Building to Resist the Effect of Wind, Volume 4: Forecasting the Economics of Housing Needs: A Methodological Guide

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Building To Resist The Effect Of Wind

VOLUME 4. Forecasting the Economics of Housing Needs: A Methodological Guide

U.S. DEPARTMENT OF COMMERCE • NATIONAL BUREAU OF STANDARDS

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Building To Resist The Effect Of Wind

In five volumes

VOLUME 4: Forecasting the Economics of Housing Needs: A Methodological Guide

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ABSTRACT

The Agency for International Development sponsored with the National Bureau of Standards, a three and a half year research project to develop improved design criteria for low-rise buildings to better resist the effects of extreme winds. This report contains information gathered from this project.

Project results are presented in five volumes. Volume 1 gives a background of the research activities, accomplishments, results, and recommendations. Volume 2 presents a methodology to estimate design wind speeds and a guide to determine wind forces. In Volume 3, a guide for improved use of masonry fasteners and timber connectors is discussed. Socio-economic and architectural considerations for Philippines, Jamaica, and Bangladesh are presented in Volume 5.

Housing is probably the single most important consumer good in most economies. Measuring the size of a region's unmet housing need is a first step to planning and implementing improvements in housing conditions. This report analyzes the concept of housing needs in an economic framework. A methodology for estimating and projecting housing needs at the regional level is developed. The methodology attempts to make explicit the income redistribution intent which is the core meaning behind the concept of housing needs.

Key words: Development; forecasts; growth; housing needs; projections.

Cover: An overcrowded district in the Philippines. In locales such as this, physical damage from high winds may be the same as in rural sites, but human losses are greater.

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***Facing Page:** Squatter settlements are the most visible manifestation of housing need as shown in this overcrowded district in the Philippines.*

1. INTRODUCTION

Determining the size of a region's unmet housing needs is an important first step to planning and enacting public policies and programs which will improve the condition, size and quality of a country's housing inventory. The assessment of current and future housing needs is particularly important in the developing regions of the world where the twin pressures of population growth and urbanization especially aggravate the housing problem.

This report develops a basic methodology for estimating and projecting housing needs. Procedures are developed to compare the costs with the potential income redistribution effects of meeting the housing need shortfall.

The condition, location, size, and quality of the housing inventory are important elements in the set of factors which describes a country's standard of living. This is irrespective of the stage of economic development or the organizational basis of a country's economic system. Housing is probably the single most important consumer good in most economies. Housing expense is often the single largest component of a household's monthly budget. The public attention given housing often centers around the universal complaint that housing costs too much. Other problems, slums and squatter settlements, congestion, crime, and overcrowding become intertwined with the heightened concerns over the adequacy of an area's housing stock. Miserable housing conditions are the most visible manifestation of an area's poverty problem.

Such perceptions, if they are to be translated into realistic and effective public intervention, require accurate assessment and definition of the nature and size of the problems that exist in the housing area. Providing such measurement is the general purpose of studies of a country's or region's housing needs or requirements.

The twin pressures of population growth and urbanization are forcing the developing nations of the world to make careful measure of their present and future housing needs. Such assessments are an imperative input to the efficient allocation of scarce public resources. Public housing programs must compete for the public dollar with other vital social programs.

The purpose of this report is to clarify some of the issues that are involved in the measurement of housing need and to provide an implementable housing needs estimation and projection methodology. First we shall discuss the economic issues involved in housing needs estimation. Next we shall present in some detail a step-by-step description of the procedures for estimating the current level, and projecting the future level of housing needs. A detailed example will illustrate the methodology. Finally we shall discuss the modifications to the methodology that are implied by the development of a building technology for low-rise/low-cost buildings to better resist extreme winds.

1.1 THE NORMATIVE BASIS OF NEEDS ESTIMATES

At any particular point in time, a country's or region's housing need is measured by the number or value of additional units that would be required to bring the current inventory up to some pre-defined standard of acceptablility. Given this definition, the subjective or normative basis of housing "needs" or "requirements" is clear. What is judged as acceptable housing conditions will vary between countries and between regions of a country. Differences in the minimally accepted standard will be influenced by income, methods of construction, climate, custom, and expectations. Only if the standard of acceptability is clearly defined and the underlying normative basis for it is widely agreed upon, will the meaning of the needs estimate be unambiguous and useful. Often in needs studies the housing standard against which need is measured is not explicitly stated. Housing needs studies usually imply their standard through a process of elimination. For example, often what is done is to examine current housing statistics to identify the number of housing units which are substandard by some physical criteria, and then to count or estimate the number of families that are living in doubled up arrangements. The sum of these components is taken as the magnitude of unfilled housing needs.

The notion of housing need can be clarified and its subjectivity modified by examining the economic meaning behind it. By definition an individual is in need if he or she does not have at his or her disposal an adequate amount of housing stock or housing capital. In order for the policy maker or reader to judge if the need level is reasonable an explicit definition of the housing standard or target level must be stated. A housing need study which only defines situations in which housing need exists and does not specify the minimum socially acceptable level that each consumer should have (i.e., how much should exist) has only fulfilled part of its function.

1.2 PROJECTING FUTURE HOUSING NEEDS

A housing needs study is concerned with more than the assessment of the size of the housing gap at present. It also is concerned with projecting the future position of that gap given certain assumptions about the path of housing production. Furthermore, a housing needs study must identify those sectors in the economy which are to receive the subsidies that are implied in meeting housing needs. These are difficult research tasks.

To make a projection we must perform three tasks which are at the conceptual core of a housing needs study. We need to (1) assess the future standard, which will be influenced by conditions of supply and demand in the future, (2) to determine the gap between the actual per capita quantity and the target per capita quantity, and (3) to project the future size of the population.

In actual practice, it is very difficult, if not impossible, to obtain accurate projections or forecasts of precisely these constructs, given the nature of the existing data. In practice, an analyst will have to rely upon the information that is available. Nevertheless, the concepts of benefits and costs and the use of an economic model are useful in defining the nature of the research task and in guiding the specification of a projection methodology. In the next section a methodology for estimating and projecting housing needs is presented. The economic *conceptual* model which guided the development of the methodology is discussed in Appendix A.

Facing Page: *When land is at a premium, population densities reach up rather than out; as here in Hong Kong.*

2. A NEEDS ESTIMATION AND PROJECTION METHODOLOGY

ments used to indicate the inappropriateness of expecting that some housing standard would be applicable across countries support the view that a single national standard would be inappropriate to apply across the diverse regions within a particular country. Of course, the problems of a single standard have considerably less relevance in a country with a high degree of regional homogeneity. Examples of such countries are rare, however.

The existence of wide regional divergences and variations in culture, weather conditions, levels of income and development, income distribution, methods and costs of construction, degree of urbanization, and expected population growth indicates that a decentralized approach to housing needs determination is appropriate. The regional approach enables these regional divergences to be reflected in the separate regional determination of the housing standard or target. This approach is also consistent with the economic reality that housing markets are not national markets, but local markets. Regional differences would most easily be reflected in housing standards if the needs projections are the products or determinations of those most familiar with their local housing market conditions.

If a coordinated regional or summation approach is to be feasible several requirements must be met. First, the regional housing needs studies must follow a consistent needs estimation and projection methodology. Also, it is necessary that overall coordination and planning remain in some centralized housing or planning agency since the reconcilation and summation of the regional or local needs studies can only be accomplished at one point. Finally, the separate needs studies should share common factual assumptions about future population projections. Again this requires a centrally located research agency to supply the regional researchers with consistent population and migration projections.

The purpose of this section is to provide one input to the regional or summation housing needs research strategy, i.e., a basic methodology of estimating and forecasting housing needs. The methodology is deisgned to be flexible. It will accommodate data scarcities and can be implemented by decision makers with minimal background and/or training in social sciences.

2.1 ESTIMATION OF CURRENT NEEDS

Housing needs estimation involves the assessment of the size and nature of current deficiencies in the housing inventory and the projection of the future inadequacies in the inventory. Dichotomizing the research task in this way allows us to keep separate two major issues: (a) how does one calculate the level of housing need at a particular point in time, and (b) what role does projecting population growth and housing growth play in housing needs estimated for future years. We shall first concentrate on the question of the determination of current needs, and look later to the methodological issues involved in the projection of housing needs in the future.

The calculation of current housing needs involves 11 basic research steps. These tasks can be apportioned into 4 major areas of investigation or analysis. (see table 1). The first major area of analysis involves the accurate and relevant description of the housing inventory in detailed statistical terms.

TABLE 1. BASIC RESEARCH STEPS IN THE CALCULATION OF CURRENT HOUSING NEEDS

I. Description of the Housing Inventory
- *Task* 1. Construction of a Housing Characteristics Matrix
- *Task* 2. Construction of a Population Matrix
- *Task* 3. Construction of a Per Capita (per family) Housing Characteristics Matrix

II. Determining the Housing Standard
- *Task* 4 Selection of Target Cell from the Per Capita Housing Characteristic Matrix

III. Determining the Needs or Shortfall Matrix
- *Task* 5. Construction of a Matrix of Relative Housing Values and Rents
- *Task* 6. Construction of a Quality Deflator Matrix
- *Task* 7. Cell by Cell Calculation of Housing Needs
- *Task* 8. Distribution of Housing Needs by Construction Type and by Income Class

IV. Calculating the Cost of Meeting Housing Needs
- *Task* 9. Definition of Low-Income Housing
- *Task* 10. Construction Cost of a New Standard House: Total Annual Public Cost Determination
- *Task* 11. Cost Evaluation of the Redistributive Impact

The availability and accuracy of the data set will determine the overall accuracy and detail that is possible in the final needs calculations. The second area of analysis requires the specification of the housing standard or target. This will be based on inspection of the data matrix arising out of the first major task area. The third major research area involves the conversion of the housing matrix into housing standard equivalents, and the calculation of cell by cell shortfalls of the housing inventory matrix. Finally, the housing need level has to be costed, and this total cost can then be subjected to an analysis of its cost-effectiveness of redistributing income. If the total income redistribution gains of filling housing needs is less (more) than the implied resource costs, then a new, lower (higher) standard can be chosen and the housing needs estimates be reiterated.

2.1.1 Description of the Housing Inventory

Task 1. Construction of a housing characteristics matrix: The goal of this task is the construction of a data matrix which has the number of housing units arranged by locational/tenurial/physical characteristics and cross classified by the income class of the occupants' households. This matrix in effect will divide the housing inventory into a set of mutually exclusive submarkets.

