# THE HOUSING MODEL OF DETROIT

## A Critical Analysis

## and Some Proposals for Improvement

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This is another study in our continuing series on Detroit. This report is an evaluation of Detroit's Community Renewal Program's housing model. I hope the users will find this of interest.

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Appreciation

This paper was elaborated during my stay in Detroit as a senior fellow at the Center for Urban Studies. I would like to thank the Center for giving me the opportunity of studying the problems of the city of Detroit here on the spot.

At the same time, I would like to thank the staff of Detroit CRP for helping me to find that kind of information I needed to make these comments on the housing model of Detroit.

Walter Bohlk

Detroit, December 1971

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# Foreward

A complicated planning tool, such as a mathematical model, cannot be developed in a short time. The development of such a model must progress through varying stages, each with its specific limitations. It is, therefore, most important for the people employing the model to be aware of such limitations so as not to overestimate the tool's usefulness. I found indications of this awareness in publications, and discussions with various people, from the CRP of Detroit.

In this paper I have elaborated upon all those weak points which seemed to me to be most important. I hope that the proposals for implementation at the end of the paper will contribute to the improvement of the model.

## 1. Reasons to Develop a Mathematical Model

### 1.1 General Reasons

Plans are made in the urban field and elsewhere to allocate the limited amount of resources in that way in which the goals are achieved to the highest possible degree.* Which of various alternative plans is the best one can only be decided by knowing their achievement of the various goals. This cannot be done by discussing the qualitative aspect only, but also the quantitative one, which always demands some kind of calculation.

On the other hand, the planner knows quite a lot about various relations in the urban process, but the whole system is so complex that no one can calculate all the relations we know today without any tool. . And with increasing knowledge of quantitative relations definitive nobody will be able to see the impact of various actions on the whole system without using some kind of computer.

But mathematical models are not only a necessity in urban planning, they also can have a lot of other advantages, some of them shall be mentioned briefly:

a) Politicians and planners must fix their goals.** No hidden ideologies or goals are going into the model, as this very often happens in normal plans.

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* How to find the goals and the problem of contradicting goals shall not be discussed in this paper.

** There is, of course, a feedback from the result of a plan to the goal, but this can easily be taken into consideration in a new computer run (another advantage).

b) Everybody can repeat the whole process of planning, and comes to the same result as long as he agrees with the assumptions. If he does not agree, he may change the assumptions and with a new computer run he gets the impact of his changes.

c) The discussion can be focused on the main points as a sensitivity analysis shows the most relevant points.

d) Nobody can predict future events exactly, therefore the planner has to use a planning tool which controls the actual development, compares it with the plan, and remodels the plan if necessary. This can be done far faster with a mathematical model than with other planning tools. Beside the advantage of high speed for updating, it is also insured that only those constraints are changed which are due to change, so that the results of the various plans are comparable.

There are quite a lot of other possible advantages which shall not be discussed in this paper.

### 1.2 Main Reasons for Developing the Housing Model of Detroit

Beside the general reasons of point 1.1, there were three main reasons for the development of a housing model for Detroit.

#### 1.2.1 Better Information About the Existing Housing Stock and Its Changes

Before the housing model was developed, there was very little information about the existing housing stock and its change. The knowledge of what exists was an advantage per se and at the same time the first necessary step for the model.

### 1.2.2 Better Understanding of the Housing Market

One of the main forces influencing the development of American cities is coming from the housing market. Up to now, very little is known about these forces. But with a higher involvement of public money in this process the local politicians must have a better understanding of the market forces.

### 1.2.3 Checking Impacts of Various Public Actions

Nearly all public actions have, more or less, impact upon the housing market. For a politician it is very important to know which impacts his various actions have. For instance, what will be the influence of 1,000 public houses per year on the housing market or the construction of a new motor-way or code enforcement programs, etc.

