instead of the 40,122 actually constructed (Table IV-28). At the same time a new number of 42,432 dwellings could have filtered downwards instead of the 23,397 dwellings actually filtered upwards. Strategy If allows low income families (F0 and F1) to abandon their temporary dwellings since they could receive more adequate dwellings (H1, H2) through downward filtering. Under strategy If the weighted average index (F1-F5) of housing adequacy rises to .97 from the actual .66 as families in the three lowest income groups improve their position in the stock-user matrix, while higher income families have to settle for less housing than they actually consumed.

Under Strategy If there are still 36,109 dwellings which filter upwards, but these are more than offset by 78,541 dwellings which filter downwards to low-income families. This produces a net amount of downward filtering of 42,432 dwellings.

The reallocation of the housing stock, which is left to the market forces, would eventually result in the acquisition (through upward filtering) by high income families of all the minimum (D2) and medium (D3) quality dwellings unless higher quality dwellings are built in the future. Nevertheless, the higher life expectancy of good (D4) and luxury (D5) dwellings will enable a proportion of high income families (F4, F5) to remain in those dwellings while lower income groups improve their housing conditions. The improvement of the housing conditions for low and lower-middle income families (F0, F1, F2) in turn will allow an increase of construction in the future of successively higher quality dwellings (see Chapter V).

Strategy II - New Families Well-Housed

Strategy II seeks to provide adequate dwellings for all new families who appeared during the period 1960-1970. The investment constraint is estimated to provide new or old dwellings located on the diagonal of the matrix to families in the range of F2 to F5. Lower income families (F0, F1) are excluded from all building strategies because the non-commercial resources allocated to the construction of temporary and substandard dwellings cannot be easily subject to any form of governmental control. Low income groups however benefit from the filtering trends originating under the proposed strategies.

Under strategy II (new families well-housed) the index of housing adequacy rises to .74 from the actual .66

but the share of GCP spent on residential construction also rises to 4.9% from the actual share of 3.8%. All income groups now occupy dwellings located closer to the matrix diagonal (compare Table IV-21 with the actual matrix shown in Table IV-5). Under Strategy II, the number of dwellings increases to 43,602 from the 40,122 actually built. These figures include 12,007 substandard dwellings built in the unorganized sector outside the investment constraint. Unlike Strategy If which completely eliminated the number of families living in temporary shacks, Strategy II only reduces the proportion of H0's to 27.2% from the actual 29.6%. This is achieved by reducing the number of dwellings filtered upward to 5,670 from the 23,397 actually filtered upward during 1960-1970. Although the lowest income groups (F0, F1) do not receive any dwellings through filtering, they would be better off in the sense that fewer families would have to compete for temporary and substandard dwellings. Under Strategy II upward filtering occurs only between the lowest income groups (F0 and F1) while filtering is completely prevented among higher income groups (F2 to F5) since they obtain the exact number of dwellings needed for new families and replacement ($Tn = 0$, if $Dn = \Delta Fn + Rn$). In brief, the main beneficiaries of Strategy II (which calls for the construction of all types of dwellings) are the lower-middle and high income groups (F2 to F5). The lowest income groups slightly improve their housing conditions only because fewer dwellings are filtered upwards.

Strategy IIf - Optimal Building, Investment as in Strategy II

Strategy IIf seeks to maximize downward filtering and new construction with the investment constraint (4.9% of GCP) estimated for Strategy II. Unlike Strategy II which aimed at providing adequate dwellings for all new families, Strategy IIf has no predetermined quantitative target. The index of housing adequacy rises to 1.11 (from .74 under Strategy II) and it increases the number of dwellings built to 83,718 (from 43,602 under II). The number of families living in temporary shacks is eliminated as a net number of 65,179 dwellings are filtered downward. As in Strategy If, the building activity is concentrated on minimum (D2) and medium (D3) quality dwellings.[20] Given that the investment constraint is higher for Strategy IIf (4.9% of GCP) than for Strategy If (3.8% fo GCP), the number of medium (D3) dwellings built under Strategy IIf is increased at the same time as fewer minimum (D2) dwellings are built. Under strategy IIf the three lowest income groups (F0 to F3) improve their position in the stock-user matrices (see Table IV-22) at the expense of the highest income groups (F4, F5).

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[20]Strategies If, IIf, IIIf, and IVf are called optimal building strategies because the objective function is not subject to any special constraint, whereas Strategy II (new families well-housed) interferes with the maximization process.

Strategy III - Middle and Upper Income Groups Well-Housed

Strategy III seeks to provide adequate dwellings for all families in the middle and high income groups (F3, F4, F5). Under Strategy III, the index of housing adequacy rises to .93 from the actual .66 but investment increases to 6.5 percent from the actual 3.8 percent. Since F3's, F4's , and F5's are now living in "adequate" dwellings on the diagonal of the matrix (Table IV-23), there is a downward filtering trend from the top to the bottom of the income scale without any dwelling being filtered upward. Under Strategy III however, there are still 23,834 families (16.2% of the total number) living in temporary shacks. This suggests that raising the investment allocated to residential construction is not enough by itself to solve the housing problem of the poor. Using a lower share of GCP (4.9 versus 6.5 for Strategy III), Strategy IIf results in the elimination of temporary shacks by concentrating on the construction of minimum and medium dwellings. Thus the selection of the types of dwellings which result in the largest number of dwellings filtered downward is essential to any housing program with limited resources.

A housing strategy should not aim exclusively at producing downward filtering trends as under Strategy III. For instance, Strategy IIf (optimal building allocation) results in the elimination of all temporary shacks and improves the housing conditions of all income groups except the highest income groups (F4 and F5) by combining downward and upward filtering trends. Whereas under Strategy III (F3, F4, F5 well-housed), the housing adequacy index rises for all income groups by exclusively producing downward filtering, but it leaves 16.2 percent of the families still living in temporary shacks.

<u>Strategy IIIf - Optimal Building, Investment as in Strategy III</u>

Strategy IIIf is subject to the investment constraint (6.5 percent) estimated in Strategy III (F3, F4, F5 well-housed). Under Strategy IIIf the index of housing adequacy rises to 1.21[21] from .93 in Strategy III. This gain is accomplished by exclusively building minimum (D2), medium (D3) and good dwellings (D4) while no luxury dwellings are built. We should indicate that the number of dwellings built is the same (83,718) under Strategies If, IIf, IIIf, and IVf, while the amount of downward filtering rises with the share of GCP spent on construction. These strategies reach the maximum number of units built (83,718) which is equal to the total number of families (147,447) less the remaining number of dwellings (63,729).

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[21]The index of housing adequacy gives a weight of 2.08 to those families who receive dwellings located above the matrix diagonal through downward filtering. Thus, the overall index (for F2-F5) can be higher than 1.0 if a large number of dwellings is filtered downwards.

Under Strategy IIIf (optimal building allocation) middle and lower income groups (F0 to F3) improve their position in stock-user matrix (Table IV-24) at the expense of the two highest income groups while in Strategy III (F3, F4, F5 well-housed) all income groups are better off. The difference between these two strategies which use the same share of GCP (6.5) is that Strategy IIIf eliminates all the temporary dwellings, while 16.2 percent of the families live in temporary shacks under Strategy III. This again suggests that the lowest income groups (F0 and F1) would benefit significantly from the filtering process if resources were concentrated only in the construction of minimum and medium quality dwellings. On the other hand, a housing program designed to increase the construction of temporary and substandard (D0 and D1) dwellings would not be financially feasible given the unstable jobs held by the lowest income families (F0 and F1).

<u>Strategy IVf - Optimal Building, Investment 4.5 Percent of GCP</u>

Strategy IVf (optimal building strategy) is subject to an investment constraint which represents 4.5 percent of GCP. This strategy raises the index of housing adequacy to 1.03 from the actual .78. It eliminates the number of temporary shacks and improves the position of the lowest income groups (F0, F1) at the expense of middle and higher income families. We will use this strategy which is subject to a fixed share of GCP to compare the results of all cities in the next section.

In the strategies already described, we have assumed that resources could be channeled from the highest to lower income groups for residential construction. A more realistic approach is to exclude the highest income group which often has the financial means to acquire dwellings regardless of the housing goals adopted by the government. Thus we will exclude the wealthy families from the objective function and investment constraint in Strategies V and VI. It is recalled that the lowest income groups (F0 and F1) are excluded in all the proposed building strategies because they also cannot be subject to controlled financing.

Strategy V - No Investment Constraint for the Highest Income Group, 3.0 Percent of GCP

Strategy V is subject to an investment constraint which represents 3.0 percent of GCP. The highest income group obtains the actual number of luxury dwellings built in 1960-1970. This reduces the number of dwellings that middle and higher income groups have to bid away from lower income groups. Although the investment constraint allocated (3.0 percent plus 1.0 percent for luxury dwellings) is the same as the actual investment of the period 1960-1970, Strategy V results in a net amount (33,507 of downward filtering, in contrast to the 23,397 actually filtered upward (see Table IV-28). Under Strategy V, the index of housing adequacy rises to .92 from the actual .66. No families are now living in temporary dwellings. Given the limited amount of resources used under the strategy, the housing conditions are allowed to deteriorate for middle and upper-middle income groups. The next strategy also excludes the highest income group from the building program, but is subject to a higher investment constraint.

Strategy VI - No Investment Constraint for the Highest Income Group, Investment 4.5 Percent of GCP

Strategy VI is subject to an investment constraint which represents 4.5 percent of GCP. The highest income (F5) group obtains (as in Strategy V) the same number of luxury dwellings that were actually built in 1960-1970. The cost of building (1.0 percent of GCP) luxury dwellings is not included in the investment constraint since we assume that wealthy families will not apply for home financing, but will build with their liquid assets. Under strategy VI the index of housing adequacy rises to 1.07 (from the actual .66) with no families living in temporary dwellings. All income groups with the exception of the second highest, are now closer to the matrix diagonal (see Table IV-28). This is the result of building all dwelling types except good quality (D4) dwellings. Families in the second highest group however, are able to bid away dwellings from the next lower group (F3) who nonetheless, improve their position in the stock-user matrix.

Table IV-34 summarizes the number of dwellings built for each type and the filtering trends of each strategy.

The results of the building strategy for Monterrey which are shown in Table IV-34, can be summarized as follows.

1) The gap between family formation and housing construction during 1960-1970 produced a net upward filtering trend from the lowest to the highest income group. The lack of a sufficient number of dwellings at all income levels induced some families to bid away dwellings from lower income groups while other families had to remain in the same quarters even though their income increased.

Tables IV-28 to IV-33 show that net upward filtering occurred during 1960-1970 in the five cities as in the nation as a whole.

2) The over-all housing conditions could have been improved under all the proposed building strategies. All strategies with the exception of Strategy II (new families well-housed) produce a net amount of downward filtering. Under Strategy II which requires the construction of all dwelling types, there is still a net amount of upward filtering. Strategy III (F3, F4, F5 well-

Table IV-34. Monterrey (1960-1970), Number of Dwellings Built of Each Type, Amount of Filtering and Index of Housing Adequacy for Various Strategies

Dj = Units built, Tj = Units filterd: -up, +down)

Building Strategy		Index of Housing Adequacy	D1 (T1)	D2 (T2)	D3 (T3)	D4 (T4)	D5 (T5)	Dj (Tj)
Actual	(1)	(F1-F5)	12,007	8,747)	9,462	7,426	2,480	40,122)
Allocation		.66	(-9,155)	(-3,481)	(-7,291)	(-2,378)	(-1,692)	(-23,397)
If	(2)	.97	8,022	68,692	7,004	0	0	83,718
			(+34,440)	(+44,101)	(-19,654)	(-12,283)	(-4,172)	(+42,432)
II	(3)	.74	12,007	4,937	14,375	8,111	4,172	43,602
			(-5,676)	(0)	(0)	(0)	(0)	(-5,676)
IIf	(4)	1.11	8,022	45,954	29,751	0	0	83,718
			(+34,440)	(+44,101)	(+3,093)	(-12,283)	(-4,172)	(+65,179)
III	(5)	.93	12,007	8,747	22,404	11,281	5,445	59,884
			(+10,606)	(+16,282)	(+12,972)	(+4,443)	(+1,273)	(+45,076)
IIIf	(6)	1.21	8,022	24,320	45,299	6,077	0	83,718
			(+34,440)	(+44,101)	(+24,718)	(-6,206)	(-4,172)	(+92,881)
IVf	(7)	1.03	8,022	60,106	15,590	0	0	83,718
			(+34,440)	(+44,101)	(-4,653)	(-12,283)	(-4,172)	(+56,433)
V	(8)	.92	12,007	61,724	0	0	2,480	81,030
			(+31,752)	(37,428)	(-24,178)	(-9,803)	(-1,692)	(+33,507)
VI	(9)	1.07	8,022	55,348	16,868	0	2,480	83,718
			(+34,440)	(+44,101)	(+305)	(-9,803)	(-1,672)	(+67,046)

Notes:
(1) Actual allocation, investment H2-H5, 3.8% of GCP
(2) If, Optimal building, actual investment
(3) II, New families well-housed, investment 4.9% of GCP
(4) IIf, Optimal building investment as in II
(5) III, F3, F4, and F5 well-housed, investment 6.5% of GCP
(6) IIIf, Optimal building investment as in III
(7) IVf, Optimal building investment, 4.5% of GCP
(8) V, no investment constraint for F5, investment 3.0% of GCP
(9) VI, no investment constraint for F5, investment 4.5% of GCP
(10) Investment on luxury dwellings (D5) in V and VI, 1.0%

housed) which emphasizes the construction of medium and higher quality dwellings (D3-D5) results in a downward filtering trend from the top to the bottom of the income scale. Strategies IIf and IIIf (optimal building allocation), which are subject to the same investment constraint as Strategies II and III, result in a higher amount of downward filtering and new construction. This is achieved by mainly building minimum (D2) quality dwellings under Strategy IIf (with 4.9% of GCP) and medium (D3) dwellings under Strategy IIIf (with 6.5% of GCP). Thus strategies IIf and IIIf which combine upward with downward filtering enables the lowest income groups (Fo, F1) to abandon their temporary shacks.

Housing conditions are most improved by selecting the dwelling types which result in the maximum amount of downward filtering and new construction. Raising the share of GCP allocated for residential construction does not necessarily result in better over-all housing conditions as we found when we compared Strategy IIf (optimal building allocation, 4.9% of GCP) with Strategy III (F3, F4, F5 well-housed, 6.5% of GCP). Eliminating upward filtering is also not a desirable goal when resources are limited. For instance, Strategies IIf, IVf (optimal building), V, and VI (no investment constraint for the rich) produce a larger net amount of downward filtering by combining upward and downward filtering than does

Strategy III, which prevents upward filtering using a larger share of GCP.

3) The theoretical possibilities of downward filtering are higher at the top of the income scale since the number of families who can benefit from downward filtering is larger when residential construction is concentrated at the top rather than at the bottom of the income scale. The investment constraint however gives a higher priority to minimum quality (D2) dwellings because the net number of units than can be transferred downwards from lower-middle (F2) to lower income groups (F0 and F1) is larger than the number of higher quality dwellings that could be transferred downwards using the same amount of investment.

The optimal building strategies (If, IIf, IIIf, IVf) maximize the objective function by construction of minimum and medium quality dwellings. Under these strategies the maximum number of dwellings is built (83,718), while the amount of downward filtering increases with the share of GCP. Alternatively the amount of upward filtering decreases with higher shares of GCP as fewer D2's and more D3's are built. These strategies however, improve the housing conditions of most families at the expense of the highest income groups.

4) A second best but more realisitc policy is to exclude the highest income group (F5) from the objective

function and the investment constraint. Strategy VI (no investment constraint for F5) allows the poor to abandon their temporary shacks as better dwellings are filtered downward and it improves the housing conditions of all income groups except the second highest group (F4). Under this strategy, the objective function is maximized by exclusively building minimum (D2) and medium (D3) quality dwellings, while luxury (D5) dwellings are built outside the investment constraint.

Given that high income families would eventually bid away all the minimum (D2) and medium (D3) quality dwellings built under the optimal strategies (If, IIf, IIf, and IVf) it seems necessary to allow the rich to build luxury dwellings as in Strategy VI. This strategy would have required a larger share (5.6%) of the GCP than the actual share (3.8%) allocated for residential construction in Monterrey during 1960-1970. Thus in addition to building the optimal selection of dwelling types, it is suggested that Monterrey should have invested a higher share of GCP on housing construction.

We have assumed in all the building strategies that home financing was available to lower-middle and upper income groups (F2-F5). This would have required a larger effort by the government to overcome the private bankers' reluctance to grant home loans to lower-middle income families (F2). The government, for instance, could have guaranteed the full sum borrowed instead of only the first eighteen monthly installments (see Chapter II).

The financial procedures adopted by INFONAVIT in 1972 seem to be a simple and secure method to increase the flow of resources into housing construction. Under this method housholds pay a fixed percentage of their income (we assume 22.5%) as a monthly payment until the home loan is repaid. There is no required downpayment. This method also assures that the amount of funds available for housing construction will increase in the future as family income rises.