The characteristics of the housing inventory that are of interest will include the location of the housing units (rural or urban), the tenure class of the housing units (owner occupied, renter occupied, or squatter), and the physical attributes of the units (construction type or the soundness of the condition, or the age). Table 2 illustrates a possible array and organization of the housing inventory. The degree of detailed subclassification will be determined, for the most part, by the adequacy and detail of the available census data. It would be desirable if data were available to classify the housing inventory in even greater detail than indicated by table 2. For example, the subcategory of age could be made a subset of the construction type category. Another subset of interest, if data were available, would be by condition of unit, i.e., sound dilapidating, or deteriorating.

Once the cell totals for an array have been determined, the next step is to distribute the dwelling unit totals in each cell among income classes. It may be that a national census will have the regional dwelling unit data already so classified. If not, a method of distribution is required.[1] Ideally, the data in table 2 would be extended into a matrix as seen in table 3. Each cell in this matrix will contain a measure of the number of dwelling units or the total number of rooms.

Task 2. Construction of a population matrix: The goal of this task is to construct a population matrix which in combination with the housing characteristics matrix of task 1 will enable a cell by cell computation of housing units per capita. The column and row headings of this matrix will be identical to that of table 3. However, instead of housing unit data comprising the cellular entries, population data is required.

The construction of the population matrix also may require an estimation or data development procedure. For example, data on the population size of urban renters may be available but not be distributed by income class. In this case it would be reasonable to assume that the total or urban renters could be distributed by income classes according to the national distribution of the urban population among income classes. The population of rental income class must then be distributed according to their division among building construction types. Information for deter-

TABLE 2. THE ARRAY OF HOUSING CHARACTERISTICS REQUIRED AS INPUT TO A REGIONAL NEEDS STUDY

	The Number of Dwelling Units or Total Number of Rooms																	
LOCATION	URBAN									RURAL								
TENURE	Owner Occupied			Renter Occupied			Squatter			Owner Occupied			Renter Occupied			Squatter		
CONSTRUCTION TYPE[a]	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L

[a] S: Strong
M: Mixed
L: Light

[1] Let us assume that the analyst only has available an income distribution by families or households which is cross classified by urban or rural and not by any other housing characteristic. Two alternatives exist in a situation like this. Either the analyst requests and is able to get an unpublished cross-classification from the census bureau, or he or she employs some method of interpolating the totals that are available, among the construction types. Once again there may exist some description in a related area which will allow the construction of reasonable distribution procedures.

mining this distribution by construction types may be available from tangential sources such as reports, surveys, or documents containing estimates of family size by income class. Also data may exist on the extent of "doubling up", two or more families occupying one dwelling unit, which in turn is related to the physical characteristics of dwelling units. These data could be combined using specific assumptions in such a way that the analyst would be able to distribute the population of an income/tenure class among the construction material categories. No set rules for data development are available because each country's data contingencies will dictate the kinds of adjustments which may be required.

Task 3. Construction of a per capita (or per family) housing characteristics matrix: This task is a straightforward division of the elements in the housing characteristics matrix by the elements determined in task 2. The result will be a cell by cell or submarket by submarket) portrayal of housing quantity per capita, h_{in}/pop_{ij}. It permits comparisons between cells of the amount of housing stock or housing service consumed by each income/housing type submarket of the housing stock.

2.1.2 Determining the Housing Standard

Task 4. Selection of a target cell(s) from the per capita housing characteristics matrix: This task is essentially one of judgment. The analyst must designate a target which represents the minimal socially acceptable level of housing consumption per capita. This target, or standard, will be relative to the existing conditions in the current inventory. Thus, initially the analyst can designate one cell in the per capita housing characteristics matrix as depicting or representing the highest standard of housing which should be attained by all household units. Separate standards can be designated for the urban population and rural population.

In effect, the housing needs analyst makes the initial judgment that the housing quality and per capita quantity represented by one cell of the per capita housing characteristics matrix is what should be available for all. It could be, for example, the kind of urban (and rural) owner occupied housing of mixed construction consumed by the middle income class. This particular cell(s) of the per capita housing characteristics matrix is (are) designated as the standard or target cell(s). It becomes the point from which the adequacy or inadequacy of housing conditions in the region, as portrayed in the other cells of the matrix, is measured.

The advantage of this procedure lies in the clear meaning of the standard. Designating, say the housing type and per capita quantity of a particular income class as the standard is unambiguous and allows the

TABLE 3. HOUSING CHARACTERISTICS MATRIX

	The Number of Dwelling Units or Total Number of Rooms																			
Housing Characteristics	LOCATION	URBAN									RURAL									
	TENURE	Owner Occupied			Renter Occupied			Squatter			Owner Occupied			Renter Occupied			Squatter			Sub-totals
Income Class of Occupying Households	CONSTRUCTION TYPE[a]	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	
0 - 3,000																				
3 - 5,000																				
5 - 7,000																				
7 - 10,000																				
10,000 +																				
																				TOTAL

[a] S: Strong
M: Mixed
L: Light

reasonableness or unreasonableness of the standard to be perceived by the audience of policy makers. The standard represents an implicit judgment by the housing analysts about the inadequacy of the income distribution. The remaining tasks of a needs study can be viewed as translating such an implicit judgment into explicit terms.

2.1.3 Determining the Needs or Shortfall Matrix

Task 5. Construction of a matrix of relative housing values and rents: The entries in the housing characteristics matrix represent housing units which vary widely in quality. Housing is a very complex good with many factors determining the quality of one unit relative to another. Thus, the units in the different cells of matrix 1 are in a real sense non-comparable. The purpose of this task and task 6 is to arrive at a means by which the quantity units of matrix 1 can be adjusted for quality and thus be susceptible to direct comparison.

The simplest and most sensible measure of variation in quality is recorded in judgments of the market place in its determination of relative price. This means that if quality adjustments are to be made, a matrix of average housing prices is required. This means that a matrix comparable to that described in table 3 must be constructed with housing value (if owner occupied), and rental values (if renter or squatter occupied) as the cell entries.

This is a difficult task and will require expertise and knowledge on the part of the local needs analyst. Because there is wide regional variation in the structure of housing prices, the completion of this task is only feasible at the regional level.
Evidence suggests that such data are difficult to locate. Thus, the housing needs analyst will probably find it necessary to canvas local expert opinion in order to ascertain the actual structure of housing market prices. Of course sample survey techniques are more accurate, but the cost of a special census of current housing prices at the regional level are prohibitive.

Task 6. Construction of a quality deflator matrix: The housing price and rental data matrix of task 5 can now be converted into a matrix of relative values—relative to the value or rent of the price of housing in the standard or target cell. This will result in a cell by cell comparison of the price or rent in any particular cell to that of the price of standard housing. In other words, this task requires that each cell of this matrix of housing prices and rents be divided by the price or rent of the standard or target unit.

In order that the value cells in the owner-occupied columns be comparable to those in the renter and squatter-occupied columns, the housing values in the owner-occupied columns must be converted into service values or prices. Thus, if a owner-occupied unit has a stock value of $15,000, it would be necessary to convert this into a gross rental value of $1,500. This can be done by assuming a gross rent/price ratio of a given magnitude based on the following equation:

$$R/P = V_d + V_k + V_v \qquad (1)$$

where
R/P = the annual gross rental receipts divided by owner occupied value,

V_d = the rate of depreciation, maintenance, and repair expenditures,

V_k = the tax rate on housing services, and

V_v = the rate of return on housing services.

The rate of return on housing services will be at least as large as the mortgage rate currently prevailing in the housing finance market.

Task 7. Cell by cell calculation of housing needs: Housing needs now can be computed for each cell. This will result in a new matrix, the housing needs matrix. The cell-by-cell computation is relatively straightforward. For each cell we wish to calculate need level, N_{ij}. It will be the product of two terms: the per capita shortfall from the designated standard in housing quantity per capita times the population in that cell. Equation 2 specifies this procedure. The first term on the right-hand side of equation 2 represent the per capita shortfall in cell ij.

$$N_{ij}=(S-h_{ij}/pop_{ij} \quad D_{ij})\times pop_{ij} \qquad (2)$$

where

S = per capita quantity observed in the standard cell.

h_{ij}/pop_{ij} = per capita quantity in cell ij,

D_{ij} = the deflator value in cell ij,

pop_{ij} = the population of cell ij,

For example, let us assume that the income row i represents the $3,000 to $5,000 income class and the housing characteristic column j is urban rental housing of medium construction. Assume that the standard cell has an observed per capita quantity ratio of 1/5 while that for cell ij is 1/8. Also assume that the rental value deflator D_{ij} is 0.70 (calculated in task 6) and that the cell contains a population of 5,000 (calculated in task 2). This data results in a need estimate of 562.5 units (= [0.20 − (0.125 × 0.7)] 5,000). This means that 562.5 units comparable to standard units would have to be added to the housing stock of cell ij, either by new construction or in the form of rehabilitation of existing units, in order to bring housing in that portion of the housing inventory up to standard. Thus in this cell the 562.5 units of standard quality plus the 437.5 existing units of standard quality (437.5 = 0.7 × 625) add up to a final total of 1,000 standard quality dwelling units. Thus the goal of 0.2 standard units per capita has been attained.

Task 8. Distribution of housing needs by construction type and by income class: The matrix approach has the advantage that the distributions of housing needs by income class or by urban/rural and building characteristic will automatically result from the summation of the row entries and column entries. Some cells, particularly those in the higher income rows, will probably contain negative entries in the needs matrix. This means that housing in those submarkets surpasses that of the standard.[2] Thus, when summing the rows and columns of the need matrix the negative entries should be set equal to zero, indicating that no housing need exists in those submarkets because the housing quantity per capita exceeds that of the housing standard specified in task 4.

2.1.4 Calculating the Cost of Meeting Housing Needs

Task 9. Definition of low-income housing: Defining a low income unit is equivalent to defining how much the low income part of the population is willing and able to pay for the standard house or dwelling unit which has been defined in task 4. Thus, this task is essentially one of determining that price or rent level which can be afforded by the poorer part of the population.

The income-class, price data of task 5 can be used to accomplish the analysis of the income and housing price relationship. The data of task 5 can be inspected to determine the current average price of housing which is being paid by each income group. If facilities are available, a simple regression of housing prices (or rents) can be estimated as a function of income using the data from task 5. Thus, the estimated relationship,

$$P_i = \alpha_0 + \alpha_i Y_i + e_i \qquad (3)$$

where P represents housing prices or rent, Y is the measure of income, and e is the residual, can be used to determine what housing price can be afforded with a given particular family income, Y. Once the low-income level of income is defined according to the region's definition of relative poverty, the maximum price of a low income dwelling unit can be determined by substituting the low-income cutoff in the estimated regression and solving for the price or rent level. Any dwelling unit renting for a higher price or whose market value implies a higher inputed rent can not be considered as a low-income house. The differential between the maximum price of housing that the poor can afford and the price of the standard dwelling unit describes the subsidy per dwelling unit that will be necessary to fill the low-income populations' housing needs.