## 2. Description of the Model*

The housing model of Detroit is a market simulation model. Depending on the various classifications, it is a heuristic model rather than an optimization and it is a deterministic, not a stochastic one. It starts with the U.S. census of 1960 and develops for each two-year period demand and supply of housing up to 1980. The existing housing stock is divided into 45 groups taking into consideration tenure (own or rent), building type (single family or multiple of various size and public housing), size of dwelling units (rooms), and conditions (normal, deteriorated, dilapidated). There are 12 location categories depending on the predominant type of housing and median family income in the neighborhood. The forecast for the amount of dwelling units in each group and location for each time period (2 years) is made externally.

To meet the model's need on the side of demand, the population is divided into 40 groups depending on income, race, family type and family size, and for each time period a forecast of the number of households in each group has to be made.

As a simulation of the market process, every second year all housholds try to supply their housing demand under certain preferences. The main output of the model is a list of surplus or shortage of dwelling units belonging to the various housing groups in various locations. For lack of other information it is assumed that the actual distribution of household groups in 1960 to groups of dwelling units and location corresponds with the preferences of the housholds.

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* For more detailed information, see list of references at the end of this paper.

Therefore, the houshold groups are distributed every second year to the available housing on the basis of the group's actual distribution in 1960.

There are alot of other possibilities built into the model, which just now--in the so-called first generation--cannot be used for lack of information.

## 3. Some Critical Remarks

### 3.1 The General Concept

Before Detroit decided to develop a housing model it had studied all existing models to find that one which was most appropriate to their problems. There is no doubt that the best way to analyze the mechanism of the housing market and to study the impact of public actions to the market is to develop a market simulation.

### 3.2 The Problem of Accumulating Errors

The Detroit housing model is derived from the San Francisco CRP model which had 114 household groups, 22 land-use types, 14 location categories and 4 conditions of housing. The preference list for housing had 50 possibilities. The combination of these large groups included a high possibility of accumulating errors. Therefore, and to diminish the work involved in data collection and external forecast, it was decided to have more activities in one group and have a smaller amount of groups. But here, only a qualitative statement was made where a quantitative analysis of possible errors at the end of the computer run should have been made. Taking only the possible amount of error into consideration which comes into the model through the external forecast of 40 household groups for each second year, in combination with the 45 housing groups, may lead to high probability of error which could make the whole model less useful than to use less household and housing groups. This should be tested before the result is used for policy decisions.

### 3.3 Simulation of the Market and Reality

A well-known difficulty in developing a mathematical model is to get the right frame of references. As it would be far too complex to make a

model of reality with all bindings to other activities, one has to cut the minor relations, replace them by external assumptions and concentrate on the main subject. It is relatively easy to define the "main subject." That would be in this case the housing market of Detroit. But what are "minor bindings" which may be neglected? There are lots of relations to space, time and other subjects. Some of them are dealt with in the following points.

### 3.4 The Regional Aspect

There exists no housing market in Detroit within the city boundary. Everyone who is looking for accommodation in Detroit is talking about the region and not about the city, and each developer who offers a house, offers it in the region (including the city). On the other hand, one of the main problems of Detroit is caused by the fact of this regionally open housing market. Therefore to analyze the function of the housing market or to study the impact of various public actions, one has to take the whole region into consideration. This must not be done within the same model, but considerations must be made on how, for instance, the various public actions may affect the external variables (such as number of inhabitants in the various household groups). And even by analyzing the preferences of the various households to housing groups, one cannot get an accurate result by looking only at the distribution within the city boundaries.

### 3.5 Accessibility

The road network of Detroit is so dense and so good that it sounds very believable that for housing decisions, accessibility within the city boundaries plays a minor role. But for two reasons one should take this

aspect into consideration:

a) As soon as the necessary extension to the region is made this problem inevitably comes back to the model.

b) One of the main reasons for developing the model was to check the impacts of various public actions. This is not only meant for actions within the narrow field of housing, but also in other public fields such as highways and public transportation. If there would be no impact of a proposed subway to land use, it would not be worthwhile to spend the money.

### 3.6 Changing of Housing Stock

The model itself provides the possibility of taking the change of the existing housing stock into consideration. But for lack of information this advantage cannot be used. On the other hand, the deterioration of the existing housing stock seems to be one of the biggest problems in Detroit. Neglecting it means to miss the point. There will be some further comments on this problem under 4.2.