The proposed building strategies do not require the construction of subsidized dwellings since the selected income groups (F2-F5) have the financial capacity to repay home loans. Lower income families would nevertheless benefit from the filtering process. Although some families may not be willing to move, the proposed filtering trends can be implemented if home financing is made available for both new and old dwellings. Adequate home financing can be used to obtain the maximum amount of filtering since the desire for home-ownership seems to be the chief reason families move in Mexico.[22]

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[22]This was the chief reason given by families involved in the chain of moves in Chihuahua (Chapter II). Identical results were found in Mexico City by Charles Prentice in a forthcoming dissertation, University of Wisconsin.

Section 5. <u>Comparison of the Filtering Model Results Among the Cities</u>

We found in the last section how the over-all housing conditions could have been improved during the period 1960-1970 under various building strategies using actual and higher investment constraints. The proposed building strategies are likely to produce different results in each city according to the original housing conditions, the rate of family formation, and the share of GCP allocated for residential construction.

Table IV-35 shows the results of the building strategies for all the cities and the nation as a whole. It is recalled that that data for Mexico City includes only the federal district while the largest expansion of residential construction has taken place outside the boundaries of the federal district. Thus the results for Mexico City (federal district) cannot be strictly compared with the other cities. The data for the nation as a whole. It is recalled that the data for Mexico City includes only the federal district while the largest expansion of residential construction has taken place outside the boundaries of the federal district. Thus the results for Mexico City (federal district) cannot be strictly compared with the other cities. The data for the nation as a whole also cannot be compared with the cities since the housing stock of the nation cannot

Table IV-35. Monterrey, Puebla, Chihuahua, Morelia, Mexico City (Federal District) and Nation Investment Constraint, Index, of Housing Adequacy, and Proportion of Temporary Dwellings (HO) for Various Housing Strategies (1960-1970)

City	Indicators	Actual Allocation (1)	If (2)	II (3)	IIf (4)	III (5)	IIIf (6)	IVf 4.5% (7)	V 3.0% (8)	VI 4.5% (9)	Inv. for H5 for Options V and VI
Monterrey	Inv. Constraint	3.8%	3.8%	4.9%	4.9%	6.5%	6.5%	4.5%	3.0%	4.5%	1.0%
	Indèx, F1-F5	.66	.97	.74	1.11	.93	1.21	1.03	.92	1.07	
	Index, F2-F5	.69	.70	.78	.90	.97	1.05	.78	.71	.84	
	Temporary Homes	29.6%	0.0%	27.2%	0.0%	16.2%	0.0%	0.0%	1.8%	0.0%	
Puebla	Inv. Constraint	4.6%	4.6%	7.4%	7.4%	7.5%	7.5%	4.5%	3.0%	4.5%	1.2%
	Index F1-F5	.68	.94	.87	1.13	.92	1.14	.93	.80	.97	
	Index, F2-F5	.68	.73	.90	1.02	.95	1.03	.72	.70	.77	
	Temporary Homes	30.2%	3.4%	20.7%	3.4%	18.4%	3.4%	3.4%	11.8%	3.4%	
Chihuahua	Inv. Constraint	4.3%	4.3%	5.5%	5.5%	5.4%	5.4%	4.5%	3.0%	4.5%	0.7%
	Index, F1-F5	.72	.94	.83	1.10	.88	1.10	.97	.78	1.00	
	Index, F2-F5	.77	.78	.86	.90	.92	.89	.78	.76	.80	
	Temporary Homes	24.3%	0.0%	16.7%	0.0%	16.2%	0.0%	0.0%	11.5%	0.0%	
Morelia	Inv. Constraint	4.2%	4.2%	5.3%	5.3%	3.5%	3.5%	4.5%	3.0%	4.5%	0.5%
	Index, F1-F5	.75	.89	.87	1.06	.81	.81	.93	.77	.95	
	Index, F2-F5	.81	.86	.90	.93	.88	.80	.86	.77	.88	
	Temporary Homes	31.2%	15.2%	22.9%	6.3%	28.2%	21.1%	12.1%	25.5%	11.6%	
Mexico City (F.D.)	Inv. Constraint	3.5%	3.5%	4.8%	4.8%	5.6%	5.6%	4.5%	3.0%	4.5%	1.0%
	Index, F1-F5	.65	.93	.79	1.11	.90	1.17	1.08	.90	1.12	
	Index, F2-F5	.69	.72	.83	.93	.94	1.01	.89	.75	.95	
	Temporary Homes	25.4%	0.0%	15.7%	0.0%	10.5%	0.0%	0.0%	0.0%	0.0%	
Nation	Inv. Constraint	3.3%	3.3%	5.6%	5.6%	5.4%	5.4%	4.5%	3.0%	4.5%	0.5%
	Index, F1-F5	.62	.77	.82	1.02	.83	1.01	.92	.74	.94	
	Index, F2-F5	.64	.70	.82	.90	.86	.89	.76	.69	.77	
	Temporary Homes	40.1%	22.5%	25.9%	9.5%	30.1%	9.5%	9.7%	25.2%	9.5%	

Notes: (1) Actual allocation, inv. H2-H5 (2) If -- optimal building strategy, actual inv. (3) II -- new families well-housed (4) IIf -- optimal building strategy, inv. as in II (5) III -- F3, F4, F5 well-housed (6) IIIf -- optimal building strategy, inv. as in III (7) IVf -- 4.5% for H2-H5, optimal building strategy (8) V -- 3% for H2-H4, no inv. const. for F5 (9) VI -- 4.5% for H2-H4, no inv. const. for F5.

easily re-allocated among families who live in different localities.

Strategy If - Optimal Building, Actual Investment

Table IV-35 shows that strategy If (optimal building, actual investment) could have improved the over-all housing conditions as measured by the index of housing adequacy in the five cities and in the nation as a whole. Under strategy If the over-all index of housing adequacy (F1-F5) rises to .89 in Morelia (from the actual .75), .94 in Chihuahua (from .72) and .97 in Monterrey (from .66).

Notice also in Table IV-35 that the index of housing adequacy for the organized sector (F2-F5) increases by a smaller margin from the actual F2-F5 index than does the over-all index (F1-F5) from the actual F1-F5 index. This is due to the fact that the main beneficiary of the optimal building strategy is the F1 income group whose housing condition is improved through downward filtering.

The lowest income groups (F0, F1) are able to abandon their temporary (H0) dwellings when a sufficient number of better dwellings are filtered downward from the organized housing sector (H2-H5). Under Strategy If which emphasizes the construction of minimum (D2) dwellings, all the temporary dwellings are abandoned in Monterrey, Chihuahua, and Mexico City. The proportion of temporary dwellings is reduced from 30.2 percent to 3.4 percent in Puebla, 31.2 percent to 15.2 percent in Morelia, and 40.1

percent to 22.5 percent in the nation. The lowest income groups (F0 and F1) in Morelia and Mexico (nation) could not abandon all the temporary dwellings because they did not receive enough dwellings through downward filtering from the lower-middle income groups (F2). As Table IV-36 shows, the lower-middle income group increased at a higher rate in Morelia (7.6%) and in the nation (7.7%) than in other cases. Thus the rapid increase in the number of lower-middle families in Morelia and Mexico (nation) resulted in a relatively small number of dwellings filtered down to the lowest income groups (F0 and F1). The relatively small increase in the number of F2 families in Monterrey and Mexico City (see Table IV-36) allows a larger number of minimum (H2) dwellings to filter downward. This in turn results in a relatively larger increase in the F1-F5 index for Monterrey and Mexico City.

Table IV-36. Relative Size and Growth Rate of the Lower-Middle (F2) and Upper Income Groups (F3, F4, F5)

(1960-1970)

	Lower-Middle Income Group (F2)			Upper Income Groups (F3,F4,F5)		
	1960 Share	1970	Annual Growth Rate	1960 Share	1970	Annual Growth Rate
Monterrey	32.5%	24.8%	0.5%	30.0%	38.7%	6.2%
Puebla	27.5%	23.2%	4.5%	25.5%	35.8%	10.4%
Chihuahua	34.9%	40.1%	5.2%	23.3%	32.2%	7.2%
Morelia	24.8%	36.1%	7.6%	11.8%	18.8%	8.6%
Mexico City (Federal District)	30.8%	32.9%	3.9%	33.7%	44.4%	6.2%
Mexico (Nation)	18.7%	29.4%	7.7%	16.4%	25.8%	7.7%

Note: The growth rates are calculated with the data from the stock-user matrices shown in Tables IV-5 to IV-16.

Strategy II - New Families Well-Housed

Strategy II (new families well-housed) requires the construction of all dwelling types in order to place new families on the diagonal of the stock-user matrix. Under this strategy the index of housing adequacy rises according to the actual housing conditions. For instance, the index rises to .90 (from the actual .75) in Morelia and .74 (from the actual .66) in Monterrey. The share of GCP required under Strategy II is around 5.1 percent except in Puebla (7.4%) which experienced the highest rate of family formation during 1960-1970.

Under Strategy II there is still a substantial proportion of families living in temporary dwellings (H0) in all cases since no dwelling is filtered downward from the organized sector (H2-H5). It is recalled that Strategy II prevents filtering among the lower-middle and upper income families since the number of dwellings built is equal to the number of new families (F2-F5) plus the number of dwellings (H2-H5) to be replaced. Strategy II nevertheless allows some F1 families to abandon a number of temporary dwellings (H0) because F2 families do not have to bid away H1 dwellings from F1 families.

Strategy IIf - Optimal Building, Investment as in Strategy II

The investment estimated for Strategy II (new families well-housed) could be used to achieve results under Strategy IIf (optimal building) which emphasizes the construction of minimum (D2) and medium (D3) dwellings. Strategy IIf produces a net amount of downward filtering from the lower-middle income group (F2) to the lowest income groups (F0 and F1) which results in a smaller proportion of families living in temporary dwellings in all cases. Strategy IIf also results in a higher index of housing adequacy in all cities under consideration. The relatively high shares of GCP used in Strategy IIf (optimal building) allows the construction of minimum (D2) and medium (D3) quality dwellings in all cities whereas only D2's can be built under strategy If (optimal building) in

Morelia and Chihuahua with the actual investment. Thus Strategy IIf enables lower-middle (F2) income families to acquire old medium quality (H3) dwellings from the middle income group. Since the lower-middle income group (F2) is the chief beneficiary under Strategy IIf, those cities with the largest proportion of F2 families living in inadequate dwellings will show the largest increase in the over-all index of housing adequacy. For instance, the index for the organized sector (F2-F5) rises more in Monterrey (from the actual .69 to .90) and Mexico City (from .69 to .93) than in Chihuahua (.77 to .90 and Morelia (.81 to .93) because the index for F2's increases more in Monterrey (from the actual .64 to 1.36) and Mexico City (.60 to 1.29) than in Morelia (.76 to 1.14) and Chihuahua (.75 to 1.19). It should be noted that the F2 income group is the largest group in the F2 to F5 range in all cities. Consequently the F2 income group receives the largest weight in the F2-F5 index of adequacy. Finally, the index under Strategy lIf rises more in Puebla (from .68 to 1.02) because the high share of GCP (7.4 percent) used in this city allows the construction of all dwelling types except the highest quality (D5).

Strategy III - Middle and Upper Income Groups Well-Housed

Under Strategy III (F3, F4, F5 well-housed) the three highest income groups occupy adequate dwellings located on the diagonal of the stock-user matrix. Under this strategy the over-all index of adequacy is higher in Monterrey (.97) than in Morelia (.88) but the required share of GCP is also higher in Monterrey (6.5 percent) than in Morelia (3.5 percent). The share of GCP required to place the three highest income groups on the diagonal of the matrix is higher in Monterrey, Puebla, and Mexico City than in Morelia and Chihuahua. At the same time the proportion of middle and upper income groups (F3, F4 and F5) is relatively larger in Monterrey (38.7% in 1970) and Puebla (35.8%) and Mexico City (44.4%) than in Morelia (18.8%) and Chihuahua (32.3%). Thus Strategy III produces a higher index of housing adequacy in the cities with the largest proportion of F3, F4, and F5 families (Puebla, Monterrey, and Mexico City) but they also require a higher share of GCP than Morelia and Chihuahua.

In all cities under Strategy III there is still a large number of low income families (F0 and F1) living in shacks, which implies that the poor do not benefit much from the filtering process when resources are channeled to the construction of only medium and higher quality dwellings (D3, D4, D5).

Strategy IIIf - Optimal Building, Investment as in Strategy III

The investment constraints required under Strategy III (F3, F4, F5 well-housed) could be used more effectively under Strategy IIIf (optimal building). Strategy IIIf which emphasizes the construction of minimum (D2) and medium (D3) dwellings results in a smaller proportion of families living in temporary dwellings in all cities by combining downward filtering (from F2 to F1 to F0) and upward filtering (from F3 to F4 to F5). Strategy III prevents upward filtering by building a sufficient number of medium and high quality dwellings but the low income families do not receive enough dwellings through downward filtering. Given that the share of GCP used under Strategy IIIf (the same as for Strategy III) is higher for Monterrey, Puebla, and Mexico City, the index of housing adequacy is also higher for these cities.

Strategy IVf - Optimal Building, Investment 4.5 Percent of GCP

Strategy IVf allows us to compare the cities becasue they are all subject to the same share of GCP (4.5 percent). Table IV-37 shows that the index of housing adequacy under Strategy IV rises according to the increment in the share of GCP from the actual share. For instance, the over-all index (F1-F5) rises more in Mexico City (from .65 to 1.08) and in the nation (from .62 to .92) than in Morelia (.75 to .93) but the share of GCP also rises more in Mexico City (from 3.7% to 4.5%) and in the nation (3.3 to 4.5) than in Morelia (4.2 to 4.5 percent).

Also notice that the F2-F5 index of adequacy under Strategy IV follows the order of the actual F2-F5 index (with the exception of Mexico City); for instance, Morelia which had the highest actual F2-F5 index is still better off than Monterrey, Puebla and Chihuahua.

Table IV-37 also shows that under Strategy IVf all the temporary (H0) dwellings can be abandoned in Monterrey, Mexico City, and Chihuahua as low income families move to better dwellings which have filtered downwards. As previously mentioned, low income families (F0 and F1) in Morelia and in the nation could not abandon all the temporary dwellings because the relatively large increase in the number of lower-middle income (F2) results in a relatively small number of minimum quality (H2) dwellings filter downwards.

It should be recalled that we have ignored the possibilities of upgrading temporary and substandard dwellings (H0 and H1). Once we obtain information on this process we can set a limit on the number of minimum quality (D2) dwellings that need to be built and to the number of old H2's that can filter downward.

Under Strategy IV as in the other optimal building strategies, the relative number of minimum (D2) and medium (D3) quality dwellings to be built depends on the relative volume of funds available which in turn is related to the relative size of the upper income groups (F3, F4, F5).

Table IV-37. Actual Investment, Actual Index of Housing Adequacy, Index of Housing Adequacy Under Strategy IVf, and Proportion of Temporary Homes (H0)

	1960-1970		1970					
City	Actual Investment (% of GCP)		Actual Index of Housing Adequacy		Index of Housing Adequacy for Strategy IVf (opt. bldg., 4.5% GCP)		Proportion of Temporary Homes (percent of H0)	
	H1-H5	H2-H5	F1-F5	F2-F5	F1-F5	F2-F5	Actual	Strategy IV
Monterrey	4.1	3.8	.66	.69	1.03	.78	29.6	0.0
Puebla	5.3	4.6	.68	.68	.93	.72	30.2	3.4
Chihuahua	4.5	4.3	.72	.77	.97	.78	24.3	0.0
Morelia	5.0	4.2	.75	.81	.93	.86	31.2	12.1
Mexico City (Federal District)	3.7	3.5	.65	.69	1.08	.89	25.4	0.0
Mexico (Nation)	4.0	3.3	.62	.64	.92	.76	40.1	9.7

Table IV-38 shows that the larges proportion of F3 to F5 families in Mexico City (44.4 percent in 1970) permits the construction of the largest proportion of medium dwellings (30.0%). The proportion of F3 to F5 families accounts for 38.7 percent in Monterrey and 35.8 percent in Puebla, while the proportion of medium dwellings built is 20.6 percent and 16.4 percent respectively. On the other hand, the relatively small proportion of middle and upper income families in Chihuahua, Morelia, and the nation does not generate enough funds to permit the construction of medium quality dwellings (D3). Thus the relatively poor cities

(Morelia and Chihuahua) have to concentrate all resources under strategy IVf (4.5% of GCP) in the construction of minimum (D2) quality dwellings whereas Monterrey, Puebla, and Mexico City can build both minimum and medium quality dwellings.