Task 10. Construction cost of a new standard house; total annual public cost determination: The result of task 8 is a detailed estimate of the number of new standard housing units required to bring the housing stock up to the socially desirable standard. These estimates are categorized two ways: by income class and by housing type. In order to determine if these housing needs are worth meeting, or, to determine if the housing standard or target has been set too high, an estimate of the annualized public costs of filling these needs is required.

A housing needs study does not require an elaborate and detailed cost estimation. Only an order of mag-

[2] A negative entry will arise in equation 2 when $S < h_{ij}/pop_{ij} \times D_{ij}$

nitude estimate of cost is necessary. The cost concept involved is the annual public subsidy required to supply standard housing to those who can not afford the cost of standard housing (see task 9). The additional standard/needed units will not be supplied by the building community unless the subsidy is granted since those for whom the housing is intended cannot afford the standard house at its going market price.

The main capital costs that require estimation are the average unit costs of land acquisition and development and the average cost of construction of a new unit which is comparable to the standard or target unit. These total investment costs can then be annualized using an appropriate length of life and an appropriate interest rate. The difference between these annualized costs and the average yearly rentals that the poor can afford represents the annual net resource costs which must be borne by the public sector.

The total size of the annual governmental housing subsidy, the public cost of meeting housing needs, can now be computed. The total public cost can be computed either on a cell-by-cell basis and summed or computed only for each income class and then summed. Within each cell or for each income class, the total cost will be the product of the subsidy per unit times the number of needed units which require subsidization.

Task 11. Cost evaluation of the redistributive impact: The costs discussed above in task 10 have the primary purpose of attempting to raise the real income levels of that portion of the population residing in housing which is less than standard. Augmenting the inventory in those housing submarkets where the need is the greatest will generate real income increases in those submarkets. The real income increases will accrue to those who will occupy the subsidized housing. Also of importance will be the impact on real incomes which will arise because of the price effect that will occur because of the significant increase in the size of the housing stock. A fall in the price of housing services should occur because of the increase in supply. This will raise real income levels by reducing rent levels. Thus the primary effects of fulfilling housing needs are to be found in the changes in real income of those at the lower end of the income distribution. The income increases discussed above are in effect transfer payments. This is the case since the lower housing prices, while of benefit to those not owning the stock (the renters), are net losses of rental receipts to the holders of the stock. The redistribution from the landlord to the tenant (in owner-occupied units the landlord and tenant are one and the same) is not done costlessly. The costs discussed in task 10 represent the public sectors' administrative or income redistribution implementation costs. In evaluating the reasonableness of statements about housing needs the policy makers of the public sector should be appraised of the cost effectiveness of these implementation costs since alternative methods of achieving the same level of redistribution may be available. Thus the last task of the needs estimation methodology is to assess the size of the potential income redistribution and to identify the gainers and losers in each cell of the housing characteristic matrix.

The amount of the income increase (redistribution) within any particular submarket (or cell in the housing characteristic matrix) will be measured by the gain

in consumers' surplus[3] which will arise because of the fall in the price of housing services due to the increase in the size of the inventory needed to bring that submarket up to standard.

Thus if the need level in a particular submarket cell has been computed to be x percent of the existing in-

[3]For an explanation of consumers' supius, see Appendix A.

ventory, one must ask: What effect will an x percent increase in the size of the inventory have on housing prices?. Answering such a question presumes knowledge of the price elasticity of demand[4] for housing in that particular submarket. For the moment, assume reliable information about price elasticities is available. The gain in consumers' surplus can be approximated by the change in price, Δp,[5] times the existing number of standard units, h, plus one-half times Δp times the additions to the inventory$(1/2\Delta p \cdot \Delta h)$. The cell-by-cell calculations of consumers' surplus gains will, when summed, yield the income redistribution change that would be associated with attainment of the housing standard and the elimination of housing needs. This change in the income distribution can then be compared to the resource costs or implementation costs which have been calculated in step 10. It may be that the cost effectiveness of redistribution via the fullfillment of housing needs is competitive with other programatic approaches. If the housing needs levels and the income redistribution gains are not cost effective it may be that the housing standard has been set too high. A reiteration of the needs estimate may be called for where a lower standard or target has been specified. The implementation costs will be lower and it may be that cost effectiveness will be increased. A table like table 4 below can be computed as a means of explicitly presenting these considerations to the policy maker.

TABLE 4. THE COST EFFECTIVENESS OF MEETING HOUSING NEEDS AS A MEANS OF REDISTRIBUTING INCOME (SAMPLE FORMAT)

(1) STANDARD	(2) HSG NEED ESTIMATE	(3) IMPLEMENTATION COSTS	(4) INCOME REDISTRIBUTION AMOUNT	(5) COST-EFFECTIVENESS (5)=(4)/(3)
A				
B				
C				
D				

4 Price elasticity of demand is discussed in more detail in Appendix B.

5 The price change will be equal to the product of the percentage change in quantity, $\Delta q/q$, times the price per unit in that submarket divided by the price elasticity of demand.

2.2 PROJECTING FUTURE HOUSING NEEDS

In the context of the needs methodology discussed above, the projection of future housing needs involves applying tasks 1 through 11 to data which represent values that are expected to exist in the future projection year. Thus, the housing need analyst will be required to modify the current needs matrices so they contain projected values. This section discusses ways in which the projections can be feasibly accomplished.

2.2.1 Projecting the Housing Characteristics Matrix

The problem involved in projecting the housing characteristics matrix is in finding a set of factors which when multiplied by the elements in the housing characteristic matrix of the base or current period yields reasonable projections of the corresponding future values. If we let the current housing characteristics matrix be denoted by HC^c, the set of projection factors be denoted by matrix F, and the projected future housing characteristics matrix by HC^f, then the conversion of HC^c to HC^f, can be viewed symbolically as the operation of (in matrix notation):

$$\underset{(i\times j)}{HC^c} \bullet \underset{(j\times j)}{F} = \underset{(i\times j)}{HC^f} \tag{3}$$

Thus, the housing needs analyst must find a reasonable approximation of F. To further simplify the problem let us assume that F can be a diagonal matrix, i.e., one in which the non-diagonal elements take on zero values. If this is the case, then an element of F along the main diagonal will be equal to

$$f_j = hc^f_{ij}/hc^c_{ij} \tag{4}$$

that is, the ratio of any element i from column j of the future housing characteristics matrix divided by the corresponding i^{th} element from column j of the current housing characteristics matrix. This is equivalent to assuming that all the elements a given column of the current matrix will grow at the same rate. In other words we are assuming that urban housing of a given tenure and building characteristic type will increase at the same rate across all income classes. This is not as restrictive an assumption as it may first appear since it is likely that a particular kind of housing, say owner-occupied of strong construction, or squatter-occupied of light construction, will be concentrated in a few income classes. This assumption will considerably ease the problem of projection. Without such an assumption, the housing needs analysts would be required to make separate projection of each cell of the current housing characteristics matrix.

The j^{th} diagonal element of the growth factor matrix will be based on the net rate of growth:

$$F_j = (1 + g_j - d_j)^n. \qquad (5)$$

where

- g_j = the projected annual average rate of gross additions to the housing stock of housing type j,
- d_j = the projected annual average rate of depreciation from the housing stock of housing type j, and
- n = the length of the period in years over which the projection is to be made.

Thus, the projection problem is essentially one of determining for each housing type (for each of the columns of the housing characteristics matrix) reasonable estimates of the net growth rate. The net growth rate is the sum of two rates as seen above. The rate of gross additions of housing type j can be based on past experience. Annual data on new construction by building type, location, and tenure class can serve as the basis for calculating g_j. If a trend is observable in a time series of g_j, the value of g_j can be modified to reflect projections of that trend. Annual data on losses from the inventory by housing type may also be available; if not, alternative assumptions about the deterioration rate can be substituted. For example, different lengths of life can be assumed which are based on the kind of construction material used in the dwelling unit. Straight-line depreciation can be assumed and the depreciation rate can be calculated as one over the average length of life of units of a given construction type. Alternatively, an estimate of the projected rate of net additions ($na_j = g_j - d_j$) can be included. This can be based on comparisons of the size of the inventory of housing of type j as revealed in the decennial census for 1970 and the census for 1960.

2.2.2 Projecting the Population Matrix

As was the case in the discussion above, the problem is again one of finding a set of factors by which the base period population matrix can be multiplied to yield estimates of future population. A workable approach to determining such factors even where data is extremely limited is to multiply all the cell entries in the base period population matrix by a factor, G,

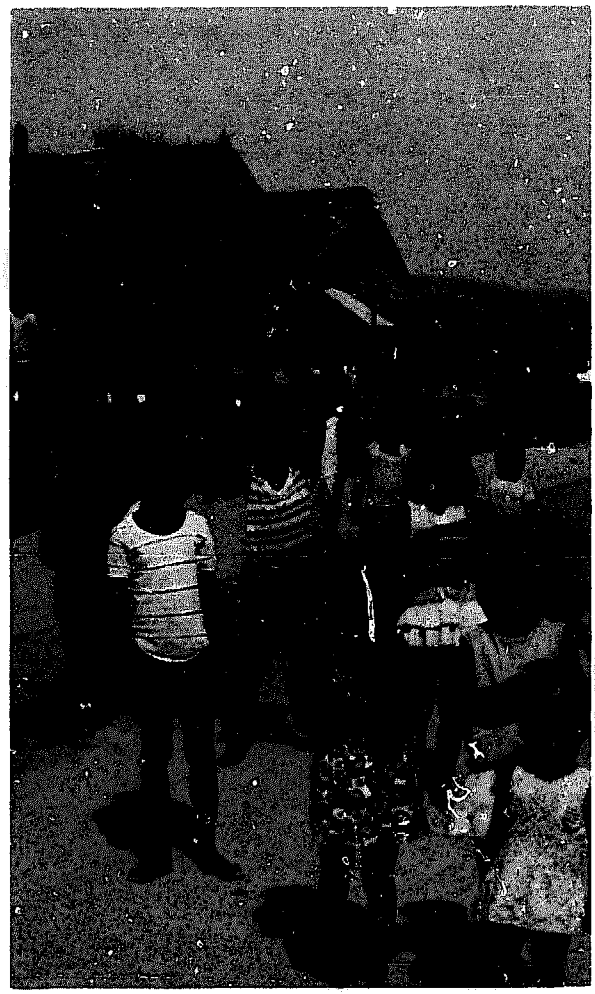
$$G = (1 + p + nmr)^n \qquad (6)$$

where

- p = the rate of natural increase in the population
- nmr = the net migration rate of the region, and
- n = the length of the period in years over which the projection is to be made.

Most central governments develop estimates of the projected rate of natural increase by region. Similarly, they may project nmr by region.