### 3.7 Influence of Demand and Supply on the Market Price

One of the basic rules of the market theory is that the price depends on supply and demand. Consequently this relationship is built into the model. As soon as the demand for a special housing type in a special area exceeds the supply, price for this type will increase and therefore demand will decrease (and at the same time construction activity will be generated as profit increases). But again, for lack of information, this basic function had to be neglected in the first computer run. The construction activity is forecasted externally and therefore no possible reaction of private developers to public actions can be measured.

### 3.8 Housing Preferences

As mentioned earlier (see point 2) household groups are distributed to the available housing stock every second year on the basis of the group's actual distribution in 1960. By doing so, it is either assumed that each household in 1960 was satisfied with its home or that the proportion of dissatisfaction in 1960 is going to continue through 1980. Instead of this, effort should be made to diminish the existing dissatisfaction. This is only possible if the planner had a list of the real preferences of the households and if possible its change by time. Some further remarks on this problem follow under point 4.1.2.

### 3.9 Rate of Interest

There is undoubtedly a relationship between the rate of interest and construction activity on the housing market. Unfortunately, up to now there has been very little research done in this field. But nevertheless, this relationship should be taken into consideration--especially as it seems to be worthwhile to think about public activities on various levels to stimulate or discourage private construction by introducing an artificial rate of interest for special investments.

### 3.10 Rate of Inflation

Various factors of the housing model are influenced by the rate of inflation. The most important points are: the influence on the external forecast of population (especially the distribution of various socio-economic groups), the influence on the housing preferences, and the influence on the construction activity. Further aspects will be discussed under the next point.

## 4. Proposals for Implementation

### 4.1 Impact of Inflation Rate

#### 4.1.1 Population Forecast

The future number of inhabitants in Detroit has to be calculated externally. This was done in the past in close connection with the forecast of TALUS. There has been quite a lot of population forecasting done for Detroit before TALUS (see list of references) and afterwards, as for instance in the Doxiadis Study. And for those who are mainly interested in the various methods of population forecasting, there are many studies for other American cities available. As this population forecast in connection with the housing model has to take into consideration the development of income, it also has to deal with the inflation rate. This can be done in various forms, but one has always to consider the adequacy to the distribution problem. The easiest way of handling the problem seems to be to calculate only with real income figures, and never in nominal figures. By taking the inflation factor: $f = \frac{\text{Nominal Income}}{\text{Real Income}}$ .

into consideration, it is always easier to convert one kind of income into the other one.

There may be some problems in forecasting the percentage of households belonging to the various income groups, but that shall not be discussed in this paper.

#### 4.1.2 Impact of the Inflation Rate on Prices for Housing

There is also an impact of inflation to the price (selling or renting) of housing. It is argued that the inflation rate can have various kinds of influences to the housing prices; depending upon whether the special