Table IV-38. Proportion of Dwelling Types to be Built Under Strategy IVf (Optimal Building, 4.5% of GCP) and Proportion of Middle and Upper Income Groups (F3, F4, F5)

(in percentages)

City	Dwelling Types to be Built D2	D3	Proportion of F3,F4,F5 1960	1970
Monterrey	70.9	29.1	30.0	38.7
Puebla	82.3	17.7	25.2	35.8
Chihuahua	100.0		23.3	32.2
Morelia	100.0		11.8	18.8
Mexico City (District)	70.0	30.0	33.7	44.4
Mexico (Nation)	100.0		16.4	25.8

Strategy V - No Investment Constraint for the Highest Income Group, 3.0% of GCP

Strategy V (no investment constraint for F5) excludes the highest income group from the objective function and the investment constraint. The wealthy families are assumed to build (without financing) the same number of luxury dwellings that were actually built during 1960-

1970. The relatively small investment constraint used under Strategy V (3.0% of GCP) permits only the construction of minimum quality dwellings. Nevertheless, the relatively rich cities (Monterrey, Puebla, and Mexico City) are able to place all the F2 families on the diagonal of the matrix (F2 index equal to 1.0). The smaller proportion of middle and upper income families in Morelia and Chihuahua produce funds to place only a proportion of F2's on the matrix diagonal; thus the index for F2's in .92 in Chihuahua and .85 in Morelia. Consequently, the index of adequacy (F2 to F5) rises more in Monterrey, Puebla, and Mexico City than in Chihuahua and Morelia.

<u>Strategy VI - No Investment Constraint for the Highest Income Group, 4.5% of GCP</u>

Strategy VI (no investment constraint for F5) also excludes the highest income group (F5) from the objective function and the investment constraint. Luxury dwellings (D5) are built outside the investment constraint by F5 families at an average cost of 1.0 percent of GCP in the large cities and 0.5% in Morelia. The investment constraint (4.5% of GCP) permits the construction of minimum and medium quality dwellings in the relatively rich cities while only minimum dwellings are built in Chihuahua and Morelia. As a result, the over-all index (F1-F5) of adequacy rises more in Puebla (.68 to .97), Monterrey (.66 to 1.07), and Mexico City (.65 to 1.12) than in Morelia (.75 to .95) and Chihuahua (.72 to 1.00). Strategy VI, which allows the construction of luxury dwellings, also enables the poor to move into better dwellings which filter downward. Thus all the temporary dwellings are abandoned in Monterrey, Chihuahua, and Mexico City while a substantial proportion abandoned in Morelia, Puebla, and in the nation. In brief, Strategy VI will improve the housing condition of the majority of families in all cities at an average total cost of 5.6 percent of GCP which is about 30 percent more than the actual average investment during 1960-1970.

Results of the Building Strategies in Monterrey and Morelia

Table IV-39 shows which dwelling types are built and the position of families on the stock-user matrices for various building strategies in Monterrey and Morelia.

The relative number of dwellings actually built depends basically on the relative size of each income group. For instance, the proportion of minimum (D2) dwellings built accounted for 62.4 percent (of the total D2 to D5) in Morelia and 31.1 percent in Monterrey. At the same time, the lower-middle income group (F2) accounted for 65.7 percent (of the total F2 to F5) and 29.1 percent respectively in 1970. Notice that in both cities the number of D2 dwellings built is smaller than the number of new F2 families. This implies that the middle and upper income groups (F3, F4, F5) tend to absorb a more than proportional amount of

Table IV-39. Monterrey and Morelia (1960-1970) -- Typical Building, Investment Constraint, Index of Housing Adequacy, and Position of Households in the Stock-User Matrices

Building Strategy	Share of GCP (H2-H5)	Index of Adequacy (F1-F5)	Typical Building (D types)	Household Position in the Stock-User Matrix: All on the diagonal or above (F types)	None on diagonal (F types)	Below diagonal (F types)	Above the diagonal (F types)
Monterrey							
Actual Allocation	3.8%	.66	D2: 31.1% D3: 33.7% D4: 26.4% D5: 8.8%	0	-	1,2,3,4,5	-
If opt. bldg.	3.8%	.97	D2: 91.1% D3: 8.9%	0,1,2	4	3,4,5	0,1
IIf opt. bldg.	4.9%	1.11	D2: 60.7% D3: 39.3%	0,1,2	4	3,4,5	0,1,2
IVf opt. bldg.	4.5%	1.03	D2: 70.9% D3: 29.1%	0,1,2	4	3,4,5	0,1
VI No inv. const. for F5	4.5% + 1.0% for D5	1.07	D2: 73.1% D3: 23.6% D5: 3.3%	0,1,2	-	3,4,5	0,1
Morelia							
Actual Allocation	4.2%	.75	D2: 62.4% D3: 28.4% D4: 6.9% D5: 2.3%	0	-	1,2,3,4,5	-
If opt. bldg.	4.2%	.89	D2:100.0%	0,2	-	1,3,4,5	1
IIf opt. bldg.	5.3%	1.06	D2: 73.1% D3: 26.9%	0,1,2	-	3,4,5	0,1,2
IVf op. bldg.	4.5%	.93	D2:100.0%	0,2	-	1,3,4,5	1
VI No inv. const. for F5	4.5% + 0.5% for D5	.95	D2: 98.7% D5: 1.3%	0,2	-	1,3,4,5	1

resources in the construction of medium and higher quality dwellings. The lower-middle income group is even worse off because a number of minimum dwellings are filtered upward to higher income families. The proposed building strategies seek to offset these trends (which are accelerated by the financial market preferences of F3 to F5 families) by channeling resources for the construction of minimum (D2) and medium (D3) dwellings.

Table IV-39 shows that the objective function (maximum filtering + new construction) is maximized by building minimum (D2) and medium (D3) quality dwellings in Monterrey under all strategies and by exclusively building minimum (D2) dwellings in Morelia in all strategies (except IIf). As mentioned previously, the relative larger proportion of middle and upper income groups (F3, F4, F5) in Monterrey (and in Mexico City and Puebla) produces enough resources to build D2 and D3 dwellings, while in the relatively poor cities (Morelia and Chihuahua) only D2 dwellings can be built under the proposed strategies. The index of adequacy rises under all strategies in both cities because the improvement of the three lowest income groups (F0, F1, F2) more than offsets the deterioration of the housing conditions of the three highest groups (F3, F4, F5). Table IV-39 shows that F0, F1, and F2 are located on or above the matrix diagonal while F3, F4, and F5 families are located on, and to the left, of the diagonal.

Although no good (D4) or luxury (D5) dwellings are built under the optimal building strategies, the second highest (F4) income group is more likely to be located to the left of the matrix diagonal because the highest group (F5) bids away the remaining H4 dwellings from the F4 families. For instance, in Monterrey all the F4 families occupy dwellings to the left of the diagonal. In Morelia however, there are still some F4 families well-housed (on the diagonal). Fewer old H4 dwellings were filtered upwards in Morelia because the F5 income group increased at a lower rate (6.1 percent) in this city than Monterrey (9.4 percent).

Finally, Strategy VI (no investment constraint for F5) minimizes the amount of upward filtering since the highest income group (F5) is allowed to maintain its position on the stock-user matrix in both Morelia and Monterrey. At the same time, the three lowest groups (F0, F1, F2) and the five lowest income groups (F0, F1, F2, F3, F4) improve their housing conditions in Morelia and Monterrey, respectively.

Housing conditions could have been most improved during 1960-1970 in all cities by concentrating resources on the construction of minimum (D2) and medium (D3) quality dwellings. Unfortunately, private developers and private banks restricted their housing operations to medium and higher quality dwellings (D3 to D5). Even the government housing program actually concentrated on medium (D3) quality dwellings (4 to 5 rooms, all utilities, and concrete roof) whose price was between 40,000 ($3,200) to 80,000 ($6,400) pesos, plus an additional 10,000 to 20,000 pesos ($800 to $1,600) for the land site. These dwellings were affordable only by those families (F3) whose monthly income exceeded 2,300 pesos ($184) which included only about 35 percent of the families in the cities. An additional 25 to 35 percent of the families could have been included in the housing programs through the construction of minimum (D2) dwellings (3 to 4 rooms, all utilities and a roof of asbestos or prefabricated panels) whose average price was 30,000 pesos ($2,400) plus approximately 8,000 pesos ($640) for the land site.

The proposed building strategy enables us to determine the type of dwellings to be built, find the income groups which are involved in the filtering process, and estimate the required amount of investment. However, the model does not indicate which part of the city housing construction should take place. The location of each dwelling type will be determined in part by the cost of land which depends on the accessibility to commercial, cultural, and employment centers. The relatively high (locational) value of land in large cities will have to be offset by high density construction despite the reluctance of Mexican families to live in multi-family dwellings. The construction of minimum quality multi-family dwellings will have to be increased. Otherwise, poor recent migrants will continue to be forced to live in the outskirts of the cities -- which reduces their employment opportunities.

Dwelling location could be incorporated into the filtering model by distinguishing several categories within each dwelling type according to various levels of density and land values.

Summary

The housing stock increased at a lower rate than family formation in all cities during 1960-1970. The gap between housing construction and family formation was widened by the influx of migrants to the cities. As a result, we observed in all cities that a proportion of families at all levels of income were consuming less than the optimal level of housing. Furthermore, the housing conditions of low income families seems to have deteriorated in all cities because they were excluded from the private and public housing programs.

The housing condition of low income families worsened since they had to compete with higher income families for a limited number of dwellings. On the other hand, a proportion of middle and upper income families had to remain in the same quarters even though their level of income increased. This form of upward filtering may be expected in any city which experiences at least a minimum degree of social mobility. Although dwellings could have filtered down from high to lower income families (as we found in Chihuahua where, however, the chains of moves were broken before reaching the lowest 50 percent income class), net upward filtering would occur in the long run as these families rise in the income scale. Net downward filtering will take place only if the number of dwellings built exceeds the number of new families and the number of dwellings to be replaced at a given income level. This is partly achieved under the proposed optimal building strategies.

The proposed building strategies seek to determine the dwelling types whose construction maximizes the sum of downward filtering and new construction. Under the optimal building strategy, the construction of minimum (D2) and medium (D3) quality dwellings will improve the housing conditions of most families by combining downward filtering from the lower-middle to the lowest income groups and upward filtering from the middle to higher income groups. A second best but more realistic strategy excludes the highest income group from the investment constraint and concentrates the building activity on minimum and medium quality dwellings. We also found that low income families do not benefit significantly from the filtering process under the building strategy which aims at providing adequate dwellings for all middle and upper income families.

Unfortunately, in reality this was the housing policy followed by public and private developers in Mexico.

The establishment in 1972 of the new government housing agency, INFONAVIT, which is financed by a 5 percent payroll tax, offers the possibility of implementing a building program which channels a larger amount of resources to the optimal dwelling types.

APPENDIX I

Housing Typology Based on the Physical Characteristics of Dwellings

The physical characteristics of dwellings given in the census are combined into a single index. This index includes the number of rooms (R), the type of materials (M) used for the walls and roofs, and the type of utilities (U) available.

Housing quality rises in the index by the increasing combination of the three indicators. It is observed that the addition of an extra room or the installation of electric services increases the quality and the cost of a dwelling. Quality is further increased when a wood roof is replaced by a concrete roof or when a fully-equipped bathroom is added. Although a small apartment can be of better quality than a large single house, we have to assume that quality increases with dwelling size since the census does not distinguish between single and high-rise dwellings. In general, large dwellings are built with better materials (especially for the roof) and utilities than smaller dwellings. The positive relation between dwelling size and value was observed in the filtering survey (see Chapter III) where the average size decreased along the sequences of household moves.

Since the physical characteristics of dwellings tend to be interrelated, the index is the product of the number of rooms, type of materials and utilities ($R \times M \times U$) rather than the sum of them. It would be desirable to include other indicators of the quality of housing, such as: neighborhood characteristics, proximity to employment centers, and the type of public goods provided in each community. Unfortunately, the census does not provide such information.

The index is used to determine the number of dwellings of each type and to estimate their value.

The functional form of our "quasi-hedonic price index" is expressed in equations 1 and 2.

(1) $I = R^a M^b U^c$

(2) $\text{Log } I = a\text{Log } R + b\text{Log } M + c\text{Log } U$

where I is the index:

R is the number of rooms (1,2...10)

M is the type of construction material

- M = 3 in the case of adobe, mud, sticks, or thatch
- M = 4 in the case of bricks, concrete blocks, tiles, and masonry
- M = 5 in the case of concrete roof. Wooden roofs are considered inferior in Mexico because they are not as durable as concrete roofs. It also seems that the methods and materials to repair and maintain wooden roofs are expensive and not well-known.

U is the type of utility available

U = 1 if the dwelling lacks utilities

U = 2 if the dwelling has communal facilities such as water outside the dwelling

U = 3 if the dwelling has sewage disposal, running water, and electricity

U = 4 if the dwelling has all of the above, plus a fully equipped bathroom

a, b, and c are the coefficients of R, M, and U

Since the census presents the housing information at an aggregated level and separately for R(Rooms), M(Materials) and U(utilities), we could not run any regressions to determine the actual value of the coefficients (a, b, and c). A representative sample of single observations is required to determine the influence of each physical characteristic on the value of a dwelling.[1] Nevertheless, we found that the values given by the index approximately correspond to observed dwelling values in Mexico if the coefficients have a value of 10 (a = b = c = 10).

Table IV-40 shows the possible combination of weights for each housing type. Monetary values are

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[1]On the method for estimating the implicit prices of a bundle of residential services see: John F. Kain and John M. Quigley, "Measuring the Value of Housing Quality," in Journal of the American Statistical Association, June 1970, Vol. 65, No. 330.

obtained by multiplying each indicator (R, M, U) by 10. Thus a one-room adobe dwelling with no facilities implies a value of 3,000 pesos (10 × 30 × 10). The index also serves to determine the number of dwellings of each housing type. For example, in 1970 in Mexico, there were 3.3 million temporary dwellings (H0) with one room made of adobe with no utilities. The number of substandard dwellings (H1) with two rooms, adobe walls, and communal facilities was 2.3 million.

These dwellings (H1) are assigned a plausible value of 12,000 pesos (20 × 30 × 20).

Table IV-40. Index of Housing Quality: Number of Rooms (R), Type of Materials (M), and Type of Utilities (U)

Dwelling Type	Number of Rooms R	Type of Materials M	Type of Utilities U	Index (thousand of pesos)
H0	1	3	1	3
Temporary	2	3	1	6
H1	2	3	2	12
Substandard	3	3	2	18
H2	2	4	3	24
Minimum	3	4	3	36
H3	3	5	3	45
Medium	4	5	3	60
	5	5	3	75
	4	5	4	80
H4	5	5	4	100
Good	6	5	4	120
	7	5	4	140
	8	5	4	160
H5	9	5	4	180
Luxury	10	5	4	200

Note: The number of rooms in accordance with the census definition excludes bathrooms and kitchens.

The index in Table IV-40 corresponds approximately to the dwelling values (1968 pesos) given in the following construction studies:

<u>H0, Temporary</u>

5,000 pesos: reinforced adobe, wooden roof, rudimentary sanitary device, wood-burning stove, self-help, built on free land.[2]

6,912 pesos: adobe, two rooms, separate kitchen, wood-burning stove, self-help, built on free land in rural areas and in suburban slums.[3]

<u>H1, Substandard</u>

14,700 pesos: reinforced adobe, two rooms, land costs excluded.[4]

15,816 pesos: adobe-blocks, two rooms, kitchen, rudimentary sanitary device, labor costs included and land costs excluded.[5]

<u>H2, Minimum</u>

21,147 pesos: bricks, kitchen, bathroom. This dwelling type is called by C. Araud the least expensive of the city.[6] Land costs excluded.

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[2]Ricardo Prado, "Algunas Consideraciones Sobre la Vivienda Rural", V. Congreso Nacional de Arquitectos, (Documento c/27) Mexico, Mayo 1969, quoted by Jesus Puente Leyva "El Problema Habitacional" in <u>El Perfil de Mexico en 1980</u>, Vol. 2, Ed. Siglo XXI, p. 287.

[3]Raul Martinez Almazan, <u>La Vivienda Campesina en el Estado de Mexico</u>, Gobierno Estado de Mexico, Toluca 1973, page 60.

[4]Instituto Nacional de la Vivienda, "La Habitacion Rural" Octubre 1969, Mexico D.F., p.14.

[5]Raul Martinez Almazan, <u>op</u>. <u>cit</u>., p. 53.

(footnotes continued)

31,355 pesos: three rooms, bathroom, kitchen, gas installations, bricks. Land costs excluded.[7]

H3, Medium

This category corresponds to the dwellings built by the FOVI program, ("low cost housing of social interest").