The population projections can be refined. As was the case in the housing matrix discussed above, a diagonal population growth factor matrix, PG, can be constructed. For example, the population growth factor matrix could assume that all cellular entries will grow at the same rate of natural increase but that the migra-



tion rate within a region will be positive in the urban sectors and negative in the rural sectors. Further subdivisions are possible. For example, within the urban sector, the migration rate can be adjusted to reflect differences by tenure class. Specifically, a higher rate can be assumed for squatter occupied housing than for owner occupied or renter occupied housing. These rates of migration can be based on recent historical experience and adjusted according to the conditions that are expected to prevail over the projection period.

Special studies may exist which can allow the analyst to justify the rates of growth that are entered in the diagonal matrix. The employment of a diagonal growth factor projection matrix implicitly assumes that the distribution of income will remain unchanged between the current and future periods.

2.2.3 Combining the Projected Matrices

The above two projection tasks can now be combined and a per capita housing characteristics matrix can be constructed for a future period. This step brings us through the analogous task 3 as outlined above. From this point, there are only slight deviations required from the remaining calculations outlined for current needs. The procedure for selecting a target cell is identical to task 4. Even the matrix of relative housing values and rents is best left unchanged from that calculated for current housing needs. This does not mean that no price changes are expected to occur. Inflation may in fact exert a large influence on all housing prices. Nevertheless, since our interest is in real relative prices, the assumption that the matrix of relative housing prices and rents of task 5 applies to the future period avoids the construction and estimation of simultaneous housing price determination models. The housing analyst can then proceed with tasks 6 thru 11, and obtain estimates of housing needs for a future period.

Facing Page: *Housing projects, like this one in Kingston, Jamaica, are required to meet housing needs.*

3. AN ILLUSTRATION OF THE NEEDS ESTIMATION METHODOLOGY

The purpose of this section is to illustrate the basic logic of the needs estimation methodology developed in section 2. A numerical example—strictly hypothetical and highly simplified--has been developed so as to illustrate the iterative nature of the needs estimation methodology. This section can not be used as a guide for the data development and forecasting problems that the needs analyst will encounter. However, if the analyst follows this example through, he or she will come to grips with the overall strategy of the recommended methodology and will be in a better position to develop a data acquisition and forecasting strategy consistent with the goals of this methodology.

Table 5 categorizes the renter occupied housing stock of a hypothetical urban area into 15 submarkets based on structural characteristics and on the income class of the dwelling units' household occupants. Since housing needs will presumably be the most pressing in the lower half of the income distribution, the matrix has a highly aggregated income class 5—wherein 50 percent of the renter occupied housing is located. As can be seen in this illustrative matrix, 20 percent of the housing stock is of light construction with 86 percent of these building units falling into income classes 1 through 4.

TABLE 5. AN ILLUSTRATIVE HOUSING CHARACTERISTICS MATRIX FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Dwelling Units Per Housing Category			
Income Class	Strong (1,000's)	Mixed (1,000's)	Light (1,000's)	Total (1,000's)
Class 1	9	4	21	34
Class 2	23	12	15	50
Class 3	21	11	27	59
Class 4	38	20	9	67
Class 5	131	67	12	210
Total	222	114	84	420

Table 6 contains hypothetical data on the number of people living in housing of a corresponding construction type and income class. Income class 5, which contains 38 percent of the population, consumes 50 percent of the housing services produced by the housing stock. The entries in table 5 are then divided by the entries in table 6 to obtain estimates of housing stock per capita for each of the housing inventory subcategories (see table 7). The inverses of the cellular entries in this matrix reveal the population per housing unit within each subcategory of the inventory. For example, housing of light construction which is occupied by households in income class 1 contains an average of 9.1 persons per unit (1/0.11 = 9.1) whereas housing of strong construction occupied by persons in households which fall in income class 5 contains 4.1 persons per unit (1/0.244 = 4.1). Thus there is considerable variation among the different sectors of the housing stock in degree of crowding.

After the construction of the per capita housing matrix, the analyst can either arbitrarily or judgementally designate one of the cells as the target or standard cell. The analyst asserts that, say, for example, the kind of housing and degree of crowding typified by those units which are occupied by households in income class 4 and which is constructed of materials of mixed qualities should be the standard level to which all the population should have access. This judgment may or may not be supported by the rest of the analysis. (At this point the analyst is setting a standard as a hypothesis.)

TABLE 6. AN ILLUSTRATIVE POPULATION CHARACTERISTICS MATRIX FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Population Per Housing Category				
Income Class	Strong (1000's)	Mixed (1000's)	Light (1000's)	Total (1000's)	Percent
Class 1	78.94	35.71	190.91	305.56	12.5
Class 2	179.69	97.56	125.00	402.25	16.4
Class 3	151.07	84.62	203.01	438.70	17.1
Class 4	193.88	119.76	57.69	371.33	15.1
Class 5	536.89	335.00	62.50	939.11	38.1
Total	1140.47	672.65	639.11	2452.23	
Percent	46.5	27.4	26.1		

TABLE 7. AN ILLUSTRATIVE HOUSING QUANTITY PER CAPITA MATRIX FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Housing Stock Per Capita		
Income Class	Strong	Mixed	Light
Class 1	.114	.112	.110
Class 2	.128	.123	.120
Class 3	.139	.130	.133
Class 4	.196	.167	.156
Class 5	.244	.200	.192

Table 8 contains hypothetical value data in dollars for the mean yearly rental value of housing in each of the subcategories. The cell in row 4 column 2 is the designated standard or target cell. Dividing all the entries in table 8 by the rent per unit of the standard cell yields table 9—the matrix of relative housing prices.

The matrix of relative prices represents a set of deflators to apply to the stock per capita quantities contained in table 6. Using relative prices as deflators in effect is assuming that the amount of housing services rendered by a unit is measured by the number of target or standard equivalents contained in that unit. For example, if the standard unit has an annual rental value of $1,000, and if another unit is valued at $500, then the second unit is equivalent to 0.5 standard units. Thus multiplying the units per capita in each cell by the corresponding relative value yields a standardized stock per capita figure. These figures are then subtracted from the standard or target stock per capita which is given by row 4 column 2 of table 7 in order to determine the cell by cell shortfall of stock per capita (see eq. 2). Table 10 contains such shortfall estimates in per capita terms.

To convert the stock per capita shortfall or housing needs estimates into absolute numbers, the positive entries of table 10 are multiplied by the corresponding population estimates of table 6. Thus table 11 contains the first iteration of a cell-by-cell calculation of needs estimates.

This is the critical point of the analysis. The needs estimates must now be evaluated as to whether or not they are worth meeting. If not we must lower the standard or target.

Information on the cost of constructing a standard equivalent is required. Here we shall assume that the standard or target unit can be produced for $10,000. (The analyst will require a realistic construction cost* estimate and can not rely on assumption as is done in this example). This cost can then be converted to an annualized cost of $1075.[6]

TABLE 8. AN ILLUSTRATIVE MATRIX OF HOUSING PRICES FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Matrix of Annual Rental Values		
Income Class	**Strong**	**Mixed**	**Light**
Class 1	830	510	350
Class 2	960	830	500
Class 3	1,120	970	680
Class 4	1,240	1,000	900
Class 5	1,630	1,180	920

A cell-by-cell calculation of redistribution effects must now ensue. This will require that the analyst make some assumptions about the impact that adding new units to each subcategory will have on the market price within each subcategory. Recall that the main category of impacts to be considered are consumer surplus benefits—as units are added to the inventory prices will fall on the already existing housing and those who do not experience a housing subsidy

[6]This calculation assumes a 25 year life, a 10% interest rate and a scrap value of $3,000.

TABLE 9. AN ILLUSTRATIVE MATRIX OF RELATIVE HOUSING PRICES FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Matrix of Relative Prices		
Income Class	**Strong**	**Mixed**	**Light**
Class 1	0.83	0.51	0.35
Class 2	0.96	0.83	0.50
Class 3	1.12	0.97	0.68
Class 4	1.24	1.00	0.90
Class 5	1.63	1.18	0.92

TABLE 10. AN ILLUSTRATIVE MATRIX OF THE SHORTFALL IN HOUSING STOCK PER CAPITA ADJUSTED BY RELATIVE PRICE WHEN COMPARED TO THE DESIGNATED STANDARD FOR TARGET

	Shortfall in Housing Stock Per Capita		
Income Class	**Strong**	**Mixed**	**Light**
Class 1	0.072	0.110	0.128
Class 2	0.044	0.065	0.107
Class 3	0.011	0.041	0.077
Class 4	—	—	0.027
Class 5	—	—	—

TABLE 11. AN ILLUSTRATIVE MATRIX OF HOUSING NEEDS FOR A HYPOTHETICAL URBAN REGION—RENTER OCCUPIED HOUSING

	Matrix of Housing Needs				
Income Class	**Strong (1000's)**	**Mixed (1000's)**	**Light (1000's)**	**Total (1000's)**	**Percent of Existing Units**
Class 1	5.7	3.9	24.4	34.0	100.0
Class 2	7.9	6.3	13.3	27.5	55.0
Class 3	1.7	3.5	15.6	20.8	35.3
Class 4	—	—	1.6	1.6	2.4
Class 5	—	—	—	—	—
Total	15.3	13.7	54.9	83.9	20.0
Percent of Existing Units	6.9	12.0	65.4		

directly are made better off because less of their income need be spent on housing. (As price falls more, housing can be consumed within each cell, and housing stock per capita is increasing).

Returning to the problem at hand, let us see what will happen in terms of real income effects going to renters in the row 1 column 3 cell. The need estimate in this cell calls for an extra 2,440 units. Currently this cell contains 2,100 units. The current market price of housing in this cell is $350. If the price elasticity of demand is -1.0 (an x percent change in price will lead to an x percent change in quantity) then increasing quantity by 116 percent (2,440/2,100 = 1.16) would lead to a price decline to zero.[7] Thus consumer surplus gains would equal 2,100 × $350 + 2,440 × $350 = $1.16 million. These benefits would arise if 2,440 units are produced at an annualized cost of $1,075 and given away to the residents of this housing submarket. The annualized cost of implementing the redistribution of $1.16 million will be $2.58 million (2,400 × $1,075). Table 12 contains the cell-by-cell computation of redistribution impacts based on a price elasticity of -1.0.

The results in table 12 show that the aggregated redistribution effect of meeting the designated target or standard. Table 13 contains the estimates, cell-by-cell, of the annualized cost of administration or implementation. Table 14 computes the cell-by-cell ratio of redistribution level to administration costs.