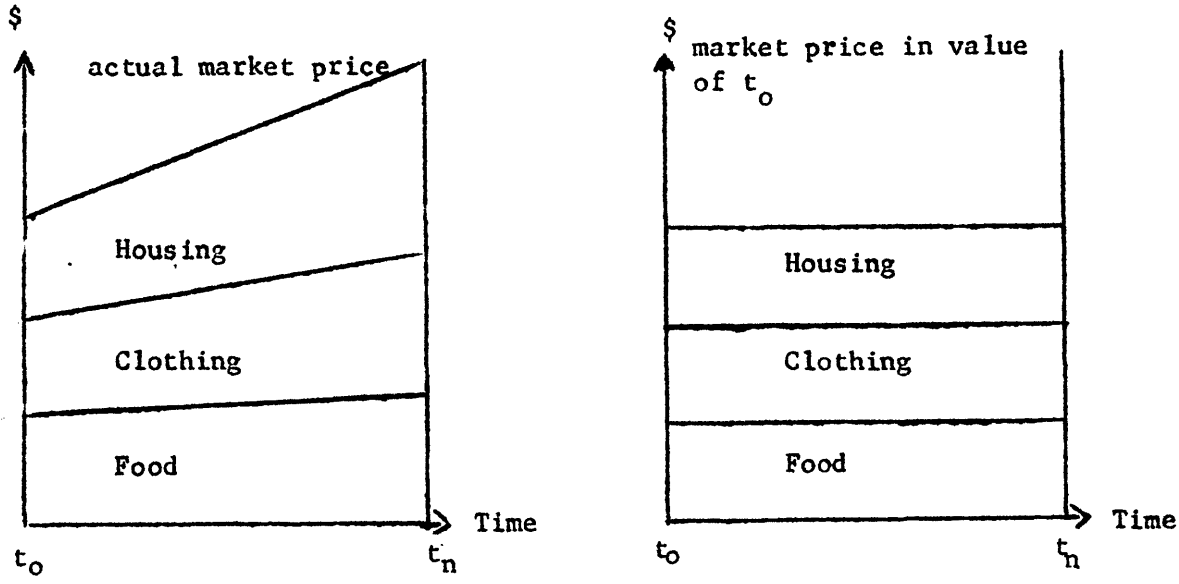
inflation rate for housing is equal to the normal inflation rate or not.

A study in this field has to start with the definition of "inflation rate":

$$f_{\Delta t} = \frac{\text{total price of various goods at time } t_n}{\text{total price of the same goods at time } t_o}$$

$$\Delta t = t_n - t_o$$

For a time period of $\Delta t$ the inflation rate will be the quotient of the prices at the end of this time divided through the price of the same goods at the beginning of the time period. These "goods" contain food, as well as clothing and housing. As long as all goods have the average inflation rate, the diagrams for the actual market prices and the market prices measured in money value of time $t_o$ over time will have the following form:

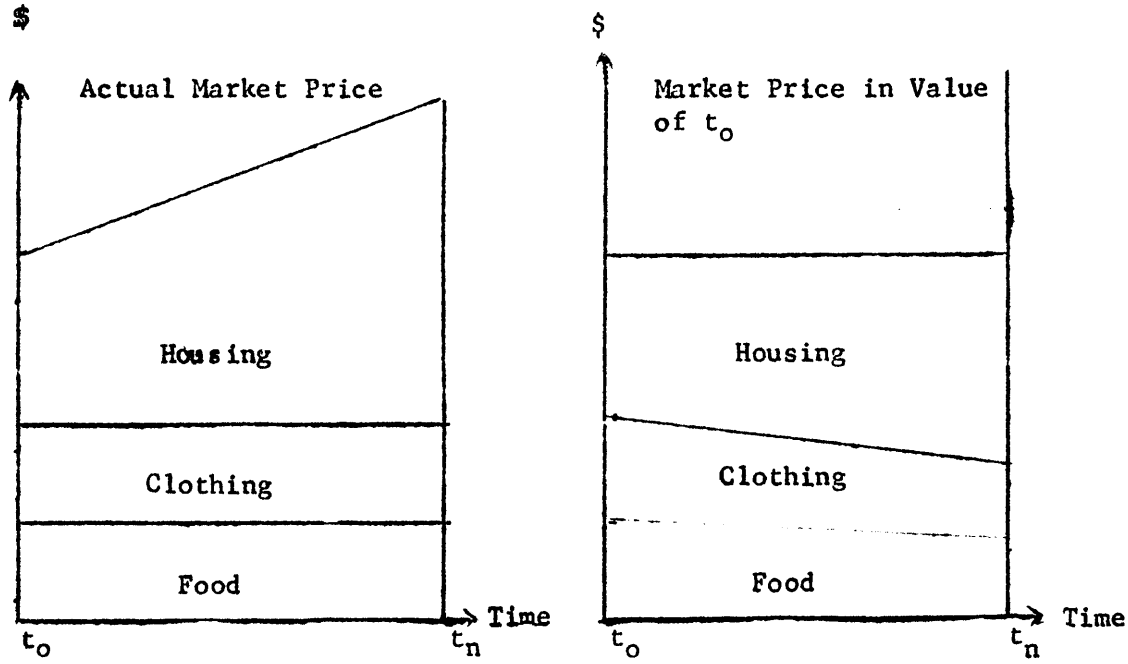



As now by definition

$$\text{Real Income} = \frac{\text{Nominal Income}}{\text{Inflation Rate}}$$

everybody with the same real income at $t_o$ and $t_n$ can buy the same things. So by taking the inflation rate into consideration in population forecasts and price development, there will be no difficulties.