These are FOVI dwelling values:

400,000 to 80,000 pesos: two and three bedrooms, living room, bathroom, kitchen, land excluded which represents 20 percent of total value.[8]

H4, Good

95,503 to 166,991 pesos: concrete roof, bricks, bathroom, kitchen, land excluded.[9]

H5, Luxury

195,209 pesos: luxury dwelling occupied by families earning more than 8,000 pesos per month. Mortgage sample, value of land excluded.[10]

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[6]Christian Araud, "Direct and Indirect Employment Effects of Eight Representative Types of Housing in Mexico" p. 90 in Studies on Employment in the Mexican Housing Industry, O.E.C.D. Paris 1973.

[7]Raul Martinez Almazan, op. cit., page 41.

[8]Fondo de Operaciones y Descuento Bancario a la Vivienda. Data from Subdireccion Financiera.

[9]Christian Araud, op. cit., page 90.

[10]P. Strassmann, "Employment and Financial Alternatives in Mexican Housing" in Studies on Employment in the Mexican Housing Industry, page 297, O.C.D.E. Paris 1973.

211,031 pesos:	Luxury dwelling in survey sample. Concrete roof, eight rooms. Land excluded.[11]
221,233 to 525,173 pesos:	concrete roof, inside garage, eight rooms in one or two storys including servants' room. Land excluded.[12]

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[11]Filtering Survey in Chihuahua (Chapter III). Land costs account for 20.0 percent of total value.

[12]Christian Araud, op. cit., page 90.

APPENDIX II

Family Average Income by Income Group

Table IV-41. Family Average Income by Income Group (Average Monthly Income in 1968 Pesos) 1960-1969

Income Group	Year	Monterrey	Puebla	Chihuahua	Morelia	Mexico City	Nation
F0 Less Than 529	1960	389	383	444	372	410	343
	1969	412	401	455	413	420	368
	Average (1960-1969)	401	392	449	392	415	356
F1 530-1,105	1960	830	754	767	805	841	772
	1969	884	856	871	889	859	878
	Average (1960-1969)	857	805	819	847	850	825
F2 1,104-2,303	1960	1,398	1,392	1,492	1,456	1,608	1,329
	1969	1,431	1,434	1,521	1,480	1,642	1,350
	Average (1960-1969)	1,414	1,413	1,506	1,468	1,625	1,339
F3 2,304-4,779	1960	2,987	3,299	2,804	2,912	3,362	2,754
	1969	3,070	3,036	3,343	3,298	3,428	3,354
	Average (1960-1969)	3,028	3,302	3,073	3,105	3,395	3,054
F4 4,800-9,999	1960	6,866	6,756	6,782	6,915	6,772	5,798
	1969	7,167	7,480	7,431	7,349	7,469	6,837
	Average (1960-1969)	7,016	7,118	7,106	7,132	7,119	6,317
F5 10,000- or more	1960	14,801	14,429	14,586	14,689	14,406	12,433
	1969	17,219	17,620	17,452	17,341	17,808	17,157
	Average (1960-1969)	16,010	16,024	16,019	16,015	16,107	14,795

National family income computed from the surveys was 202,044 million pesos in 1969. This amount was 61.2 precent of Gross National Product (330,383 million pesos) which means that GNP is 63.5 percent larger than national family income. We have also assumed that Gross City Product is 63.5 percent larger than city family income. Family income computed from the surveys is around 30.0 percent less than the national account estimate of personal disposable income,[1] which represents 79.8 percent of Gross National Product. Family income derived from the surveys underestimates the national account estimate because high income families tend to report a lower level of income while lower income families tend to underestimate their income in kind. It is also argued that disposable income is relatively low in Mexico because a substantial proportion of capital income is re-invested within the firms and a portion of corporate profits leave the country. It is also possible that Gross National Product has been over-estimated in the national accounts.

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[1] Ifigenia Navarrete, "La Distribucion del Ingreso Mexico; Tendencias y Perspectivas," in El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, D.F., pages 60-64.

CHAPTER V

APPLICATION OF A FILTERING MODEL TO THE CITIES OF MONTERREY, PUEBLA, CHIHUAHUA, MORELIA, MEXICO CITY (FEDERAL DISTRICT) AND NATION DURING 1970-1985

In Chapter IV a filtering model was applied to five Mexican cities and the nation during the period 1960-1970. This chapter describes the results of the same model for the period 1970-1985.

In Chapter IV we found that the over-all housing conditions as measured by the proportion of households living in inadequate dwellings deteriorated during the period 1960-1970, especially for low income families. In this chapter we seek to design a building strategy which will improve the housing conditions of the maximum number of households during 1970-1985. This is accomplished by selecting the type and volume of dwellings which maximize the combined amount of downward filtering and new construction.

Since the relative number of households in each income group changes through time, the proportion of dwelling types to be built under the proposed building strategies will be different for the two periods under consideration (1960-1970 and 1970-1985). The shares of

GNP (or GCP) required to achieve certain housing goals are also likely to change through time. The differences between the periods 1960-1970 and 1970-1985 will be examined in this chapter.

Section 1 presents the projected distribution of households by income group in 1985. The results of the filtering model for the period 1970-1985 are described in Section 2.

The assumptions and the structure of the filtering model were already described in Chapter IV.

Section 1. Distribution of Households by Income Group in 1985

The number of households by income group in the initial year (1970) was taken from the income surveys conducted in the cities and in the nation as a whole (see Chapter IV). In order to determine the number of dwellings to be built under the various building strategies, we have to estimate the number of households in each income group in the terminal year (1985). The projections are made under the following assumptions:

a) Population Growth

The rate of population growth attained by the nation during the period 1960-1970 is expected to decline in the future due to an older age distribution. Population is assumed to grow at an annual rate of 3.3 percent during

1970-1985 instead of 3.5 percent during 1960-1970.[1] The death rate is expected to continue decreasing (it declined from 26.6 per thousand in 1930, 11.2 in 1960, to 9.7 in 1970) in the future but at a lower rate than in the past as the average life expectancy increases. The birth rate has already begun to decline (from 44.6 per thousand in 1960 to 43.3 in 1970) as the proportion of women of child-bearing age (15 to 44 years) has decreased from 21.1% in 1960 to 20.5% in 1970. In addition to an older population structure, the recent adoption of a voluntary birth control program should also contribute to the reduction of the birth rate in the future.

The rate of migration cannot be easily predicted since the higher level of wages offered in the cities can be expected to continue to attract migrants to cities while some political decisions such as extensive redistribution of agricultural land would slow down the rural-urban migration. Assuming that past migration rates are maintained in the future,[2] cities will grow during 1970-

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[1]Ricardo Alvarado, Mexico: Proyeccion de la Poblacion Total, 1960-2000 y Ie la Poblacion Economicamente Activa, 1960-1985, Celade, Series C, No. 114, June 1969, page 12.

[2]Luis Unikel, "El Proceso de Urbanizacion" in El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, 1970, pages 234-239.

1985 at a lower rate than in 1960-1970, due exclusively to the anticipated decline in the natural rate of population growth.

Table V-1 shows the population data for 1970 and 1985. The number of households is estimated assuming an average family size of 5.3 which was the national average in 1970.

Table V-1. Population, Rates of Population Growth, Number of Households and Product per Capita 1970-1985

	Population			House-holds 1985	Product per Capita		
	1970 (thousands)	1985 (thousands)	Growth rate (percent)		1970 (1968 pesos)	1985 Uni. (1968 pesos)	1985 Div. (1968 pesos)
Monterrey	918	1,752	4.4	330	10,832	17,995	17,891
Puebla	532	1,002	4.3	189	10,808	17,846	17,658
Chihuahua	277	506	4.1	95	9,296	16,151	15,893
Morelia	191	326	3.6		6,562	11,372	10,889
Mexico City (Federal District)	6,874	11,855	3.7	2,237	13,389	21,641	21,547
Mexico (Nation)	48,337	78,644	3.3	14,838	7,312	13,038	12,594

(12.5 pesos = US $1.00)

b) Family Income and GNP Growth Rates

GNP is assumed to grow during 1970-1985 at an annual rate of 6.6%, which is similar to the rate experienced during 1950-1970.

The distribution of households by level of income is projected under two patterns of income growth rates. The first projection (called uniform) is based on the assumption that family income will grow at 3.3% at all income levels. The second projection (called diverse) is based on the assumption that family income will grow as in the past, faster for the middle and higher strata. That is, 1.5% for F0, 2.0% for F1, 3.0% for F2, 3.5% for F3, 4.5% for F4, and 3.7% for F5.[3]

The distribution of households by income level projected under the uniform and diverse growth patterns is shown in Table V-2.

The distribution of households by income level is shown in Table V-2. The projection based on diverse income growth rates (which are assumed to be higher for middle and upper strata) is more widely spread than the projection based on uniform growth rates. For instance, the proportion of low income (F0 and F1) and rich (F5) families is higher for the diverse projected distribution, while the proportion of lower-middle to upper-middle (F2 to F4) families is higher under the uniform projection. In other words, the proportion of poor families (F0 and F1) declines more rapidly under the uniform projection (from 36.5% in 1970 to 14.8% in 1985 for Monterrey) than under the diverse projection (from 36.5% to 22.9% for

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[3] Ifigenia de Navarrete, "La Distribucion del Ingreso en Mexico; Tendencias y Prespectivas," in <u>El Perfil de Mexico en 1980</u>, <u>op</u>. <u>cit</u>., page 38.

Table V-2. Proportion of Households by Income Levels in 1970 and 1985

(In percentages)

Income Groups (1968 Pesos)	Monterrey 1970 .	Monterrey 1985 U(1)	Monterrey 1985 D(2)	Puebla 1970 .	Puebla 1985 U	Puebla 1985 D	Chihuahua 1970 .	Chihuahua 1985 U	Chihuahua 1985 D	Morelia 1970 .	Morelia 1985 U	Morelia 1985 D	Mexico City 1970 .	Mexico City 1985 U	Mexico City 1985 D	Nation 1970 .	Nation 1985 U	Nation 1985 D
F0 0-529	7.2	3.8	5.4	10.3	5.4	7.7	4.7	2.5	3.5	8.9	4.7	6.6	2.4	1.3	1.8	17.2	9.0	12.8
F1 530-1,100	29.3	11.0	17.5	30.7	12.8	19.1	23.0	8.2	13.5	36.2	13.6	21.7	20.3	6.4	11.5	27.6	15.3	19.2
F2 1,101-2,300	24.8	28.1	23.2	23.2	28.7	23.2	40.1	27.4	26.2	36.1	36.2	30.8	32.9	23.6	22.2	29.4	28.1	24.2
F3 2,301-4,800	23.5	24.5	21.6	20.8	22.6	19.9	22.5	35.5	30.7	14.6	30.5	26.1	26.4	31.2	27.3	18.4	26.6	23.0
F4 4,801-10,000	10.4	20.1	18.9	9.8	18.0	16.8	6.7	18.4	17.6	2.8	11.5	11.1	12.6	22.8	21.4	5.4	15.0	14.3
F5 10,001 or more	4.8	12.5	13.4	5.2	12.5	13.3	3.0	8.0	8.5	1.4	3.5	3.7	5.4	14.7	15.8	2.0	6.0	6.5

Notes: (1) U represents uniform income growth rates for all income levels.

(2) D represents diverse income growth rates for each income level.

Monterrey). Although under both assumptions the relative number of poor families decreases, their absolute number increased under the diverse projection and decreases under the uniform projection.

The projection of the distribution of households under two sets of assumptions provides us with the range within which the actual distribution will most likely result in 1985. We also want to determine how different distributions affect the results of our filtering model.

Section 2. Results of the Filtering Model

Section 2.1 describes the investment shares of GNP or GCP required to achieve certain housing goals. Section 2.2 presents the indices of housing adequacy for various building strategies. Section 2.3 compares the proportion of dwelling types to be built in 1970 and 1985.

2.1. Investment of GNP or GCP Required to Achieve Certain Goals

The investment shares required to achieve certain quantitative goals are shown in Table V-3. We observe that the share of GCP (or GNP for the nation) required to place all households in adequate dwellings located on the stock-user matrix diagonal is slightly higher in all cases under the uniform projection (8.9% for Monterrey) than under the diverse projection (8.7% for Monterrey). This is due to the higher proportion of lower-middle and higher income families (F2 to F5) under the uniform projection (85.2% for Monterrey) than under the diverse projection (77.1% for Monterrey). This implies that a higher proportion of relatively more expensive dwellings has to be built under the uniform projections.

Since the proportion of rich (F5) and poor (F0 and F1) families is higher under the diverse projection, a higher share of GCP is required to place them on the matrix diagonal. At the same time, the share required to place all F5's on the diagonal is higher in the relatively rich cities (4.1% under the diverse projection in Monterrey) than in the relatively poor cities (1.6% in Morelia). But a higher share is required to provide adequate dwellings to all poor families in the relatively poor cities (0.7% in Morelia) than in the relatively rich cities (0.4% in Monterrey).

Table V-3 also shows that the investment share required to provide adequate dwellings for all households is higher for the period 1970-1985 under both projections in all cities (except Puebla, whose 1960-1970 boundaries were not well-defined) than for 1960-1970. This is the result of the projected increase in the relative number of lower-middle (F2) and higher income families who will demand increasingly more expensive dwellings. We expect that the high degree of social mobility observed during the period 1960-1970 in all cities will continue to occur in the future. This dynamic element of the demand for housing implies that the type of dwellings to be built under the proposed building strategies will increase in quality through time. This is examined in Section 2.3.

The projections assume that during 1970-1985 there will be no over-crowded dwellings as the average number of persons per dwelling will be equal to the average family size (5.3 per person). On the contrary, we noticed that during 1960-1970 the lack of a sufficient number of dwellings resulted in an increasingly higher index of over-crowding. The elimination of over-crowded dwellings during 1970-1985 is another reason why the investment shares required to provide adequate dwellings for all households will be higher in 1970-1985 than in 1960-1970.

Table V-3 also shows the investment shared required during 1970-1985 to maintain the base year (1970) index of housing adequacy. These shares are higher than the shares actually invested during 1960-1970. For example, the index for the nation (.64 in 1970) was attained with a share of 4.0% of GNP while 5.6% (under uniform projection) and 5.3% (under diverse projection) will be required to conserve the same index during 1970-1985. The higher shares required in 1970-1985 are, as mentioned previously, due to the larger proportion of lower-middle and higher income families. Given that higher investment shares will be required during 1970-1985 to maintain the initial

Table V-3. Investment Shares of GNP or GCP Required to Achieve Certain Goals, 1960-1970 and 1970-1985

City	Period	Investment Needed for: (Percent of GCP or GNP)			
		Put all Households on Matrix Diagonal	Keep Base Year (1970) Index of Adequacy	Put all F5's on Matrix Diagonal	Put all F0's and F1's in H1 Dwellings
Monterrey	60-70	7.6	(Index = .66)	2.2	0.7
	70-85 U	8.9	6.2	3.8	0.3
	70-85 D	8.7	6.0	4.1	0.4
Puebla	60-70	9.4	(Index = .68)	2.8	1.5
	70-85 U	7.9	5.3	3.5	0.3
	70-85 D	7.7	5.2	3.8	0.5
Chihuahua	60-70	7.6	(Index = .72)	1.5	0.4
	70-85 U	8.3	6.1	2.5	0.1
	70-85 D	8.1	5.9	2.8	0.2
Morelia	60-70	7.6	(Index = .75)	0.8	2.3
	70-85 U	8.0	6.7	1.4	0.4
	70-85 D	7.7	6.3	1.6	0.7
Mexico City (Federal District)	60-70	6.8	(Index = .65)	1.7	0.6
	70-85 U	7.3	5.5	3.3	0.1
	70-85 D	7.2	5.4	3.6	0.2
Nation	60-70	8.2	(Index = .64)	1.2	1.4
	70-85 U	8.8	5.6	2.4	0.2
	70-85 D	8.4	5.3	2.7	0.6

Note: U represents uniform projection and D represents diverse projection.

housing conditions, we can expect that the proposed building strategies will produce a lower index of adequacy in 1970-1985 than in 1960-1970. This is examined in the following section.

2.2. Indices of Housing Adequacy for Various Investment Strategies

The goal of the filtering model is to determine the optimal building strategy for improving the housing conditions of the largest possible number of households. Housing conditions are improved as some households obtain new dwellings while others receive old dwellings through downward filtering. Housing conditions are measured by the index of adequacy, which indicates the proximity of households to the diagonal of the stock-user matrix. Families are well-housed when they occupy dwellings on the matrix diagonal, in which case the index receives a value of 1.0. The indices for the periods 1960-1970 and 1970-1985 are shown in Table V-4.