For a second iteration we set the standard or target as those housing conditions obtaining in row 3, column 3 (income class 3 of light construction). Table 15 recomputes the matrix of housing needs based on this new and lower standard or target. Table 16 recomputes the

TABLE 12. THE REAL INCOME GAINS OF THE OCCUPANTS OF RENTER OCCUPIED HOUSING ARISING FROM FILLING HOUSING NEEDS (REDISTRIBUTION EFFECTS)

Income Class	Strong $ × 10⁶	Mixed $ × 10⁶	Light $ × 10⁶	Total $ × 10⁶
Class 1	0.623	0.296	1.16	2.079
Class 2	0.887	0.659	0.960	2.506
Class 3	0.198	0.393	1.366	1.957
Class 4	—	—	0.157	0.157
Class 5	—	—	—	—
Total	1.708	1.915	3.643	7.266

matrix of cell-by-cell redistribution effects and table 17 recomputes the matrix of net resource costs. Let us assume that the housing industry can reproduce this lower quality unit for $6,000 because of special scale advantages that are associated with producing such units in large numbers. We shall assume that these units will have a 20 year life, zero scrap value and that the interest rate is 10 percent. Thus the gross annualized cost will be $705 per unit, prior to any rental collections from those occupying the new units. Table 17 is based on the net annualized costs per unit. Again we have assumed in tables 15 through 18 a price elasticity of -1.0.

This second iteration produces a considerably lower need level and an annulized net resource cost approximately seven times lower then the first case. Also the real income gains accruing to the row 1, column 3 cell are only 40 percent lower than those computed under the first set of assumptions. In that cell the ratio of redistribution gains to implementation costs has nearly doubled.

[7] Zero is assumed because negative prices are not meaningful.

TABLE 13. ANNUALIZED NET RESOURCE COST OF IMPLEMENTING REDISTRIBUTION EFFECTS ASSOCIATED WITH FULLFILL-ING HOUSING NEEDS

Income Class	Strong $ \times 10^6$	Medium $ \times 10^6$	Light $ \times 10^6$	Total $ \times 10^6$
Class 1	.433	.414	2.623	3.470
Class 2	.351	.422	1.354	2.127
Class 3	.007	.144	1.228	1.379
Class 4	—	—	0.038	0.038
Class 5	—	—	—	—
Total	0.791	0.980	5.243	7.014

TABLE 14. CELL-BY-CELL RATIO OF REDISTRIBUTION LEVEL TO NET RESOURCE COSTS OF IMPLEMENTATION

Income Class	Strong	Medium	Light	Total
Class 1	1.44	0.71	0.44	0.60
Class 2	2.53	1.56	0.71	1.18
Class 3	28.29	2.73	1.11	1.42
Class 4	—	—	4.13	4.13
Class 5	—	—	—	—
Total	2.16	0.51	0.69	1.04

TABLE 15. MATRIX OF HOUSING NEEDS—SECOND ITERATION

Income Class	Strong (1000's)	Medium (1000's)	Light (1000's)	Total (1000's)
Class 1	—	1.8	14.7	16.5
Class 2	—	—	5.5	5.5
Class 3	—	—	—	—
Class 4	—	—	—	—
Class 5	—	—	—	—
Total	0	1.8	20.2	22.0

TABLE 16. THE REAL INCOME GAINS OF THE OCCUPANTS OF RENTER OCCUPIED HOUSING ARISING FROM FILLING HOUSING NEEDS—SECOND ITERATION

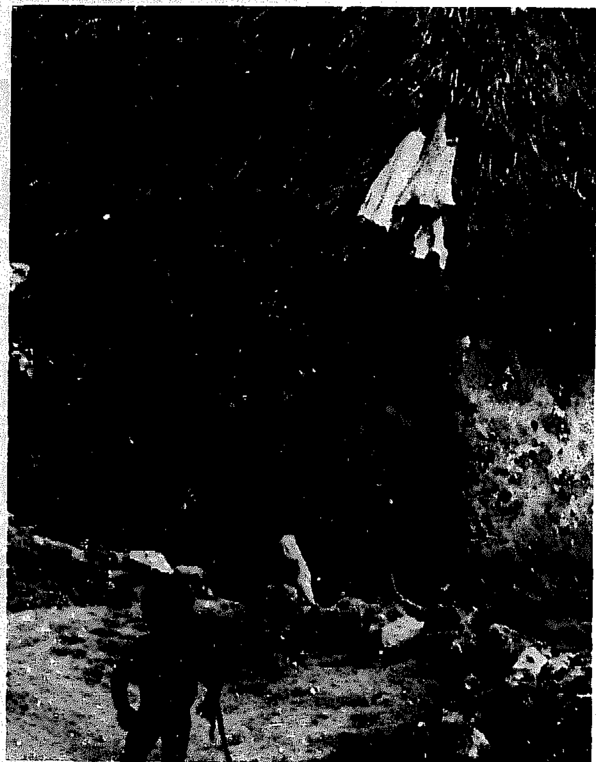
Income Class	Strong $ \times 10^6$	Medium $ \times 10^6$	Light $ \times 10^6$	Total $ \times 10^6$
Class	—	0.113	0.695	0.808
Class 2	—	—	0.325	0.325
Class 3	—	—	—	—
Class 4	—	—	—	—
Class 5	—	—	—	—
Total	—	.113	1.010	1.123

TABLE 17. ANNUALIZED NET RESOURCE COSTS OF IMPLEMENTING REDISTRIBUTION EFFECTS—SECOND ITERATION

Income Class	Strong $ \times 10^6$	Medium $ \times 10^6$	Light $ \times 10^6$	Total $ \times 10^6$
Class 1	—	.076	.875	.951
Class 2	—	—	.210	.210
Class 3	—	—	—	—
Class 4	—	—	—	—
Class 5	—	—	—	—
Total	—	0.076	1.085	1.161

TABLE 18. CELL-BY-CELL RATIO OF REDISTRIBUTION LEVEL TO NET RESOURCE COSTS OF IM-PLEMENTATION—SECOND ITERATION

Income Class	Strong	Medium	Light	Total
Class 1	—	1.48	0.79	0.85
Class 2	—	—	1.55	1.55
Class 3	—	—	—	—
Class 4	—	—	—	—
Class 5	—	—	—	—
Total	—	—	0.93	0.97



Alternative assumptions about demand elasticities could be employed in further iterations. For example it may be reasonable to assume greater inelasticity in the lower income classes. This will improve the redistribution to resource cost ratios because smaller additions to the stock in those cells will have a greater impact on market price. Thus a lower standard would, with a lower associated annualized cost of implementation, generate larger income gains. As alternative need estimates are generated under different assumptions a table like that of table 4 can be generated.

This example illustrates that selecting a standard and computing a level of need will not be an easy matter. Hopefully, even though this example is incomplete it should serve to give the methodology outlined in section 2 a degree of concreteness which will highlight the key problems and issues that are involved in needs estimation.

Facing Page: A pressed earth-block house, in Bangladesh. Construction costs can be reduced by the use of low-cost materials. Such a house can be built by low-skilled workers, usually by the very families who will live in them.

4. THE IMPACT OF A CHANGE IN BUILDING TECHNOLOGY ON HOUSING NEEDS

In this section we shall explore the effect that improvements in building technology will have on the level of housing needs in the future and we shall discuss ways in which anticipated changes in housing technology can be incorporated into the housing needs estimation methodology.

A good example of anticipated technology change involves building technology research which is related to the impact of high winds on low-rise buildings.[8] Extreme winds are a primary contribution to building damage and destruction in some developing coun

[8] Any building technology research that leads to buildings more resistant to natural disasters could be used in this example.

tries. For example, in the Philippines between 1948 and 1971 there were 482 typhoons. Similar experiences with high winds are found in Jamaica and Bangladesh.

If building technology develops methods of construction which are relatively low-cost and which result in substantial increases in the ability of low-rise buildings to withstand extreme winds there will be two major economic impacts which could be incorporated into a housing needs estimate.

First, the units which embody the new technology will have longer expected lifetimes than those that do not. This will lower the overall depreciation rate for the existing stock and will result in larger actual stocks at some future date. Coupled with this technological factor is a demand factor. Demand for new construction will also increase. This will be so because the lowering of the depreciation rate will cause a basic shift in the relationship between rental income and housing value. Longer expected lifetimes results in greater rates of return to a housing investment. This will result in greater demand for housing than would have been the case if no technological change had occurred. This means that more units will be purchased over time and that the actual stock of housing anticipated to exist at the future projection date will be larger. The gap between the desired level of housing stock and the actual level will be lower. These effects will be offset in part if the new technology causes the price of new housing to increase significantly.

The growth factor matrix must be judgmentally modified if the new technology is to be anticipated in the needs projections. The annual average rate of gross additions will be higher because of the demand affect discussed above and the annual average rate of depreciation will be lower because of the increases in expected building lifetimes. The actual percentage modifications that need to be made to these two elements will be determined by conditions which differ country by country. The needs analyst could provide alternative forecasts based on high, low, or zero building technology change assumptions.

Facing Page: *Workers erecting a single family house where the new tenants build interior walls and finishings. The house offers precast concrete walls and a timber/corrugated iron roof, a good combination to meet both fragile economics and high winds.*

5. SUMMARY AND RECOMMENDATIONS FOR FURTHER RESEARCH

5.1 SUMMARY

Determining the size of a region's unmet housing needs is an important first step to planning and enacting public policies and programs which will improve the condition, size, and quality of a country's housing inventory. The assessment of current and future housing needs is particularly important in the developing regions of the world where the twin pressures of population growth and urbanization especially aggravate the housing problem.

This study has developed a basic methodology of estimating and projecting housing needs. Procedures have been developed to compare the costs with the potential redistributive impacts of meeting the housing need shortfall. This methodology has been designed to be flexible and adaptable to situations in which housing and demographic data may be sparse. The methodology is consistent with the economic constructs which make the concept of housing needs meaningful.

Finally, this study has shown that in countries where natural disasters such as high winds or earthquakes occur relatively frequently, the development and adoption of new wind or earthquake-resistant building technology will have a mitigating effect on a region's future housing need.

5.2 RECOMMENDATIONS FOR FURTHER RESEARCH

One of the inputs to this paper's housing needs methodology is demand for housing information. Housing needs studies could be considerably improved in terms of accuracy and reliability, if reliable estimates of price elasticities of demand and supply existed at the regional level. Thus, much work could be done on developing and estimating regional models of housing demand and supply. This is particularly critical in those regions of countries where housing problems are the most pressing.

Further work is needed on conceptual and empirical understanding of the market process in squatter settlements. Both tasks would necessitate special modeling of the squatter settlements as specialized submarkets of the housing inventory. Parallel empirical investigations of the economics of squatter settlements would deepen our understanding of the specific problem areas and work to feed back a sense of priorities into the conceptual work.