As soon as the inflation rate of housing is not equal to the average inflation rate, the two previous diagrams change:




By definition again any one with the same real income at $t_o$ and $t_n$ can buy the same things (including housing).

Difficulties arise when various kinds of houses have various inflation rates. But this kind of price movement is theoretically built into the model. As for instance the demand for one special housing type is higher than the supply, the price for this type goes up and the demand goes down. (See point 3.7.) The recommendation for this problem would be to neglect the inflation rate in the first calculation and take it only into consideration when the results shall be "translated" into reality. This means, of course, that one has to use the real income as a scale for the household groups and gets therefore a sliding scale for nominal income boundaries.

In this connection there arises another interesting theoretical question.. How would the list of preferences (for housing) be affected if there would be a special inflation rate for each income group? This will be for the next time only a theoretical question because there will be no separate inflation rate available for the various income groups.

4.2 Changing of Housing Stock

A large part of the existing housing stock in Detroit was built between 1900 and 1930 when the population of the city increased from 300,000 to 1,500,000 inhabitants. These houses were not built to last forever, but to meet the enormous needs of that time. They now deteriorate very rapidly, which seems to be one of the main problems of the city. But for lack of information this fact could only be theoretically built into the model. There are various theories of deterioration developed, but none of them seem to meet the needs of the Detroit model. Therefore, just recently (August, 1971) the Detroit CRP developed their own deterioration function, using Detroit data from 1964 and 1969. With the application of regression analysis, very interesting relations between various factors were discovered. More than 100 variables were checked in the study and finally six of them were found relevant to deterioration. Unfortunately, some of these six groups of data are difficult to receive, such as "percent of heads of households with less than twelve year education" or the "index of race related turnover based on the relative change in black households with less than five years residence in an area."

As only for a certain area of Detroit (where neither extremely good nor extremely bad houses are situated) this demanded information was available;

it should be tested as to whether or not the described deterioration function is also valid for neighborhoods of extreme conditions.

In the housing model of Detroit, construction activity (private and public) is externally forecasted (not developed inside the model). The "Rebound Hypothesis" of the deterioration study seems to be quite valid, but it does not fit into the construction of the housing model. In the basic data for the deterioration function no special information was given about the impact of public actions (such as the redevelopment or rehabilitation) nor of private construction. Therefore--before using the deterioration function in the housing model--it should be checked whether the increase of good housing in 1965-69 is caused by new construction or public actions.

## 5. Summary

The main scale to judge the quality of model is the degree to which it meets the stated requirements (see point 1.2).

--It provides very good information about the housing stock and the inhabitants in 1960. The changes of the housing stock, however, cannot be predicted with the model.

--All people who study the housing model get a good understanding of the housing market although the model up to now produces very little quantitative information about the actual market forces in Detroit.

--It seems to be doubtful that the housing model in this stage can be a great help to check the impact of various public housing policies. The main reasons for this judgment are developed under point 3. They are as follows:

a) Up to now, there has been no information available about the problem of accumulating errors.

b) Without the impact of demand and supply upon the market, no reaction of the market following public actions can be checked with this model.

c) As long as the model is limited to the city of Detroit, it cannot stimulate the real market situation.

d) As long as the deterioration function is neglected in the model, a very important factor is missing.

But beside the main scale, a lot of very important advantages of the model had to be taken into consideration. As developed under point 1.1, the urban decision-maker of the future has to use some kind of mathematicl model--and the housing model of Detroit is a very good starting point. The weak points are mainly generated by a lack of very precisely formulated information. No good tool is developed in one day, and the housing model in this stage tells the researchers where to start.

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