The building strategies seek to determine the type and the volume of dwellings whose construction maximizes the combined amount of downward filtering and new construction. Since the building strategies are assumed to be financially solvent, they are restricted to the families who can obtain and repay home loans (F2 to F5). The lowest income groups (F0 and F1) can,

Table V-4. Indices of Housing Adequacy for Various Building Strategies 1960-1970 and 1970-1985

City	Period	Indices (F1 - F5) for Building Strategies (Investment as percent of GCP or GNP)				
		Vf (3.0) Opt. Bld. Strat.	V (3.0) No Inv. Const. for F5	IVf (4.5) Opt. Bld. Strat.	VI (4.5) No Inv. Const. for F5	Extra Inv. for F5 in V and VI
Monterrey	60-70	.88	.92	1.03	1.07	1.0
	70-85 U	.71	.80	.86	1.02	2.4
	70-85 D	.74	.86	.94	1.05	2.6
Puebla	60-70	.79	.80	.93	.97	1.2
	70-85 U	.75	.88	.96	1.06	2.1
	70-85 D	.78	.93	.98	1.15	2.3
Chihuahua	60-70	.75	.78	.97	1.00	0.7
	70-85 U	.71	.76	.84	.93	1.6
	70-85 D	.77	.84	.92	1.05	1.7
Morelia	60-70	.75	.77	.93	.95	0.5
	70-85 U	.69	.72	.87	.91	1.0
	70-85 D	.76	.81	.97	1.01	1.1
Mexico City (Federal District)	60-70	.86	.90	1.08	1.12	1.0
	70-85 U	.71	.91	.95	1.07	2.3
	70-85 D	.78	1.00	1.02	1.14	2.5
Mexico (Nation)	60-70	.73	.74	.92	.94	0.5
	70-85 U	.67	.74	.83	.90	1.4
	70-85 D	.77	.82	.89	.97	1.6

however, improve their housing conditions as they move into old, but adequate dwellings which filter downward.

We have applied two types of building strategies for the period 1970-1985. The first (Vf 3.0% of GCP and IVf of GCP optimal strategies) is applied to the entire organized housing sector (D2 to D5). This type of strategy results in the maximum number of dwellings built and transferred downwards or a minimal upward transfer. The second type (V and VI, no investment constraint for F5) of strategy excludes high income families (F5) because they usually have the financial means to acquire dwellings regardless of the policies adopted by the public authorities. Under this last strategy, the number of dwellings built for high income families outside the investment constraint during 1970-1985 corresponds to the actual index of adequacy attained during 1960-1970.

Table V-4 shows the indices of housing adequacy for the building strategies. Given that the share of GCP (see Table V-3) required to provide adequate dwellings for all households is larger under the uniform projection than for the diverse projection, the indices of adequacy obtained by all building strategies is lower for the uniform projection. For instance, under strategy Vf (optimal building) the indices are between .67 (for the nation) and .75 (for Puebla) for the uniform projection, while the indices for the diverse projections are between .74 (in

Monterrey) and .78 (in Mexico City and Puebla). The lower indices obtained from the uniform projection resulted from the relatively low number of dwellings transferred downwards. This is due to the relatively large increase of F2 to F5 families who retain old dwellings under the uniform projection, which otherwise could have filtered to lower income families.

Table V-4 also shows that the indices for Strategies Vf and IVf (optimal strategies) are higher for the period 1960-1970 than for the uniform projections, except for Puebla, whose ill-defined census boundaries resulted in an artificially high population growth rate for 1960-1970 which produced an unrealistically low index of adequacy in this period. Under Strategy IVf, the indices for diverse projections are also lower than the 1960-1970 indices with the exception of Morelia (and Puebla) which had the best housing conditions in the initial year.

Strategies Vf and IVf (optimal building) improve the housing conditions of all income groups except the two highest (F4 and F5) by building all dwelling types except good (D4) and luxury (D5). Under these strategies, wealthy families would eventually bid away the dwellings that were built for lower income families. A more realistic policy is to exclude wealthy families (F5) from the building strategy. Thus Strategies V and Vf (no investment constraint for F5) allow the highest income group to maintain its initial housing conditions, while F0 to F3 families obtain better dwellings.

The index of adequacy under Strategies V and VI (no investment constraint for F5) is higher for the relatively rich industrial cities (Monterrey, Puebla, and Mexico City) which have a higher proportion of wealthy families than Morelia and Chihuahua. But the additional investment for F5 families under Strategies V and VI is also higher for Monterrey, Puebla, and Mexico City. For instance, under the uniform projection the index for Monterrey rises from .94 in Strategy IVf (optimal building, 4.5%) to 1.05 in Strategy VI (no investment constraint) at an additional cost of 2.6% of GCP, while in Morelia the index rises from .97 to 1.01 at an additional cost of 1.1% of GCP.

Although Strategy VI (no investment constraint for F5) would improve the housing conditions of most households during 1970-1985, it would require relatively high investment shares of GCP, which range between 5.5% in Morelia to 7.1% in Monterrey. It cannot be expected that the cities will invest very high shares of GCP on residential construction when there are urgent needs to be satisfied such as lack of transportation, malnutrition, and illiteracy. It can also be argued that the share of GNP allocated to education -- which is about 4 percent[4]--

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[4]Enrique G. Leon Lopez, "La Educación Tecnica Supeior," in El Perfil de Mexico en 1980, Ed. Siglo XXI, page 201, Mexico, D.F., 1970.

should be increased, since 20 to 30 percent of the applicants to primary schools in the large cities have to be rejected every year due to a lack of teachers and classrooms. The cities could invest between 5 to 6 percent of GCP for residential construction under a building strategy which allows wealthy families to maintain their initial housing conditions while middle and lower income families would move to better dwellings.

Finally, it should be indicated that in all strategies for the period 1970-1985, there are a sufficient number of dwellings transferred down to the lowest income families (F0) who can then abandon their temporary dwellings (H0).

2.3. Type of Dwellings to be Built

In this section we examine the optimal combination of dwellings to be built for the period 1970-1985 under the diverse and uniform projections and for the period 1960-1970. Table V-5 shows the proportion of dwelling types to be built under Strategy VI (no investment constraint for F5). The projected stock-user matrices for Strategy VI are shown in the Appendix of this chapter.

In Table V-5 we notice the following patterns. During 1960-1970 the relatively large proportion of upper-middle (F4) and high (F5) income families in the industrial cities (Monterrey, Puebla, and Mexico City) would have resulted in the transfer of a sufficient

Table V-5. Proportion of Dwelling Types Under Strategy VI (No Investment Constraint for F5) and Proportion of Families by Income Groups

City	Period	Dwelling Types to be Built (in percent)					Proportion of Families (in percent)	
		D1	D2	D3	D4	D5	F2-F5	F4-F5
Monterrey	60-70	9.6	58.2	29.2	0	3.0	63.5	15.2
	70-85 U[1]	2.9	29.2	53.9	6.2	7.8	85.2	32.6
	70-85 D[2]	13.3	22.9	41.3	14.0	8.5	77.1	32.3
Puebla	60-70	28.1	54.5	15.1	0	2.4	59.0	15.6
	70-85 U	5.5	30.6	42.0	14.5	7.4	81.8	30.5
	70-85 D	16.8	23.2	21.8	30.1	8.0	73.2	30.0
Chihuahua	60-70	0	98.3	0	0	1.7	72.3	9.7
	70-85 U	0	47.0	0.9	0.9	5.1	89.3	26.4
	70-85 D	0.2	34.4	53.2	1.3	5.9	83.0	26.1
Morelia	60-70	26.6	72.5	0	0	0.9	54.9	4.2
	70-85 U	0	81.5	15.7	0	2.8	81.7	15.0
	70-85 D	13.0	58.0	25.9	0	3.1	71.7	14.8
Mexico City (Federal District)	60-70	0	63.7	33.0	0	3.3	77.3	18.0
	70-85 U	0	19.1	53.8	15.5	11.6	92.3	37.5
	70-85 D	0	20.8	41.8	24.1	13.3	86.7	37.2
Nation	60-70	23.5	75.7	0	0	0.8	55.2	7.0
	70-85 U	13.1	51.4	30.9	1.3	3.3	75.7	21.0
	70-85 D	22.8	31.6	40.4	1.6	3.6	68.0	20.8

Notes: (1) U stands for uniform projection

(2) D stands for diverse projection

amount of resources to build minimum (D2) and medium (D3) quality dwellings under Strategy VI (no investment for F5). In contrast, in Morelia and Chihuahua, the relatively small proportion of F4 and F5 families, coupled with the relatively large proportion of F2 families, would have resulted in the construction of only minimum (D2) dwellings under Strategy VI. It is recalled that luxury (D5) dwellings are built outside the investment constraint under Strategy VI. Secondly, the relatively larger proportion of F4 and F5 families under the 1970-1985 projection will produce enough resources to build minimum (D2), medium (D3), and good (D4) quality dwellings in all cities except Morelia, where only D2's and D3's can be built. Finally, the higher proportion of middle income families (F3) under the uniform projection would result in fewer D2's and more D3's to be built than under the diverse projection.

The housing authorities should avoid the mistake of establishing very high architectural standards which result in the exclusion of most households from the building program. The average quality of dwellings to be built under the proposed strategies can be increased through time as families rise in the income scale.

Summary

The filtering model was applied in this chapter for the 1970-1985 period. The distribution of households by income level was projected under two types of assumptions. The first (uniform) assumes that family income will grow at the same rate for all income groups. The second (diverse) assumes that family income will grow at a faster rate for middle and higher strata. Under the uniform projection, which results in a larger proportion of lower-middle and high income groups, a larger share of GCP or GNP is required to provide adequate dwellings for all households than under the diverse projection. Hence, the indices of housing adequacy under the proposed building strategies are lower for the uniform projection than for the diverse projections. In both projections, the share of GCP or GNP required to provide adequate dwellings for all families are larger than for the 1960-1970 period. In most cases both projections result in lower indices of adequacy than for the period 1960-1970, which implies that housing conditions will deteriorate (not absolutely, but for given income levels) in the future unless a relatively larger amount of resources is channeled to residential construction. It should be added, however, that the increasingly larger size of the organized housing sector (H2 to H5) would enable the lowest income group (F0) to receive a relatively larger number of dwellings through downward filtering. Finally we examined how the increase in the proportion of middle income families through time requires the construction of increasingly higher quality dwellings.

APPENDIX I

Projected Stock-User Matrices for 1970-1985
(Under Strategy VI, No Investment Constraint for F5)

Table V-6. Monterrey 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.004%, H2-H4 4.5%, H5 2.4% (Investment as Percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		12,471					12,471	3.8	
F1		13,774	22.638				36.412	11.0	1.67
F2			74,915	18,025			93,000	28.1	1.21
F3				80,865			80,865	24.5	1.00
F4				57,698	8,766		66,464	20.1	.55
F5					17,322	24,021	41,343	12.5	.78
ΣHj		26,245	97,613	156,588	26,088	24,021	330,555	100.0	1.02
Hj%	0.0	7.9	29.5	47.4	7.9	7.3	100.0		
Remaining Dwellings		18,810	22,638	18,025	10,221	3,812	73,506		
Build Dj		7,435	74,975	138,563	15,867	20,209	257,049		

Table V-7. Monterrey 1985, Strategy VI, Diverse Projection

(1970-1985) H1 0.2%, H2-H4 4.5%, H5 2.6% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		17,777					17,777	5.4	
F1		35,297	22,638				57,935	17,5	1.42
F2			58,722	18,025			76,747	23.2	1.25
F3				71,298			71,298	21.6	1.00
F4				34,818	27,715		62,533	18.9	.71
F5					18,546	25,719	44,265	13.4	.78
ΣHj		53,074	81,360	124,141	46,461	25,719	330,555	100.0	1.05
Hj%		16.1	24.6	37.6	14.0	7.7	100.0		
Remaining Dwellings		18,810	22,638	18,025	10,221	3,812	73,506		
Build Dj		34,264	58,722	106,116	36,040	21,907	257,049		

Table V-8. Puebla 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.001%, H2-H4 4.5%, H5 2.1% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		10,201					10,201	5.4	
F1		11,757	12,540				24,297	12.8	1.56
F2			43,562	10,794			54,336	28.7	1.21
F3				42,677			42,677	22.6	1.00
F4				17,026	16,904		33,930	18.0	.74
F5					10,428	13,130	23,553	12.5	.77
ΣHj		21,958	56,102	70,497	27,332	13,310	189,019	100.0	1.06
Hj%		11.6	29.6	37.3	14.5	7.0	100.0		
Remaining Dwellings		14,117	12,540	10,794	6,665	2,572	46,688		
Build Dj		7,841	43,562	59,703	20,-67	10,558	142,331		

Table V-9. Puebla 1985, Strategy VI, Diverse Projection

(1970-1985) H1 0.2%, H2-H4 4.5%, H5 2.3% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		14,543					14,543	7.7	
F1		23,489	12,540				36,029	19.1	1.38
F2			33,145	10,794			43,939	23.2	1.27
F3				31,144	6,387		37,531	19.9	1.18
F4					31,844		31,844	16,8	1.00
F5					11,134	13,999	25,133	13.3	.77
ΣHj		38,032	45,685	41,938	49,365	13,999	189,019	100.0	1.15
Hj%		20.1	24.2	22.2	26.1	7.4	100.0		
Remaining Dwellings		14,117	12,540	10,794	6,387	2,572	46,410		
Build Dj		23,915	33,145	31,144	42,978	11,427	142,609		

Table V-10. Chihuahua 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.0%, H2-H4 4.5%, H5 1.6% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0			2,352				2,352	2.5	
F1			7,828				7,828	8.2	2.08
F2			26,201				26,201	27.4	1.00
F3			9,264	24,687			33,951	35.5	.86
F4				17,584			17,584	18.4	.48
F5					2,960	4,649	7,609	8.0	.80
ΣHj			45,645	42,271	2,960	4,649	95,525	100.0	.93
Hj%			47.3	44.3	3.1	4.8	100.0		
Remaining Dwellings		5,838	10,322	6,892	2,286	831	26,161		
Build Dj			35,323	35,379	674	3,818	75,194		

Table V-11. Chihuahua 1985, Strategy VI, Diverse Projection

(1970-1985) H1 0.0%, H2-H4 4.5%, H5 1.7% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		3,353					3,353	3.5	
F1		2,590	10,322				12,912	13.5	1.86
F2			18,166	6,892			25,058	26.2	1.30
F3			5,675	23,614			29,289	30.7	.90
F4				16,760			16,760	17.6	.48
F5					3,174	4,979	8,153	8.5	.80
ΣHj		5,943	34,163	47,266	3,174	4,979	95,525	100.0	1.05
Hj%		6.2	35.8	49.5	3.3	5.2	100.0		
Remaining Dwellings		5,830	10,322	6,892	2,286	831	26,161		
Build Dj		113	23,841	40,374	888	4,148	69,364		

Table V-12. Morelia 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.0%, H2-H4 4.5%, H5 1.0% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		2,866					2,866	4.7	
F1		2,524	5,838				8,362	13.6	1.75
F2			22,225				22,225	36.2	1.00
F3			14,812	3,945			18,757	30.5	.59
F4				6,629	464		7,093	11.5	.51
F5					501	1,634	2,135	3.5	.88
ΣHj		5,390	42,875	10,574	965	1,634	61,438	100.0	.91
Hj%		8.8	69.8	17.2	1.6	2.6	100.0		
Remaining Dwellings		5,705	5,838	3,463	965	356	16,327		
Build Dj		0	37.037	7,111	0	1,278	45,426		

Table V-13. Morelia 1985, Strategy VI, Diverse Projection

(1970-1985) H1 0.2%, H2-H4 4.5%, H5 1.1% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		4,085					4,085	6.6	
F1		7,966	5,838				13,304	21.7	1.47
F2			15,462	3,463			18,925	30.8	1.20
F3			10,734	5,279			16,013	26.1	.65
F4				6,400	429		6,829	11.1	.51
F5					536	1,746	2,282	3.7	.88
ΣHj		11,551	32,034	15,142	965	1,746	61,438	100.0	1.01
Hj%		18.8	52.1	24.6	1.6	2.9	100.0		
Remaining Dwellings		5,705	5,838	3,463	965	356	16,327		
Build Dj		5,846	26,196	11,679	0	1,390	45,111		

Table V-14. Mexico City (Federal District) 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.0%, H2-H4 4.5%, H5 2.3% (Investment as percentage of GCP)

Hj / Fi	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0			28,130				28,130	1.3	
F1			143,155				143,155	6.4	2.08
F2			369,368	157,695			527,063	23.6	
F3				698,248			698,248	31.2	1.00
F4				223,698	286,867		510,565	22.8	.77
F5					85,375	244,255	329,630	14.7	.87
ΣHj			540,653	1,079,641	372,242	244,255	2,236,791	100.0	1.07
Hj%			24.2	48.3	16.6	10.9	100.0		
Remaining Dwellings			212,944	157,695	107,455	45,234	660,051		
Build Dj			327,709	921,946	264,787	199,021	1,713,463		

Table V-15. Mexico City (Federal District) 1985, Strategy VI, Diverse Projection (1970-1985) H1 0.0%, H2-H4 4.5% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		40.101					40,101	1.8	
F1		44,018	212,944				256,962	11.5	1.89
F2			338,523	157,695			496,218	22.2	1.34
F3				610,993			610,993	27.3	1.00
F4				70,156	408,776		478,932	21.4	.92
F5					91,652	261,933	253,585	15.3	.87
ΣHj		84,119	551,467	838,844	500,428	261,933	2,236,791	100.0	1.14
Hj%		3.7	24.7	37.5	22.4	11.7	100.0		
Remaining Dwellings		136,723	212,944	157,695	107,455	45,234	660,051		
Build Dj			338,523	681,149	392,973	216,699	1,629,344		