Specific empirical research on the housing market impact of the development of new construction methodologies and design criteria could also be undertaken. Although we have some idea as to the direction of the effects that extreme wind research will have, more detailed information on the probable impacts of this technology on both the stock demand for housing and the supply of new housing units would enable those countries affected by high winds to be more fully appraised of the benefits of developing such a new technology.

APPENDIX A AN ECONOMIC INTERPRETATION OF HOUSING NEEDS

The needs estimation and projection methodology of section 2 has been constructed around a basic conceptual framework. This appendix analyses the economic elements which underlie the notion of housing "need."

In Figure 1, the demand curve for housing is labelled as DD. Assume that DD reflects the demand for housing services by a typical family unit. The total amount of housing stock per family in existence, the fixed supply of housing, is represented by the vertical line SS. Assume that each unit of stock renders one unit of housing service. The intersection of the demand for housing services curve and the fixed supply determines the current price per unit of housing (P_E in fig. 1).

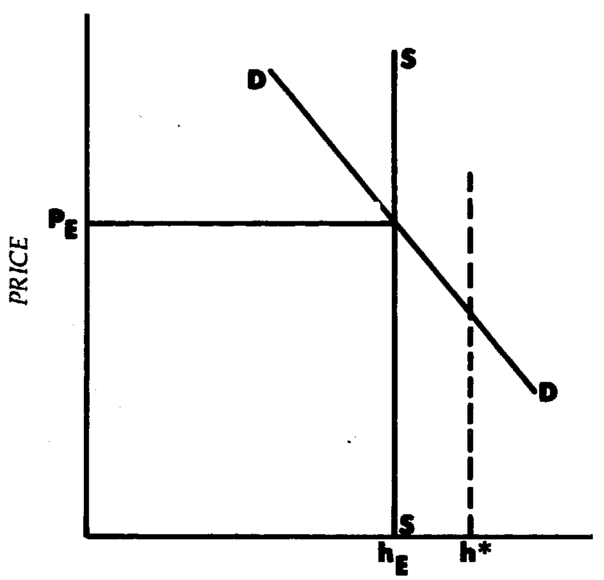


FIGURE 1. THE DEMAND AND SUPPLY OF HOUSING.

Let us assume that quantity of housing per family is measured in square feet of living space. The equilibrium quantity of housing services (stock) per family, h_E, may be less than that which is deemed to be the minimally socially acceptable amount of housing space per family.

Assume for a moment that h* represents the judgement of that amount of housing services per family which is minimally acceptable. The total housing need in this instance will then be (h^*-h_E) × N (number of families). Of course h* may have been defined to be either larger or smaller than shown on figure 1. What information could be developed which would help guide the determination of where the standard ought to be?

In order to arrive at some conceptual guidelines for determining the standard from which housing need is to be measured, it is necessary to discuss the economics of the housing market. The housing market is composed of two basic markets whose interaction determines housing prices and the amount and kind of new construction. Economists generally describe housing as a stock-flow market.

First there is the stock aspect of the housing market. Consumers can be described as having demand for a quantity of housing services which are associated with a particular size of the housing stock. Such demand will be dependent upon the market price, the level of income, the market rate of interest, and a number of other factors. Figure 1 portrays the interaction of demand with the fixed stock supply. In Figure 2, flow demand (dd), the demand for new construction, is derived from the demand for housing stock. At the price p_E in figure 2, given the existing stock of size h_E, there exists zero demand for additonal units. (See panel B.) The actual size of the housing stock is in agreement with consumers' preferences. However, at price P_1, consumers would be willing to purchase h_1 units of housing service (stock). Thus, we see in panel B that the demand for new construction at price P_1 will be h_1 minus h_E units. Similarly, if price were P_2, consumers would be faced with too large an inventory of housing stock. At that high a price the flow demand would be negative, h_2 minus h_E and holders of the stock would depreciate the stock by undermaintaining the existing inventory.

The housing construction industry responds to the flow-demand for housing. Since housing construction approximates a competitive market, little reality is sacrificed if we add to the flow side of the market an upward sloping supply curve which describes the number of new housing units that housing producers would be willing to build at each particular service price (see curve ss in fig. 3).

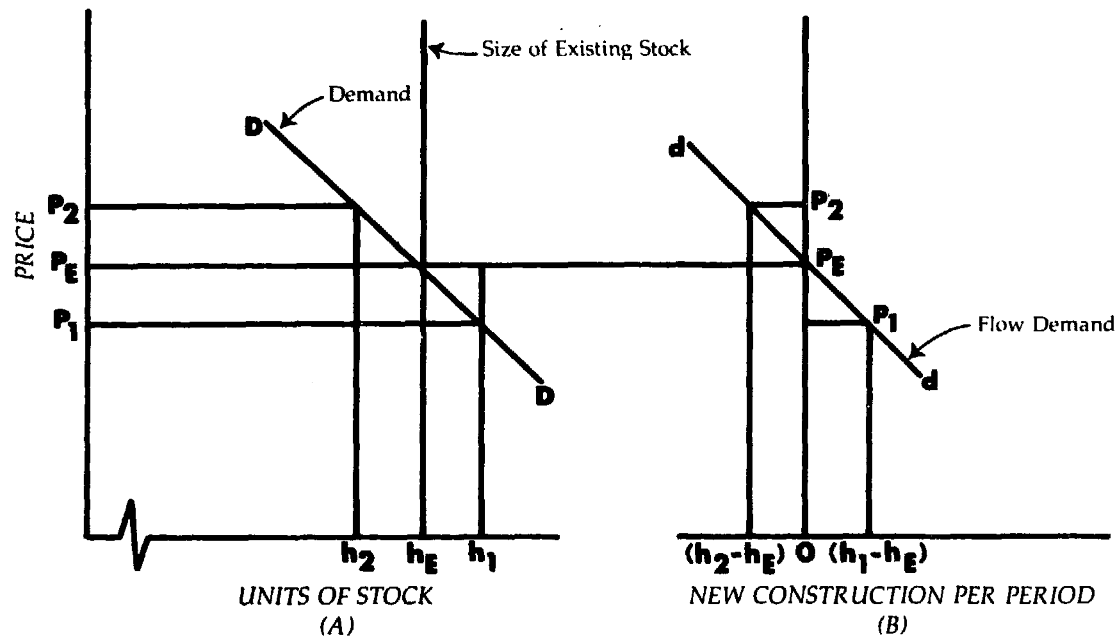


FIGURE 2. THE DEMAND FOR HOUSING STOCK AND THE DEMAND FOR ADDITIONS TO THE STOCK.

Figure 3 portrays the stock-flow housing market in equilibrium. The actual size of the housing stock, h_E, is such that at the equilibrium price, P_E, the desired stock is equal to the actual stock and the level of new construction will be zero.

If we introduce into this balanced equilibrium world a change in some underlying factor, be it an increase in income, a fall in the rate of interest, or a change in consumer tastes for more housing, which causes demand to increase the service demand function and flow demand function for housing will both shift up. Graphically, in figure 4, this would be illustrated by a shift up in demand from D_1D_1 to D_2D_2 and in flow demand from d_1d_1 to d_2d_2. P_1 was the previous equilibrium price. It will not be maintained in the face

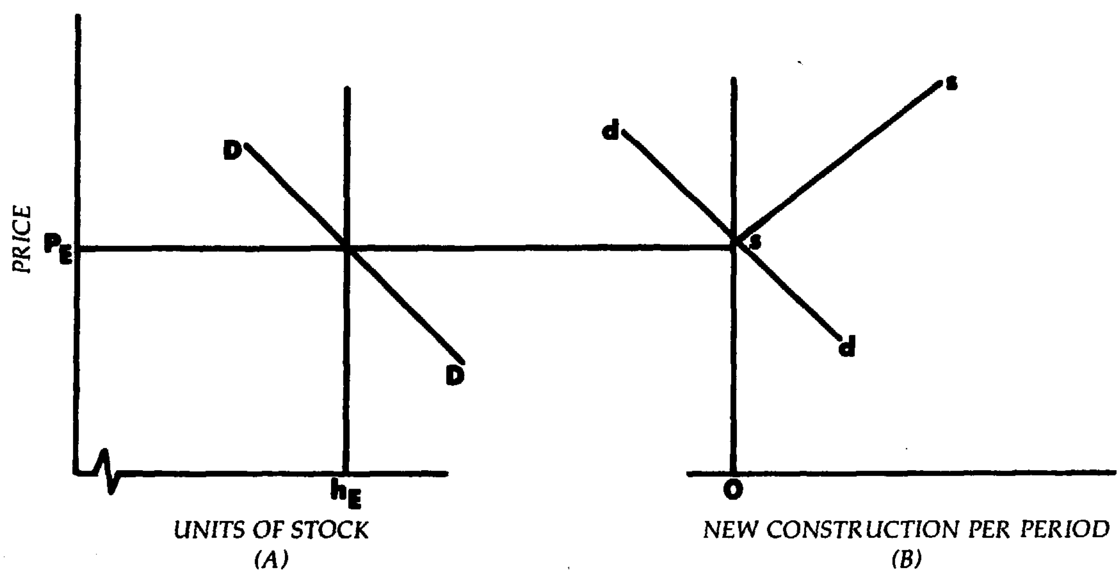


FIGURE 3. THE HOUSING MARKET IN EQUILIBRIUM.

of the increased demand. Price will immediately rise to P_2. The price of housing will fall by the end of the first period to P_n, the housing industry will be producing Δ h units per year. As these units are added to the existing inventory the flow demand schedule will fall because the housing stock of panel A will be growing. The size of the stock after the end of the first period will be ($h_E + \Delta h$) and the flow demand will be shifting down. Eventually, as the stock continues to grow and flow demand continues to fall the housing market will attain the long-run equilibrium price of P_1.

The following discussion provides an approach for determining the resource costs and income redistribution gains associated with reaching a target level of the housing stock. Before the redistributive nature of housing needs can be clearly seen we must consider the notion of the "benefits" associated with any investment, e.g., housing, which has as its object the reduction of the cost of a product or service. (Primary to the notion that a housing "problem" exists is the impression that housing is too expensive.) In these instances the basic measure of benefits can be thought of

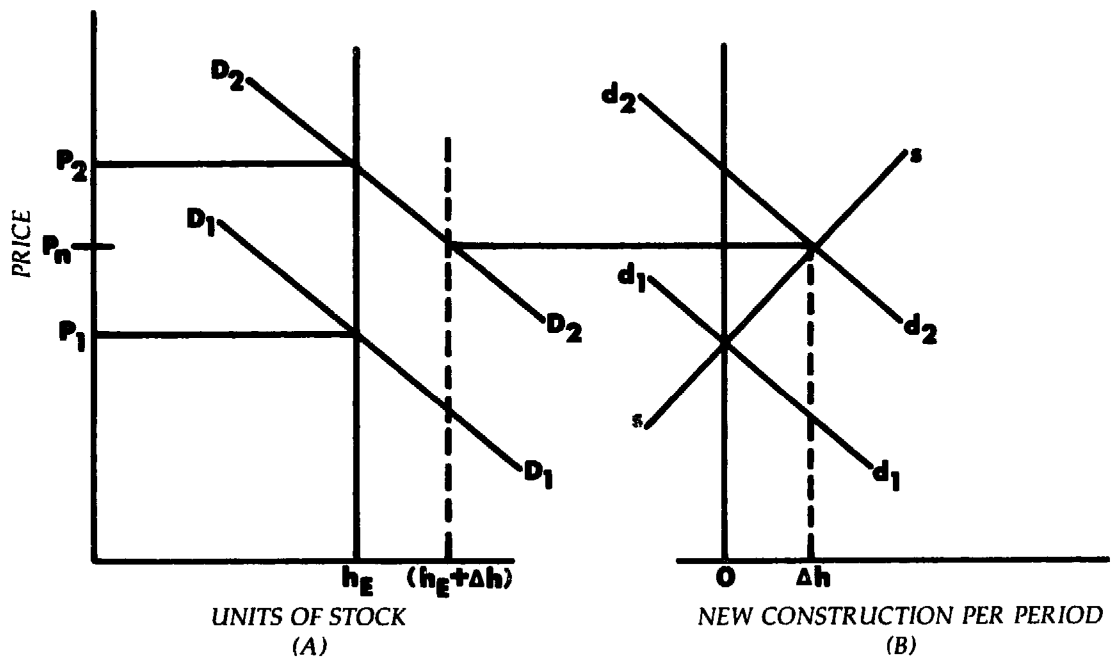


FIGURE 4. THE ADJUSTMENT OF THE HOUSING MARKET TO AN INCREASE IN DEMAND

The meaning of "housing needs" can now be put in the perspective of a stock-flow housing market analysis. Using such an analysis can shed some light on the issues that are involved in determining the minimally acceptable standard which is set as the target in a housing needs study. The obvious principle behind the establishment of a housing standard is equivalent to the specification of an amount of income redistribution that ought to take place. Accomplishing a given size of income redistribution will entail real resource costs. Explicitly identifying the size and beneficiaries of the income redistribution which is implied by a specific housing standard and asking how much it will cost in terms of resources will clarify the tradeoffs that are involved when discussing the concept of housing needs.

as a measure of "consumers' surplus." In a market situation (see fig. 5), consumers purchase x_1 units of goods at price P_1. The dollar costs to consumers for these units is given by the area OCBA. The total dollar value to consumers of the OC units can be measured by the area under the demand curve, OCBD. Thus, consumers realize a surplus of the amount ABD in their valuation of the x_1 units over their costs. This amount, ABD, is known as consumers' surplus. The benefits to consumers of a fall in the price of a product due to increased supply can be illustrated in a like manner. In figure 6, if price falls from P_1 to P_2 consumers will realize an addition to their consumers' surplus of the amount DCBA.

Programs which fulfill unmet hosing needs are of

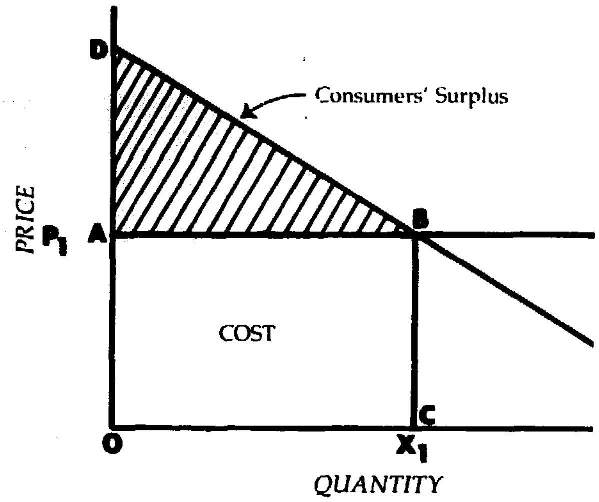


FIGURE 5. CONSUMERS' SURPLUS

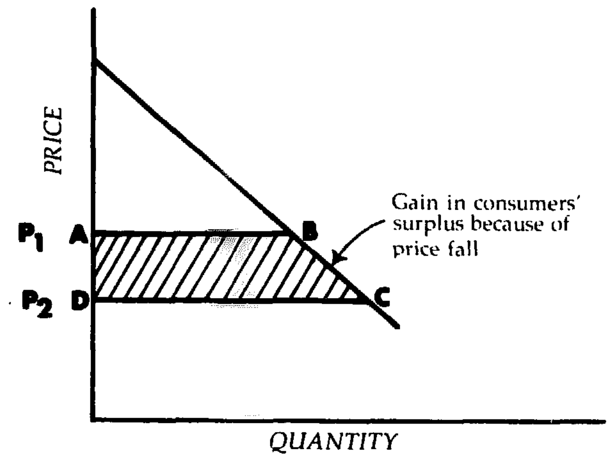


FIGURE 6. INCREASE IN CONSUMERS' SURPLUS DUE TO A FALL IN MARKET PRICE

direct benefit to those which occupy the new, standard, subsidized housing which has been built to satisfy the housing need. In addition to these direct beneficiaries, other groups will reap benefits which arise because of increases in consumers' surplus which will occur because of the impact of the needs fulfillment programs on housing prices.[9]

Returning to the stock-flow framework, the fulfillment of housing needs will result in addition to the stock of housing which will lead to lower housing prices for the rest of the inventory and corresponding gains in consumers' surplus. Figure 7 illustrates this process. If we start off in an equilibrium position at price P_E in figure 7, but assert that the housing stock is not up to the desired standard of h*, in order to secure h* prices must fall to P_1. Those occupying the existing units will benefit by an amount of EDBA because of the fall in price from P_E to P_1. This dollar amount of gain can be considered to come at the expense of the existing owners of the stock since they will experience an equivalent loss in rental income. Thus one effect of realizing h* will be to redistribute income from one group (landlords) to another group (tenants). Additionally, area DCB will also be confered to those who enter the housing market in response to the fall in price from P_E to P_1.[10]

In figure 7 the shaded area in panel A can be thought of as the amount of income redistribution that is accomplished by attaining h*. But in order to provide the extra (h*-h) units the housing construction industry will require that the housing price be P_2. The total incremental resource cost of the (h*-h) units will be $P_2 \times$ (h*-h). Since consumers will pay P_1, but not P_2, the resource costs which must be met by the public sector will be $(P_2 - P_1) \times$ (h*-h) (see the shaded area in panel B of fig. 7). This subsidy cost per unit times the extra number of units represents the resource costs borne by the public sector of achieving the income redistribution effect of ECBA.

The income redistribution will arise as these extra units are added to the inventory and a fall in price is dispersed across the rest of the occupied inventory. Price will fall to P_1, given the subsidy, and the users of the existing stock, will realize a consumers' surplus gain from the lower prices.

It will not always be the case that the amount of redistribution will be larger than the public cost of achieving that level of redistribution. Consider figure 8, where the subsidy required, P_1HTP_2, is greater than the gain in consumers' surplus, DCBH. In this case, meeting the current housing need of (h*-h) confers

---

In addition to the redistribution effects which arise because of changes in consumers' surplus, housing programs may also generate other benefits. Examples of these are increases in sanitation and subsequent reductions in ill-health, reduction of density and subsequent lowering of crime rates, and increases in worker productivity because of the better housing conditions. These by-products of housing programs may or may not exist. In fact, a new housing program could aggravate crime rates, worsen the sanitation problem, and increase densities. Evaluating these other non-market benefits can only be done in the context of a specific housing program. They are not generalizable like the consumer's surplus effects. Thus, the non-market benefits can not be dealt with in this paper.

[10] Society need not impose the cost of income distribution only upon the landlords. General tax revenues can be used to compensate landlords for their losses.

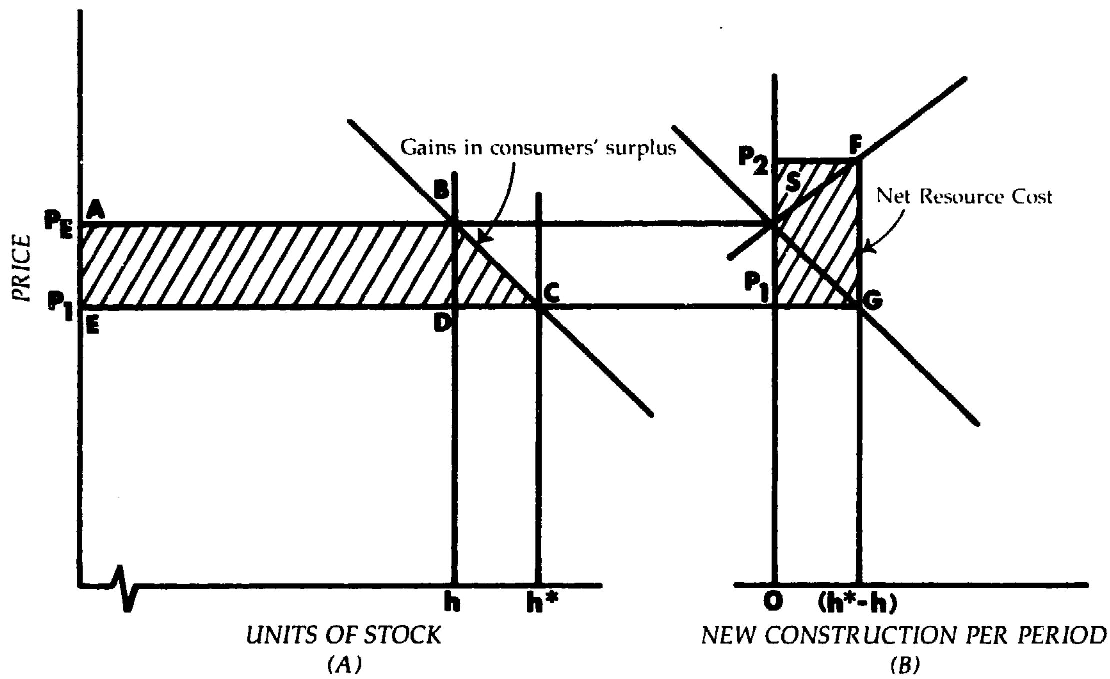


FIGURE 7. AN EXAMPLE OF THE GAINS IN CONSUMERS' SURPLUS BEING GREATER THAN COSTS—RESULTING FROM A PROGRAM DESIGNED TO MEET HOUSING NEEDS

much less in the way of redistribution change per dollar of resource cost than depicted in figure 7.