Table V-16. Mexico (Nation) 1985, Strategy VI, Uniform Projection

(1970-1985) H1 0.2%, H2-H4 4.5%, H5 1.4% (Investment as percentage of GCP

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		1,337,368					1,337,368	9.0	
F1		1,392,071	883,509				2,275,580	15.3	1.42
F2			4,164,616				4,164,616	28.1	1.00
F3			1,823,366	2,116,416			3,939,782	26.6	.76
F4				2,230,677			2,230,677	15.0	.48
F5					417,661	472,862	890,523	6.0	.76
ΣHj		2,729,439	6,871,491	4,347,093	417,661	472,862	14,838,546	100.0	.90
Hj%		18.4	46.3	29.3	2.8	3.2	100.0		
Remaining Dwellings		1,208,216	863,509	745,116	267,842	80,549	3,185,232		
Build Dj		1,521,223	5,987,982	3,601,977	149,819	392,313	11,653,314		

Table V-17. Mexico (Nation) 1985, Strategy VI, Diverse Projection

(1970-1985) H1 0.4%, H2-H4 4.5%, H5 1.6% (Investment as percentage of GCP)

Fi \ Hj	H0	H1	H2	H3	H4	H5	ΣFi	Fi%	Index
F0		1,906,516					1,906,516	12.8	
F1		1,957,359	883,509				2,840,868	19.2	1.34
F2			3,592,947				3,592,947	24.2	1.00
F3			84,205	3,328,304			3,412,509	23.0	.99
F4				2,127,075			2,127,075	14.3	.48
F5					449,604	509,027	958,631	6.5	.76
ΣHj		3,863875	4,560,661	5,455,319	449,604	509,027	14,838,846	100.0	.97
Hj%		26.1	30.8	36.7	3.0	3.4	100.0		
Remaining Dwellings		1,208,216	883,509	745,116	267,842	80,549	3,185,232		
Build Dj		2,655,659	3,677,152	4,710,263	181,762	428,478	11,653,314		

CHAPTER VI

EQUITY IN THE DISTRIBUTION OF THE HOUSING STOCK AND THE DISTRIBUTION OF FAMILY INCOME IN MONTERREY, PUEBLA, CHIHUAHUA, MORELIA, MEXICO CITY AND THE NATION DURING 1960-1970

In Chapters IV and V we described a model concerned with the efficient allocation of housing investment. In this chapter we examine the distribution of the housing stock in relation to the distribution of family income during the period 1960-1970. We also want to determine how the optimal allocation of housing investment results in a more equitable distribution of the housing stock.

It has been widely recognized that income is the most important variable on the demand for housing. By analogy, the distribution of the housing stock is expected to be determined chiefly by the distribution of family income. The distribution of income however, is likely to differ from the distribution of the housing stock at any point in time since the housing stock cannot be instantly adjusted to changes in the demand for housing. Nevertheless, the housing stock is expected to be more unequally distributed in the cities which have the highest degree of income inequality.

It has been observed that the distribution of family income becomes more unequal during the early stages of industrialization. We wish to determine whether the distribution of the housing stock becomes even more unequally distributed. Taking the distribution of income as exogenously determined, we will examine how the optimal building strategies proposed in the preceding chapters affect the distribution of the housing stock.

Section 1 compares the degree of inequality of the distribution of family income in relation to the distribution of the housing stock during 1960-1970. Section 2 examines the impact of the optimal building strategies on the distribution of the housing stock.

Section 1. Relationship Between the Distribution of Family Income and the Distribution of the Housing Stock

In the first part of this section we present the trend of income inequality in the five cities and the nation. In the second part, we compare the degree of inequality of the distribution of family income and the housing stock.

6.1. Trends of Income Inequality

It has been observed by Kuznets[1] and others that the economic and social structural changes which occur

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[1] Simon Kuznets, "Economic Growth and Income Inequality," (footnote continued)

during the early phases of industrialization (and urbanization), result in a more unequal distribution of income. First, intrasector income differentials increase as technological innovations are introduced in the industrial (urban) sector, while the relative importance of the agricultural (traditional) sector begins to decline. Secondly, income distribution within the urban sector tends to become more unequal as the wages of skilled workers, administrators, and entrepreneurs increase while the influx of migrants from the rural areas exerts a depressing influence on the level of wages for unskilled workers. Thus, the increasing inequality associated with early stages of industrialization results from a combination of rising intrasectorial and interoccupational income differentials.

Income is expected to become more equally distributed in the later phases of industrialization as productivity in agriculture approaches the level attained in the industrial sector and a larger proportion of the labor force is absorbed into the industrial and service sectors. At the same time, the spread of education tends to reduce

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1 (continued)
American Economic Review, XLV, 1, (March 1955), pages 6-15, Irving B. Kravis, "International Differences in the Distribution of Income," Review of Economics and Statistics, XLII, 4, (November 1960), pages 408-416, and Felix Paukert, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labour Review, (August-September 1973), pages 100-112.

the skills and income differentials within the urban sector. Other factors which work in favor of income equality in mature industrial societies are the increasing organization of the labor force coupled with a slowdown in the rate of population growth, the public ownership of corporations, and the adoption of progressive taxation.

The evidence presented in this section indicates that the path of economic growth followed by Mexico has indeed been accompanied by a trend of increasing income inequality. Family income surveys show the income share of the highest 20 percent income class has been increasing at the expense of the lowest 40 percent income class; whereas, national accounts data show that the share of capital in national income has been increasing during the period of rapid industrialization at the expense of labor. It should be indicated, however, that the real income of the lowest 40 percent income class experiences an absolute decline during 1950-1960, but it experienced an absolute increase during 1960-1969 (see Table VI-1).

Table VI-1 shows how national income was distributed among income classes between 1950 and 1960. It appears that the chief beneficiaries of Mexican economic development have been those families in the 80-95th percentiles (composed of technicians, administrators, and medium scale entrepreneurs) whose income share increased from 21.7

Table VI-1. Relative Shares of Family Income and Trends of Real Income by Income Group, Mexico 1950-1969

Family Percentile Class		Relative Shares (Percent) 1950	1960	1970	Real Income Trends (1950 = 100.0) 1950	1960	1970
Top	20%	51.2	55.3	57.8	100.0	146.5	206.3
Top	5%	29.5	26.5	30.6	100.0	147.1	225.4
Next lower	5%	9.1	11.6	11.6	100.0	147.1	225.4
Next lower	10%	12.6	17.2	15.6	100.0	177.1	207.8
Next lower	20%	18.2	19.6	18.0	100.0	146.9	181.8
Next lower	20%	12.9	12.3	13.4	100.0	129.4	176.5
Lowest	40%	17.7	12.8	10.8	100.0	96.0	109.2
Total	100%	100.0	100.0	100.0	National Average		
					100.0	128.5	179.5

Source: David Felix, "Trickling Down in Mexico and the Debate over Long Term Growth Equity Relationships in the LCDS," (mimeograph), Washington University, 1975, pages 13-16. Original data from Family Income Surveys by Banco de Mexico (see Chapter IV).

percent in 1950 to 27.2 percent in 1969. The top 5 percent (high-level executives, professionals, and large scale entrepreneurs) maintained their income share at around 30 percent. However it is plausible that within the top 5 percent group, income differentials widened between owner-entrepreneurs and salaried personnel since the share of capital increased during the period studied. On the other hand, the lowest 40 percent, composed chiefly of unskilled urban workers and landless peasants, experienced a substantial decline in their income share (from 17.7 percent in 1950, 12.8 percent in 1960, to 10.8 percent in 1969). Thus, industrialization seems to have increased the economic disparity between the lowest 40 percent and the highest 20 percent of the families, although a growing middle class seems to have been incorporated into the modern sector of the economy.

Table VI-1 also shows the trends of real income by income group. Average family income rose 80 percent in real terms during 1950-1969 (at the annual rate of 3.1 percent). The top 20 percent increased their real income by 106 percent during 1950-1969, while the lowest 40 percent experienced a positive but slight increase (9 percent during the same period). It should be noted that real income of the lowest 40 percent of families declined by 4 percent during 1950-1960, a period with a relatively high rate of inflation (around 7 percent per year), while their real income increased by 13 percent during 1960-1969, a period with a relatively low rate of inflation (around 2.5 percent per year). This suggests that inflation in Mexico helped to widen the income differentials between the lowest and the highest income strata.

The functional distribution of national income indicates that the process of industrialization in Mexico has increased the share of capital at the expense of labor. The share of wages and salaries in national income decreased from 37.4 percent in 1950 to 34.3 percent in 1960 to 30.5 percent in 1967, although the proportion of workers and employees in the labor force was increasing. The share of profits and other revenues of capital increased from 61.2 in 1950 (65.7 percent in 1960) to 69.5 percent in 1967. These trends suggest that the existence of an abundant reservoir of labor exerting a depressing influence on the level of wages, allowed the owners of the means of production to capture a portion of gains in productivity,

The protectionist measures and fiscal incentives granted to new industries by the government since 1940 undoubtedly contributed to income redistribution in favor of profits. Manufacturing firms also took advantage of low cost transportation, energy, and other subsidized inputs provided by government enterprises.[2]

Although investment in manufacturing industries might have been accelerated by the net shift of income in favor of profits, this shift increased the income share of the top 20 percent of the families at the expense of a substantial proportion of the population which remained marginalized in the modern sector of the economy.

Table VI-2 shows the trends in the distribution of income measured by the Gini coefficient for the cities

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[2]William E. Cole and Richard D. Sanders, "Income Distribution, Profits, and Savings in the Recent Economic Experience of Mexico," Inter-American Economic Affairs, Autumn 1970), pages 58-59.

Table VI-2. Gini Coefficients of the Income Distribution and Proportion of Households by Income Group

	Monterrey 1960	Monterrey 1970	Puebla 1960	Puebla 1970	Chihuahua 1960	Chihuahua 1970	Morelia 1960	Morelia 1970	Mexico City 1960	Mexico City 1970	Nation 1950	Nation 1960	Nation 1970
Gini Coefficient	.475	.523	.521	.553	.453	.456	.451	.420	.483	.485	.436	.489	.500
Income Groups (1968 pesos)	PROPORTION OF HOUSEHOLDS (PERCENT)												
F0 0-529	8.0	7.2	13.8	10.3	9.8	4.7	23.3	8.9	7.5	2.4	49.0	32.7	17.2
F1 530-1,100	29.5	29.3	33.5	30.7	32.0	23.0	40.1	36.2	28.0	20.3	31.1	32.2	27.6
F2 1,101-2,300	32.5	24.8	27.5	23.2	34.9	40.1	24.8	36.1	30.8	32.9	14.1	18.7	29.4
F3 2,301-4,800	20.1	23.5	15.5	20.8	16.3	22.5	8.1	14.6	20.6	26.4	3.9	11.7	18.4
F4 4,801-10,000	7.1	10.4	6.8	9.8	4.8	6.7	2.6	2.8	9.0	12.6	1.5	3.6	5.4
F5 10,001 or more	2.8	4.8	2.9	5.2	2.2	3.0	1.1	1.4	4.1	5.4	0.4	1.1	2.0

Note: The Gini coefficients were computed with the following formula:

$$G = 1 - \sum_{i=1}^{K} fi\ (Yi - 1 + Yi)$$

where: G = Gini coefficient, K = number of income classes, fi = proportion of households within income group i, Yi = proportion of income received by income group i

under consideration and in the nation as a whole.

It should be indicated that the Gini coefficient is a relative measure of the level of inequality. It does not indicate, for instance, if the income of the lowest stratum experiences an absolute increase (or decline) throughout time, but rather it measures the relative differences in the proportion of income earned by each income group. Unlike other measures of inequality whose values are not normalized, the Gini coefficient varies from 0 for perfect equality to 1 for perfect inequality. A disadvantage of the Gini coefficient is that it attaches more weight to transfers of income to middle income strata[3] and it is not sensitive to small percentage transfers of income to the lowest income group.

Table VI-2 shows that the distribution of family income measured by the Gini coefficient became more unequal for the nation as a whole during 1950-1970. The Gini coefficient for Mexico rose from .436 in 1950 to .489 in 1960 to .500 in 1970. These Gini Coefficients are within the range estimated for other Latin American countries which have followed similar paths of industrialization[4]: Argentina -- .420 (1961), Brazil --

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[3]Anthony B. Atkinson, "On the Measurement of Inequality," Journal of Economic Theory, September 1970, page 257.

[4]Felix Paukert, *op. cit.*, page 115.

.560 (1960), and Colombia -- .620 (1964). The level of income inequality tends to be lower in developed countries such as the United Kingdom with .380 (1964), Sweden with .390 (1963), and the United States with .470 (1935), .450 (1941), and .340 (1969). On the other hand, the level of inequality in Mexico and other Latin American countries is higher than in some backward African countries whose Gini coefficient is around .300. This information is consistent with the hypothesis that the level of income inequality increases in the early phases of industrialization and then decreases in later phases.

Table VI-2 also shows that the level of income inequality is higher in the relatively large industrial cities of Monterrey, Puebla, and Mexico City than in the smaller cities of Morelia and Chihuahua. The higher level of inequality in the large industrial cities reflects the constant influx of unskilled migrants who are not able to find employment in the modern sector and the concentration of income in the highest strata, whereas in traditional agriculture-oriented cities there is a smaller degree of occupational and income differentiation. For instance, in 1970 the Gini coefficient for Monterrey was .523 as the top 20 percent of the families received 62 percent of total income while the lowest 40 percent of families received 12 percent of total income. The level of income inequality was lower in the traditional city of Morelia (the 1970 Gini was .420). Here the top 20 percent received 52 percent of total income, while the lowest 40 percent obtained 18 percent of total income.

The Gini coefficients shown in Table VI-2 also indicate that distribution of income became clearly more unequal in Monterrey and Puebla, while it remained approximately the same in Chihuahua and Mexico City (but this might be due to the fact that the data excludes the outer section of the city, where an ever-increasing number of poor migrants locate) and it became more equal in Morelia. For instance, the Gini coefficient declined from .457 in 1960 to .420 in Morelia in 1970 as the proportion of poor families (F0, F1) declined substantially (from 63.4 percent in 1960 to 45.1 percent in 1970) and the proportion of high income families (F4, F5) increased only slightly (from 3.7 to 4.2 percent).

On the other hand, the level of inequality increased in Monterrey (the Gini rose from .475 in 1960 to .523 in 1970) as migration contributed to a net increase in the number of poor families (F0, F1) (whereas their proportion declined slightly from 37.5 percent to 36.5 percent) while the proportion of high income families (F4 and F5) increased from 9.9 percent to 15.2 percent. It appears that in the industrial cities the growing demand for administrators, high-level technicians, and professionals allows an increasing proportion of the middle class to move upward in the income scale while the influx of migrants reduces the average social mobility of the lowest income group.

In the next section we will examine whether the observed trends of increasing income inequality are translated into the distribution of the housing stock.

6.2. Relationship Between the Distribuition of Income and the Housing Stock

The purpose of this section is to compare the degree of inequality in the distribution of the housing stock with the distribution of family income. We want to determine whether the observed trends of income inequality are accompanied by an increasing inequality in the distribution of the housing stock.

In order to calculate the degree of inequality in the distribution of the housing stock, we use the housing typology described in Chapter IV to estimate the number of dwellings of each type. Using the census information for physical characteristics of the housing stock, we distinguished six dwelling types according to number of rooms, type of construction materials, and type of utilities available. The dwelling types range from the one-room adobe shack (H1) to the luxury residence with eight or more rooms (H5).

Since the census does not provide any information on dwelling values we use the cost data reported in various studies as the range for each dwelling type (Chapter IV). We estimate that dwelling values (excluding land costs) represent eighty monthly payments (land costs account for twenty additional monthly payments) assuming that households spend 22.5 percent of their monthly income on housing. The dwelling values used to calculate the Gini coefficients shown in Table VI-3 are estimated for three different coefficients of income elasticity of the demand for housing (E_{hy}). i) $E_{hy} = 1.0$, in which case households at all levels of income spend 22.5 percent of their income on housing, ii) $E_{hy} = 1.16$,[5] in which case the proportion of income spent on housing increases from 17.5 percent for the lowest income group (F0) to 25.6 percent for the highest income group (F5), iii) $E_{hy} = .86$,[6] in which case the proportion of income spent on housing decreases from 25.6 percent for F1's to 17.5 percent for F5's. We use the three measures of income elasticity of the demand for housing to obtain the range of Gini coefficients within which the actual coefficient lies. Nevertheless, all the evidence available[7]

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[5]If Rhy = 1.16, the proportion of income spent on housing is .175 for F0, .189 for F1, .204 for F2, .220 for F3, .237 for F4, and .256 for F5.

[6]If Ehy = .86, the proportion of income spent on housing is .256 for F0, .237 for F1, .220 for F2, .204 for F3, .189 for F4, and .175 for F5.

[7]The family budget surveys undertaken by the Banco de Mexico in 1963 and 1968 (see Chapter IV) and the data collected in the city of Chihuahua (Chapter III) indicates that the coefficient of income elasticity is close to 1.0.

Table VI-3. Gini Coefficients of the Housing Stock and Family Income Distributions. Proportion of Dwellings and Households in Each Category

(Ehy = Income Elasticity of Demand for Housing)

	Monterrey		Puebla		Chihuahua		Morelia		Mexico City		Nation	
	1960	1970	1960	1970	1960	1970	1960	1970	1960	1970	1960	1970
Gini Income	.475	.523	.521	.553	.453	.456	.451	.420	.483	.485	.489	.500
Gini Housing; Ehy = 1.00	.484	.541	.547	.562	.450	.475	.472	.463	.523	.547	.480	.514
Gini Housing; Ehy = 1.16	.534	.588	.597	.608	.500	.523	.527	.515	.569	.591	.532	.545
Gini Housing; Ehy = .86	.432	.509	.495	.509	.401	.428	.417	.412	.476	.500	.428	.460
PROPORTION OF HOUSEHOLDS (Fi) AND DWELLINGS (Hi) IN EACH CATEGORY (IN PERCENT)												
F0 + F1 Households	37.5	36.5	47.3	41.0	41.8	27.7	63.4	45.1	35.5	22.7	64.9	44.8
H0 + H1 Dwellings	57.8	53.6	60.1	58.0	58.1	46.8	74.5	61.5	54.6	46.5	80.0	69.0
F2 Households	32.5	24.8	27.5	23.2	34.9	40.1	24.8	36.1	30.8	32.9	18.7	29.4
H2 Dwellings	23.8	21.1	20.8	18.0	25.8	29.1	14.3	22.6	22.6	24.0	10.1	15.1
F3 Households	20.1	23.5	15.5	20.8	16.3	22.5	8.1	14.6	20.6	26.4	11.7	18.4
H3 Dwellings	12.6	14.7	11.4	13.6	11.2	17.0	8.2	11.8	13.2	15.6	6.6	11.1
F4 + F5 Households	9.9	15.2	9.7	15.0	7.0	9.7	3.7	4.2	13.1	18.0	4.7	7.4
H4 + H5 Dwellings	5.7	10.6	7.7	10.4	4.9	7.1	3.0	4.1	9.6	13.9	3.3	4.8

Note: The proportion of dwellings and households in each category are calculated from the data shown in Tables IV-6 to IV-15 of Chapter IV.

indicates that the income elasticity of the demand for housing is not significantly different from 1.0.

The Gini coefficients shown in Table VI-3 indicate the following patterns:

i) In all cities studied the housing stock shows a greater dispersion than does family income, assuming that the coefficient of income elasticity is equal or greater than 1.0. If the coefficient of income elasticity is .86, the degree of inequality of the distribution of the housing stock is lower in most cases than it is for the distribution of income. However, as previously mentioned, all of the evidence available indicates that the coefficient of income elasticity is close to 1.0 which means that an increase in family income is accompanied by a proportionate increase in the quantity of housing demanded.

ii) In the relatively large industrial cities of Monterrey, Puebla, and Mexico City which have the highest degree of income inequality, the housing stock has more unequal characteristics than in the smaller agriculturally-oriented cities of Chihuahua and Morelia.

iii) The degree of inequality of the housing stock increased during the period 1960-1970 in all cities where the distribution of income became more unequal while it decreased slightly in Morelia, which also experienced a reduction in the degree of income inequality.

In Table VI-3 we can examine the difference in the degree of inequality of the housing stock and family income distributions by comparing the proportion of households with the proportion of dwellings in each category. The Gini coefficients for the housing stock and family income distributions would be the same under the assumption of unitary income elasticity if the proportion of dwellings of each type were equal to the proportion of households in each income group. However we can see in Table VI-3 that in all cities studied, the proportion of lower-middle to high income families (F2-F5) exceeds the proportion of lower-middle to higher quality dwellings (H2-H5). Since the increase in the number of families in the F2-F5 range exceeded the number of dwellings built in the organized housing sector (H2-H5) during 1960-1970, a proportion of high income families had to bid away middle quality dwellings from middle income families. In turn, middle income families had to settle for low quality dwellings. At the same time, a proportion of low income families who had moved up in the income scale remained in low quality dwellings. Thus in all cities the proportion of low quality dwellings (H0-H1) exceeds the proportion of low income families (F0-F1). The more than proportional concentration of low quality dwellings (H0-H1) coupled with a less than proportional concentration of middle quality dwellings (H2-H3) is reflected in a relatively higher coefficient of inequality (Gini) for the distribution of the housing stock.

It is recalled that the housing stock is allocated among income groups under the assumption that the highest income families obtain the best dwellings available (see stock-user matrices in Chapter IV), whereas successive lower income families occupy the remaining dwellings. Although, in general this seems to be a plausible assumption, it is possible that a small number of high income families choose to occupy middle quality dwellings while some lower income families might occupy higher quality units.

Table VI-3 shows that the decline in the relative number of low income families (F0-F1) was accompanied by a less than proportional decline in the relative number of low quality dwellings (H0-H1) in all cities with the exception of Monterrey (where the relative number of low income families remained almost unchanged as their absolute number increased through a large influx of migrants). The proportion of low quality dwellings could have been further reduced if a net number of higher quality dwellings had filtered down to the lowest income groups. However, we found in the filtering survey in Chihuahua (Chapter III) and in the stock-user matrices in Chapter IV that housing shortages in the organized housing sector prevented the net transfer of dwellings to the lowest income groups.

Alternatively, the proportion of low quality dwellings could have been reduced further if a larger number had been upgraded through the provision of public services and use of better construction materials. However, investment in urban infrastructure which is undertaken by local governments, was apparently insufficient to satisfy the growing demand for public services. In Section 6.3 we will see that the housing stock becomes more equally distributed under the optimal building strategies as old, but adequate dwellings (H2) filter down to low income families (F0-F1). This leads to a substantial reduction in the proportion of temporary and substandard dwellings (H0-H1).

The Gini coefficients shown in Table VI-3 indicate that in the relatively large industrial cities of Monterrey and Puebla the housing stock became more unequally distributed during 1960-1970 (the Gini for housing under Ehy = 1, increased from .484 and .547 in 1960 to .541 and .562 in 1970 respectively) as the level of income inequality increased from .475 and .521 to .569 and .585, respectively. However, in the traditional city of Morelia, the Gini coefficient estimated for the distribution of the housing stock declined slightly (from .472 in 1960 to .463 in 1970) despite the greater reduction in the level of income inequality (the Gini decreased from .451 to .420). Finally it should be noted that in the medium-sized city of Chihuahua and in Mexico City (which excludes the outer sections of the city) the level of income inequality remained unchanged while the distribution of the housing stock became slightly more unequal during 1960-1970. These trends in the level of inequality can be explained by examining Table VI-4 which shows the changes in the number of households and dwellings in each category.

Table VI-4. Changes in the Number of Households and Dwellings in Each Category During 1960-1970 and Gini Coefficients

Income and Dwelling Category	Increase (Decrease) in the Number of Households and Dwellings during 1960-1970 (Percentage Change from 1960 to 1970)					
	Monterrey	Puebla	Chihuahua	Morelia	Mexico City	Nation
F0	24.2	35.4	(-32.2)	(-47.3)	(-56.7)	(-32.0)
H0	35.1	44.1	14.4	(-7.8)	12.7	(-6.8)
F1	37.1	66.3	1.7	24.2	(-2.0)	10.9
H1	20.5	128.1	13.3	50.3	18.2	53.6
F2	5.3	53.1	62.6	101.0	44.4	103.3
H2	22.2	57.3	59.3	118.8	43.9	94.0
F3	61.4	143.5	95.1	148.9	73.2	103.3
H3	61.5	116.1	114.6	98.1	58.8	115.6
F4	102.2	161.5	97.2	48.7	89.3	93.9
H4	160.1	152.6	107.9	91.9	96.8	87.5
F5	136.5	225.2	93.5	75.7	78.0	135.1
H5	139.2	129.2	105.0	86.3	93.1	90.5

	Gini Coefficients											
	1960	1970	1960	1970	1960	1970	1960	1970	1960	1970	1960	1970
Gini Income	.475	.523	.521	.553	.453	.456	.451	.420	.483	.485	.489	.500
Gini Housing (Ehy = 1)	.484	.541	.547	.562	.450	.475	.472	.463	.523	.547	.480	.514

The trends in the level of inequality shown in Table VI-4 can be summarized as follows:

i) The level of income inequality increased significantly in the industrial cities of Monterrey and Puebla as migration led to an increase in the number of families in the lowest income group (F0), while a relatively large number of middle income families moves up to the highest income strata (F4, F5). In these two cities the distribution of the housing stock clearly became more unequal as the number of temporary (H0) dwellings increased even more rapidly than the number of families in the lowest income group (F0). As previously mentioned, the insufficient number of dwellings built in the organized housing sector (H2-H5) resulted in a proportion of lower-middle income families (F2) occupying substandard dwellings (H1). F1 families in turn had to settle for temporary dwellings (H0). It should be indicated that although in Monterrey and other cities the number of new F4 and F5 families exceeded the number of H4 and H5 dwellings added, the latter increased at a faster rate than the former.

ii) The level of income inequality declined in the traditional city of Morelia as the reduction in the number of low income (F0) families (their number declined by 47.3 percent) was accompanied by a large increase in the number of middle class families (F3) (their number increased by 148.9 percent). In contrast, the level of inequality of the distribution of the housing stock declined slightly (from .472 in 1960 to .463 in 1970) as the increase in the number of middle quality dwellings (H3) did not increase as rapidly as the number of middle income families (F3), while the small decline in the number of temporary dwellings (H0) was accompanied by a large increase in the number of high quality dwellings (H4, H5). It should be pointed out that in cities other than Morelia the number of temporary dwellings (H0) increased during 1960-1970 which is reflected in an increasingly higher Gini coefficient for the distribution of the housing stock.

iii) In the medium-sized city of Chihuahua the level of income inequality remained statistically unchanged as the number of low income families (F0) declined while the number of high income families (F4, F5) increased faster than the number of middle income families (F3). The housing stock however, became more unequally distributed during the period as the number of temporary (H0) dwellings continue to increase because the insufficient number of dwellings built in the organized housing sector (H2-H5) obliged F2 families to occupy H1 dwellings which in turn force F1's to occupy H0's. The same pattern is observed in Mexico City, but this may be due to the fact that the data excludes the outer parts of the city where most of the recent migrants have established slum settlements.

The trends described above indicate that the housing stock became more unequally distributed during 1960-1970 in those cities where the level of income inequality increased. Even in those cities in which the level of income inequality remained statistically unchanged, the housing stock became slightly more unequal during 1960-1970 as the number of temporary (H0) dwellings continued to increase. This suggests that the distribution of the housing stock cannot be easily adjusted within the ten year period in accordance with the changes in the distribution of families by income level. Given the high fixed costs of housing and the rapid changes in the distribution of family income, it would require relatively larger amounts of investment in residential construction in order to equate the actual with the desired distribution of the housing stock ina ten year period. This is illustrated in Table VI-5.

<u>The Housing Stock Distribution under the Hypothetical Case of Perfect Income Equality</u>

In Table VI-5 we show the Gini coefficients of the distribution of the housing stock for a city like Monterrey, assuming that in 1970 all families are members of the middle (F3) income group. The purpose of these calculations is to show that even under the hypothetical case of perfect equality in the distribution of family income, housing stock would still be unequally distributed at the end of ten and twenty five year periods unless relatively high shares of Gross City Product were invested in residential construction.

The hypothetical cases shown in Table VI-5 seek to answer two types of questions. First, how long does it take in order to equate the actual to the desired housing stock distribution, assuming perfect income equality? Secondly, we ask how much investment (as a share of Gross City Product) is required in order to equate the actual to the desired housing stock distribution, assuming perfect income equality.

Table VI-5. Hypothetical Gini Coefficients of the Housing Stock and Family Income Distributions for Monterrey, 1970 and 1985

Actual Gini Income in 1960 = .475, Actual Gini Housing (Ehy = 1.0) in 1960 = .510, Hypothetical Gini Income in 1970 = .000, Hypothetical Gini Income in 1985 = .000

1960-1970			1960-1985		
Population Growth Rate (Percent)	Investment Share (% of GCP)	1970 Gini Housing (Ehy=1)	Population Growth Rate (Percent)	Investment Share (% of GCP)	1985 Gini Housing (Ehy=1)
0.00	3.5	.245	0.00	3.5	.033
0.00	4.5	.196	0.00	4.0	.000
0.00	8.9	.000			
4.65	3.5	.380	4.65	3.5	.382
4.65	4.5	.344	4.65	4.5	.307
4.65	12.3	.000	4.65	7.7	.000
5.40	3.5	.392	5.40	3.5	.399
5.40	4.5	.358	5.40	4.5	.334
5.40	12.8	.000	5.40	8.2	.000

The Gini coefficients shown in Table VI-5 are calculated under the assumption that all families are members of the middle income group (F3) by 1970 and 1985 and that only middle quality (H3) dwellings are built during 1960-1970 and 1960-1985. It is shown that even with no population growth and perfect equality in the distribution of familiy income (Gini = .000), the housing stock would still be unequally distributed unless 8.9 percent of GCP is invested on residential construction. This investment share is more than double the actual share (4.1 percent) during 1960-1970 in Monterrey. It is only after twenty five years of building exclusively middle quality (H3) dwellings and having no population growth that the housing stock would be equally distributed (Gini = .000) with an investment share (4.0 percent of GCP) similar to the share actually invested (4.1 percent of GCP) during 1960-1970. Finally we can see in Table VI-5, that for higher population growth rates, larger amounts of investment on residential construction would be required to achieve perfect equality in the distribution of the housing stock.

The trends of inequality observed in the industrial cities of Mexico during 1960-1970 suggest that the housing stock will become more unequally distributed as the level of income inequality continues to increase. However, based on the calculations shown in Table VI-5, it is expected that reductions in the level of income inequality will not produce in the next two or three decades, a significant decline in the degree of inequality of the housing stock distribution.

6.3. Impact of the Optimal Building Strategies on the Distribution of the Housing Stock

In this section we examine the influence of the optimal building strategies (described in Chapter IV) on the distribution of the housing stock.

It is recalled that the proposed building strategies were based on the type of dwelling whose construction maximizes the combined amount of downward filtering and new construction. In Table VI-6 we show the effect of two building strategies on the distribution of the housing stock as measured by the Gini coefficients. Strategy IV maximizes the sum of downward filtering and new construction, subject to an investment constraint which represents 4.5 percent of Gross City Product (or GNP for the nation). The investment constraint under Strategy IVf is applied to the entire organized housing sector (H2-H5), Strategy VI excludes the highest income group (F5) from the objective function and the investment constraint (4.5 percent of GCP). Under Strategy VI, wealthy families are assumed to build (outside the investment constraint) the same number of luxury dwellings as were actually built during 1960-1970. Since the building strategies are assumed to be financially solvent, both Strategies IV and VI exclude the lowest income groups (F0, Fl) who cannot obtain and repay home loans. The lowest income groups (F0, Fl) however, indirectly benefit from the building strategies since they receive some adequate old dwellings from the organized housing sector through downward filtering.

Table VI-6. Gini Coefficints of the Distribution of the Housing Stock Under the Optimal Building Strategies (Assuming Ehy = 1.0)

	Monterrey	Puebla	Chihuahua	Morelia	Mexico City	Nation
Actual Gini Income 1960	.475	.521	.453	.451	.483	.489
Actual Gini Income 1970	.523	.553	.456	.420	.485	.500
Actual Gini Housing 1960	.484	.547	.450	.472	.523	.480
Actual Gini Housing 1970	.541	.562	.475	.463	.547	.514
Hypothetical Gini Housing 1970 for Strategy IV (optimal building strategy, 4.5% of GCP)	.314	.357	.247	.305	.300	.290
Hypothetical Gini Housing 1970 for Strategy VI (no investment constraint for F5, 4.5% of GCP)	.383	.427	.295	.335	.349	.327

Table VI-6 shows that the proposed building strategies could have reduced the level of inequality of the housing stock distribution registered in 1960 and 1970 in all cities studied. Strategy IV (optimal building strategy) results in the lowest Gini coefficient since it maximized the objective function by allocating the entire investment constraint in the construction of minimum (D2) and medium (D3) quality dwellings (see Chapter IV, pages 91-94). Under the proposed building strategies, the housing stock becomes more equally distributed as the construction of minimum (D2) and medium (D3) quality dwellings results in a net transfer of old minimum quality dwellings (H2) to the lowest income groups (F0, F1). This in turn enables low income families (F0, F1) to abandon a substantial proportion of temporary (H0) shacks. Since wealthy families are allowed to build luxury (D5) dwellings outside the investment constraint under Strategy VI (no investment constraint for F5), the level of inequality is higher for this strategy than for Strategy IV (optimal building strategy). Nevertheless, Strategy VI (no investment constraint for F5) could have significantly reduced the degree of inequality of the housing stock distribution.