Within the context of this stock-flow model, three factors interact to determine how expensive the income redistribution associated with a particular mimimal standard or target (specification of h*) will be. They are: (a) the price elasticity[11] of the stock demand for housing, (b) the price elasticity of the supply of new construction, and (c) the relative size (as a percent of the size of the existing inventory) or the housing needs gap (see appendix B to this paper for a more detailed discussion of these conditions). These factors can be manipulated to describe one upper limit of the housing standard. The size of the housing gap (h*-h) can be expressed as a fraction of the original size of the housing stock, i.e., as $\beta \times h$ where β is a constant multiplier equal to (h*-h)/h. This gap parameter can be used to describe where a housing standard, h* max, implies net resource costs equal to the amount of income redistributed. In equation (7), h* max. is the size of the stock of housing such that any additions to the stock past h* max will result in a housing needs construction program whose public sector resource costs are greater than the dollar value of its redistribution impact.

$$h^*_{max} = h + \beta^* h \qquad (7)$$

In this model β^* depends on the ratio of the stock demand price elasticity of housing to the price elasticity of new construction supply. If the standard set in a needs study implies a standard where $\beta > \beta^*$, then the housing standard specifies that achieving $1 of income redistribution entails more than a $1 net resource cost. If $\beta < \beta^*$, fulfilling housing needs will result in housing programs where the redistribution gains are greater than the net resource costs which must be borne by the public sector.

Although it is the case that housing needs studies are bound to involve normative elements, the discussion above implies that there are economic factors relating to the real resource costs of redistribution which can guide the setting of the housing standards. These factors are rooted in the housing market characteristics of a particular economy. The first economic characteristic of impact is the price elasticity of demand. It will depend upon the underlying tastes and preferences of the consumers in a particular area. It will be influenced by an area's level of income. Of equal importance is the elasticity of supply. It also

[11] The elasticity of demand is the ratio of the percentage change in quantity demanded divided by the percentage change in prices. The elasticity of supply is the ratio of the percentage change in quantity supplied divided by the percentage change in price.

will depend upon many institutional factors which vary across economies. The degree of competitiveness in the housing industry, the level of production technology employed within a particular country, and the responsiveness of the housing industry to innovation are three underlying factors. Nevertheless the desire for greater equity[12] and a willingness to use the housing market as a tool to increase equity, fundamentally potential Pareto[13] improvements. Thus care should be taken not to interpret cost-effectiveness computations as ranking redistribution schemes on the basis of efficiency grounds. Whether or not the equity or redistributive effects of such programs are justifiable must be decided, not on economic grounds, but on the views of the policy makers towards the desirability of attaining a more equitiable distribution of income at some cost to real income.

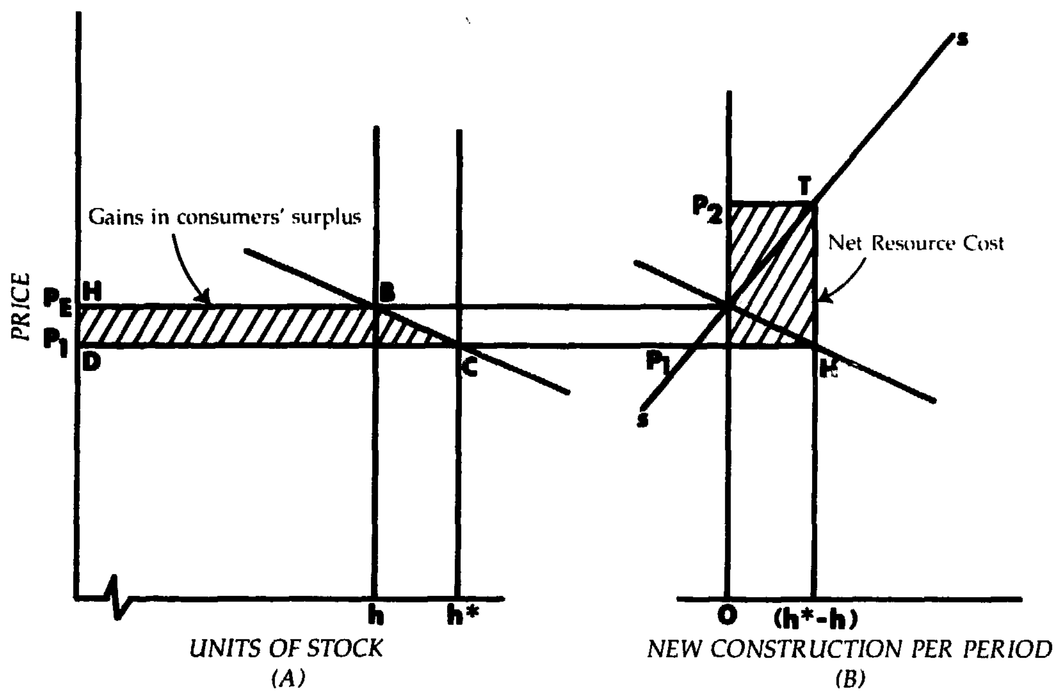


FIGURE 8. AN EXAMPLE OF THE BENEFITS OF FULFILLING HOUSING NEEDS BEING LESS THAN THE COSTS OF MEETING THOSE NEEDS

lies in the hands of the public policy decision makers. A housing needs study can be used to specify the real resource costs of achieving greater equity. However, other methods are available to the public sector for income redistirbution, e.g., negative income taxes, food subsidy programs, and the non-enforcement of laws against theft. The cost effectiveness in redistributing income via housing programs must be compared to these other alternatives.

The income redistribution goals of housing or other welfare-type programs generally are not examples of

[12] Greater equity is concerned with the redistribution of income from higher income groups in the population to those at the lower end of the distribution.

[13] A potential Pareto improvement is one in which an economic rearrangement can result in the gainers being able to more than compensate the losers. In the case of filling housing needs the gainers (the tenant classes) will not be able to compensate the losers (the landlord classes) and still remain better off.

APPENDIX B Derivation of the Housing Standard

The resource costs borne by the puboic sector of a housing program designed to meet the gap in housing needs will be distance AB in figure 9 times the size of the gap, which will be $\beta + h$. Distance AB will be the

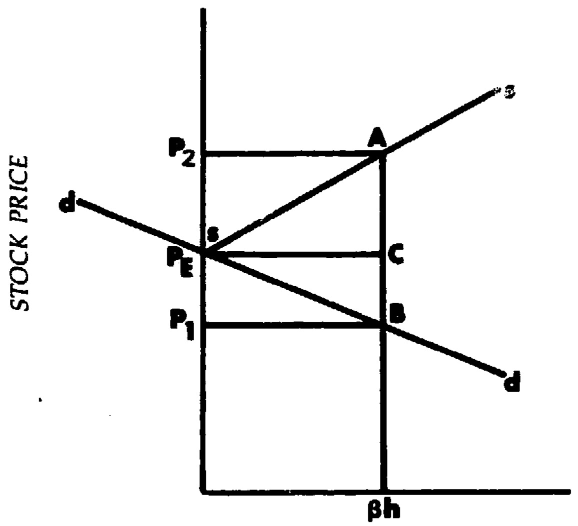


FIGURE 9. DETERMINING THE RESOURCE AND SUBSIDY COSTS OF MEETING HOUSING DEMANDS.

sum of the change in price, CB, that moves along the demand curve, dd, (ΔPd) plus the change in price resulting from moving along supply curve, SS, distance CA, (ΔP_S). Thus, the subsidy cost, SC will be

$$SC = (\Delta Pd + \Delta Ps)\,\beta\, h \qquad (8)$$

The redistributive effect can be measured as the increment in consumers surplus under the stock demand function of Figure 10.

It will be the change in price ΔPd times h plus (utilizing straight line demand curves) 1/2 ΔPd = βh. Thus the benefits, B, will equal.

$$B = \Delta Ph + 1/2\, \Delta Pd\, ph \qquad (9)$$

Setting redistribution effects equal to implementation costs, we can proceed to solve for the value of β which can be used to determine the housing standard at

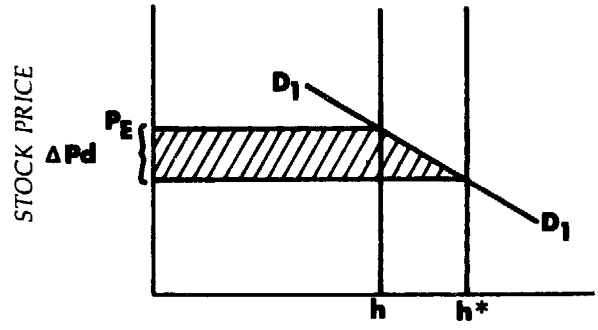


FIGURE 10. MEASURING THE REDISTRIBUTIVE IMPACT OF A HOUSING NEEDS PROGRAM.

which implementation costs are matched by income redistribution effects.

$$(\Delta Pd + \Delta Ps)\,\beta h = \Delta Pdh + 1/2\,\Delta Ph\beta h \qquad (10)$$

Rewriting (10),

$$2\,\Delta Ph\beta h + 2\Delta Ps\,\beta h = 2\,\Delta Pdh + \Delta Pd\beta h, \qquad (11)$$

Subtracting Δ Pdβh from both sides and dividing by h x ΔPd yields

$$\beta + 2\beta\,\Delta Ps/_{\Delta Pd} = 2, \qquad (12)$$

since $\Delta Pd = \beta h \times \frac{P_E \times 1}{Ed \times h}$ and $\Delta P_S = \beta h \times \frac{P_E}{Es \times h}$

(where Ed is the price elasticity of demand and Es is price elasticity of supply) then Equation (12) can be rewritten

$$1/2 + \frac{Ed}{Es} = 1/\beta \qquad (13)$$

which can be rewritten to solve for β

$$\beta = 1/2\,\frac{Ed}{Es} - 1 \qquad (14)$$

Interpreting equation 14 yields the following conclusions:

- The greater the size of the gap between the standard and the actual size of the inventory, the less likely it will be that the housing needs are worth filling.

- Knowledge of the degree of price elasticity of stock demand and flow supply is an important input in the determination of housing needs.

- A combination of very elastic demand and very inelastic supply will combine to make housing needs not worth filling.
- A combination of inelastic demand and elastic supply combine to make the filling of housing needs socially profitable.

ACKNOWLEDGMENTS

This report was conducted by the Building Economics Section to demonstrate the application of economic analysis to the determination of housing needs. Dr. Harold Marshall and Ms. Rosalie Ruegg of the Building Economics Section and Dr. Carl Muehlhause of the Institute for Applied Technology provided constructive reviews of this paper. Mr. Noel Raufaste Jr., project coordinator of the Center for Building Technology's project to develop design criteria and methodologies for low-rise/low-cost buildings to better resist extreme winds, provided valuable editorial assistance. Those errors which remain are, of course, my responsibility.

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