Finally, it should be noted in Table VI-6 that under the proposed building strategies the degree of inequality of the housing stock is higher (especially under Strategy VI) in the large industrial cities of Monterrey and Puebla which have a higher degree of income inequality than Morelia and Chihuahua.

Summary

The economic and social structural changes which occur during the early phases of industrialization in Mexico have resulted in a more unequal distribution of income. The level of income inequality increased significantly in the large industrial cities (Monterrey and Puebla) as migration led to an increase in the number of families in the lowest income group while the concentration of income was accentuated in the highest strata during 1960-1970. In contrast, the level of income inequality declined in the traditional city of Morelia as the decline in the number of low income families was accompanied by a large increase in the number of families in the middle strata.

The housing stock was found to be more unequally distributed than family income in all cities studied and in the nation as a whole. This is due to the fact that the proportion of low quality dwellings exceeds the proportion of low income dwellings as the insufficient number of dwellings built in the organized sector induces lower-middle income families (F2) to occupy low quality dwellings (H0, H1). On the other hand, the gap between the proportion of high income families (F4, F5) and high quality dwellings (H4, H5) was reduced in most cases during 1960-1970.

The housing stock became more unequally distributed as the level of income inequality increased during 1960-

1970. However, in the cities where the level of income inequality remained unchanged, the level of inequality of the housing stock distribution continued to increase. The durable nature of housing implies that once a pattern of inequality is established, it takes a long time before such a trend can be reversed by a decline in the degree of income inequality.

Finally we saw that under the building strategies proposed in Chapter IV, the level of inequality of the housing stock could have been reduced significantly during 1960-1970. The reduction in the level of inequality under the proposed building strategies is achieved by concentrating the building activity in minimum and medium quality dwellings. This in turn leads to a decline in the proportion of low quality dwellings as higher quality dwellings are filtered down to the lowest income groups.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Although the over-all quality of the housing stock in Mexico has improved through time, there is still a substantial proportion of dwellings which do not meet minimum structural and sanitary standards. In addition, we found that the gap between family formation and housing construction has resulted in housing shortages at all levels of income. The total housing deficit (qualitative and quantitative) for 1970 is estimated conservatively at 4 million dwellings which represents half of the existing housing stock in 1970.

Due to population growth and replacement requirements for the period 1970-1985, the housing needs are estimated at 8.5 million dwellings. In order to eliminate the 1970 housing deficit and satisfy the housing needs d-ring 1970-1985, Mexico will have to build about 800,000 dwellings per year. This amount of housing construction represents about four times the number actually built during 1960-1970.

Given the magnitude of the housing problem and the limited amount of resources available, it is urgent for Mexico to implement a housing investment strategy which results in the amelioration of the housing conditions of the maximum number of families. The chief objective of this study was to design and apply a model for optimal allocation of housing investment. The model was applied to five Mexican cities and the nation as a whole for the periods 1960-1970 and 1970-1985.

The investment strategies proposed in the model seek to take advantage of the transfer or filtering effects initiated by new construction. Dwellings filter down when they are transferred to households whose income is lower than the income of the previous occupants. In contrast, dwellings filter up when they are transferred from low to higher income families. Thus, we had to determine the importance and the characteristics of the filtering process in Mexico.

We used two methods to study the filtering process in Mexico. First, we undertook a vacancy chain survey in the city of Chihuahua in 1975. Secondly, using stock-user matrices, we examined the changes in the allocation of the entire housing stock by income group from 1960 to 1970 in five cities and the nation as a whole.

The filtering survey in Chihuahua followed the chains of moves initiated when new dwellings were occupied by families who vacated their homes which were then available for other occupants. Chains of moves can also be initiated by the disappearance of family units (through emigration and death). However, we restricted the survey to those chains of moves initiated by new construction since this is the only source of filtering which can be influenced by public policy.

The chief findings of the filtering survey were:

i) The average length of the chains of moves was 2.13 which means that for each dwelling built, there were approximately two households who improved their housing conditions.

ii) Dwellings were filtered down on the average from high to lower income families. However the level of income reached by the chains of moves was above the income earned by approximately fifty percent of the families in Chihuahua. This suggests that housing shortages of middle and minimum quality dwellings reduces -- or even eliminates-- the number of dwellings that can be filtered down to the lowest income strata.

iii) Dwellings in the middle value range initiated the longest chains of moves. Thus the construction of middle value dwellings would benefit the largest number of families. However, the construction of the least expensive dwellings would result in the lowest cost per dwelling filtered and built.

We also used the data collected in the city of Chihuahua to determine the influence of several variables

on the demand for housing through single and multiple regression techniques. Family income was found to be the most important variable on the demand for housing. The level of education and downpaymnet requirements were found to exert some influence on the demand for housing when income was excluded from the regressions. The age of household head and family size were statistically unrelated to housing consumption. This does not mean however that family size should not be taken into account in a housing program. It only suggests that large families for instance, are not willing or able to spend more on housing than a smaller family of the same income level.

The filtering survey in the city of Chihuahua registered the household moves in a period of two months. During this period 93 percent of the chains of moves were completed. This relatively high turnover rate suggests the existence of a relatively large unsatisfied demand for housing. The filtering survey showed that there was a net downward filtering trend in Chihuahua during the period in which the survey was taken. This type of survey, however, does not detect patterns of upward filtering which occur when dwellings are permanently occupied by families whose incomes have increased through time. This last form of upward filtering was studied by examining the changes in the stock-user matrices from 1960-1970.

We studied the allocation of the housing stock among income groups during 1960-1970 using the stock-user matrices which were constructed with data from the housing censuses and family income surveys. The stock-user matrices classify households by level of income in the rows and type of dwellings in the columns.

The stock-user matrices showed the following patterns:

i) We observed in all cities under consideration that a proportion of households at all levels of income were located to the left of the matrix diagonal which suggests that they were consuming less than the optimum or desired level of housing services. Although some families may have *chosen* to consume less than the optimum level of housing, it is more likely that housing shortages *induced* a proportion of families at all levels of income to consume less than the optimum or desired level of housing services.

ii) The gap between family formation and housing construction during 1960-1970 resulted in a decline in the over-all housing conditions as measured by the proportion of households living in inadequate dwellings for their level of income. The housing conditions of low income families worsened since they had to compete with higher income families for a limited number of dwellings. At the same time, a proportion of middle and upper income families had to remain in the same dwellings even though they had risen in the income scale. This form of upward filtering, observed in all cities, reduced the possibilities for low income families to improve their housing conditions through the filtering process.

iii) The housing conditions, measured by an index of housing adequacy, were found to be worse in the large industrial cities of Monterrey, Puebla, and Mexico City than in the smaller cities of Morelia and Chihuahua. In the industrial cities the influx of migrants resulted in increasingly worse housing shortages at the bottom of the income scale.

iv) In the industrial cities which have the highest degree of income inequality as measured by the Gini coefficient, the housing stock is more unequally distributed than in the smaller cities.

The model applied to five Mexican cities and the nation seeks to improve the quality of the existing housing stock and to reduce the observed housing shortages. This goal is accomplished when the number of old dwellings transferred downwards and the number of dwellings built is maximized subject to an investment constraint. Thus, the objective function of the model is to determine the type and volume of dwellings whose construction maximizes the combined amount of downward filtering and new construction. The impact of the optimal building strategy on the allocation of the housing stock by income groups is then evaluated through the changed stock-user matrix as measured by an index of adequacy.

Since the proposed building strategies are assumed to be financially solvent, we restricted the allocation of new dwellings to those families who have the capacity to repay home loans (i.e., those families who earn above 1,100 pesos per month, which is approximately the minimum legal wage -- 1968 pesos). Lower income families however, benefit indirectly from the building strategies to the extent that they can move into old but adequate dwellings which are filtered downwards.

The results of the housing investment strategies derived from the model follow,

i) The over-all housing conditions could have been improved significantly, using the same amount of investment actually spent on residential construction during 1960-1970 by allocating the entire investment to the construction of minimum and medium quality dwellings in the relatively rich industrial cities and to minimum quality dwellings in the smaller cities.

The optimal building strategy would have improved the over-all housing conditions by combining downward filtering from the lower-middle to the lowest income groups and upward filtering from the middle to higher income groups. This strategy would have enabled a substantial proportion of poor families to move into higher quality dwellings which filtered downwards.

ii) The optimal combination of dwellings to be built cannot be determined a priori, but depends on the relative size of each income group which varies through time, according to rates of population and income growth. For instance, in the relatively rich industrial cities the objective function would have been maximized by building exclusively minimum and medium quality dwellings during 1960-1970. In these cities, the objective function would be maximized by building all dwelling types, except the highest quality during 1970-1985.

iii) High income families would eventually bid away most of the medium quality dwellings built under the optimal building strategy. Thus, a second best but more realistic strategy is to allow high income families to build luxury dwellings with their own liquid assets. On the other hand, the average quality of dwellings built under the optimal building strategy can be increased through time as the average family rises in the income scale.

The implementation of the proposed building strategies would require the financial institutions to channel an increasingly larger amount of resources for residential construction but a reasonable and possibly constant share of national product. The new housing agency, INFONAVIT, whose resources are provided by a five percent payroll tax, would be able to provide long term financing without downpayment requirements to lower-middle income families, who in the past were not able to obtain home loans.

The model can be used to determine the optimal combination of dwellings to be built, to identify the income groups involved in the filtering process and to estimate the amount of investment requried to attain particular goals. The model however, does not take into account the location of dwellings to be built. The location of dwellings will be determined chiefly by the availability and cost of land and public services and the accessibility to employment, educational, and recreational centers.

We have also ignored the processes of upgrading and conversion. Research is needed to determine how housing shortages and rising land values induce the conversion or partition of dwellings. We also need information on the methods and costs of upgrading temporary and substandard dwellings into higher quality dwellings. The rates and costs of converting and upgrading dwellings can then be incorporated into the model.

The methodology presented in this study can be used in any country to determine the impact of new construction on the allocation of the entire housing stock. The new housing agency -- INFONAVIT -- in particular, could use the model to evaluate alternative building programs for each city in Mexico.

BIBLIOGRAPHY

BIBLIOGRAPHY

Alvarado, Ricardo, Mexico: Proyeccion de la Poblaci6n Total, 1960-2000 y de la Población Economicamente Activa, 1960-1985, Celade, Series C, No. 114, June 1969.

Atkinson, Anthony B., "On the Measurement of Inequality," Journal of Economic Theory, September, 1970.

Araud, Christian, "Direct and Indirect Employment in the Mexican Housing Industry," Studies on Employment in the Mexican Housing Industry, OECD, Paris, 1973.

Banco de Mexico, S.A., Cuentas Nacionales y Acervos de Capital, Consolidada, y por Tipo de Actividad Economica 1950-1967, Mexico, D.F, 1969.

________, La Distribucion del Ingreso en Mexico, Encuesta Sobre los Ingresos y Gastos de las Familias, 1968, Mexico, D.F., 1974.

________, Vivienda de Interes Social, IX Convencion Pan Americana de Ingenieros, Mexico, D.F., 1966.

City of Detroit Mayor's Committee for Community Renewal, "Housing Turnover and Filtering," Research Report No. 18, July 1971.

Cole, William E. and Sanders, Richard D., "Income Distribution, Profits, and Savings in the Recent Economic Experience of Mexico," Inter-American Economic Affairs, Autumn 1970.

Direccion General de Estadistica, V, VI, VII, VIII and IX Censo General de Población, 1930, 1940, 1950, 1960 and 1970, Mexico, D.F., 1932, 1942, 1952, 1962 and 1972.

Fisher, E.M. and Winnick, Louis, "A Reformulation of the Filtering Concept," Journal of Social Issues, Vol, VII, 1951.

Ferchiou, Ridha, New Construction, Subsidies, and Filtering of Dwellings in Tunisia: A Vacancy-Chain and Linear Programming Analysis, dissertation, Michigan State University, East Lansing, Michigan, 1975.

Frankenhoff, Charles, "A Popular Housing Policy," Land Economics, August 1973.

Gelfand, Jack E., "Mortgage Credit and Lower-Middle Income Housing Demand," Land Economics, May 1970.

Germidis, Dimitrios A., The Construction Industry in Mexico, OECD, Paris, 1972.

Herbolzheimer, E.O., Cross Section Analysis for Housing Demand in Venezuela, dissertation, Michigan State University, East Lansing, Michigan, 1972.

Instituto Nacional de la Vivienda, "La Habitacion Rural," Mexico, D.F., Octubre 1969.

Kain, John F. and Quigley, John M., "Measuring the Value of Housing Quality," Journal of the American Statistical Association, June 1970.

Kravis, Irving B., "International Differences in the Distribution of Income," Review of Economics and Statistics, November 1960.

Kristof, Frank S., "Housing Policy Goals and the Turnover of Housing," Journal of the American Institute of Planners, August 1965.

Kuznets, Simon, "Economic Growth and Income Inequality," American Economic Review, March 1955.

Lansing, J.B., Clifton, C.W. and Morgan, J.N., New Homes and Poor People, A Study of Chains of Moves, I.S.R., Ann Arbor, Michigan, 1969.

Leon Lopez, Enrique G., "La Educacion Tecnica Superior," El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, D.F., 1970.

Lee, Tong Hun, "Demand for Housing: A Cross Sectional Analysis," Review of Economics and Statistics, May 1963.

Lowry, Ira S., "Filtering and Housing Standards: A Conceptual Analysis," Land Economics, November 1960.

Martinez, Almazan Raul, La Vivienda Campesina en el Estado de Mexico, Gobierno Estado de Mexico, Toluca, 1973.

Morgan, James N., "Housing and Ability to Pay," Econometrics, April 1965.

Muth, Richard F., "The Demand for Nonfarm Housing," The Demand for Durable Goods, A.C. Harberger, University of Chicago Press, Chicago, Illinois, 1960.

Navarrete, Ifigenia, "La Distribucion del Ingreso Mexico; Tendencias y Perspectivas," El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, D.F., 1970.

Oksanen, Ernest H., "Housing Demand in Canada, 1947 to 1962: Some Preliminary Experimentation," Canadian Journal of Economics and Political Science, August 1966.

Oldman, Oliver, Aaron, Henry, J., Bird, Richard M. and Kass, Stephen, Financing Urban Development in Mexico City, Harvard University Press, 1967.

Paukert, Felix, "Income Distribution at Different Levels of Development: A Survey of Evidence," International Labour Review, August-September 1973.

Prentice, Charles, forthcoming dissertation, University of Wisconsin.

Puente Leyva, Jesus, Distribucion del Ingreso en un Area Urbana: El Caso de Monterrey, Ed. Siglo XXI, Mexico, D.F., 1969.

________, "El Problema Habitacional," El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, D.F., 1970.

Reid, Margaret C., Housing and Income, University of Chicago, Chicago, Illinois, 1962.

Secretaria de Industria y Comercio, Ingresos y Egresos de las Familias de la Republica Mexicana 1969-1970, Mexico, D.F., 1971.

________, Las 16 Ciudades Principales de la Republica Mexicana: Ingresos y Egresos Familiares, Mexico, D.F., 1962.

Smith, Wallace F., "Filtering and Neighborhood Change," Research Report No. 24, Center for Real Estate and Urban Economics, Institute of Urban and Regional Development, University of California Press, Berkeley, 1964.

Stern, Claudio, "Migracion, Educacion y Marginalidad en la Ciudad de Mexico," Demografia y Economia, El Colegio de Mexico, 1974.

Strassmann, W. Paul, "The Substitution of Materials or Capital for Labor in Mexican Construction," Studies on Employment in the Mexican Housing Industry, OECD, Paris, 1973.

________, "Employment and Financial Alternatives in Mexican Housing," Studies on Employment in the Mexican Housing Industry, OECD, Paris, 1973.

________, "Productivity, Construction, and Employment in Developing countries," International Labour Review, May 1970.

United Nations, "Income Distribution in Selected Major Cities of Latin America and in their Respective Countries," Economic Bulletin for Latin America, Vol. XVIII, No. 1, New York 1973.

________, World Housing Survey, January 1974, New York, 1974.

Unikel, Luis, "El Proceso de Urbanizacion," El Perfil de Mexico en 1980, Ed. Siglo XXI, Mexico, D.F., 1970.

U.S. Department of Housing and Urban Development, Comparison of Construction Costs in Latin America Cities, Washington, 1973.

Winger, Alan R., "Housing and Income," Western Economic Journal, Vol. V, No. 3, June 1968.