A NEIGHBORHOOD INTERACTION MODEL OF HOUSING MAINTENANCE AND QUALITY CHANGES BY OWNER OCCUPANTS

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Traditional models of housing upkeep expenditures, such as those by Dildine and Massey [7], Asmus and Iglarsh [2], Ozanne and Struyk [21], Segal [25] and Winger [32], have assumed that owner occupants attempt to maximize the present value of "profits" or "net returns" implicitly provided by the level of housing services embodied in their dwelling. As such, owner occupant behavior becomes indistinguishable from that of investment-motivated landlords or housing contractors. Yet, there have been numerous assertions and anecdotal observations that owner occupants' housing quality decisions may be made according to different criteria than those employed by purely profit-maximizing landlords [13, 22, 26, 27, 28, 29]. This coupled with growing evidence of the influence of socio-psychological dimensions of the neighborhood on homeowners [1, 10, 12], suggests that a model ground in consumer theory which embodies both physical and socio-psychological neighborhood effects be given more systematic consideration. Valuable initial steps in this direction have been taken by Sweeney [30] and Mendelsohn [16], who have developed homeowner maintenance models based on utility-maximizing behavior which also attempt to integrate investment considerations.[1]

The formal model presented in this paper follows in the spirit of this latter work, but synthesizes neoclassical economic consumption theories, production theories, and social-psychological concepts. The model is comprised of two central elements. The first is the "utiltiy function" of the owner occupant household, the arguments and parameters of which are shaped by current and expected future physical and socio-psychological conditions in the neighborhood. The other is a set of "transformation functions" which embody the budgetary, technological, and neighborhood physical and socio-psychological constraints involved in obtaining various housing quality packages via modifications of the homeowner's original package.

Several unique contributions are provided by the model:

a) Behavioral impacts of current and expected future neighborhood characteristics such as physical condition, overall housing price levels, and the homeowner's socio-psychological relationship with neighbors are explicitly modelled.
b) A unified framework is developed within which not only homeowner's maintenance but also discontinuous upward and downward alterations of housing quality can be comprehended.

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[1] Sweeney [30] relates the length-of-tenure consumption desires of owner occupants to their dynamic housing investment decisions; Mendelsohn's static formulation [16] specifies the asset value of the dwelling as an argument in the household utility function. An approach similar to Mendelsohn's is employed here. Chinloy's model [5] also represents a hybrid of consumption-investment behavior, but does not derive optimal maintenance rules.

c) Differentiated constraints determined by the type of housing quality strategy being considered are specified with embody not only budgetary but also technological and neighborhood physical and socio-psychological dimensions.

d) The extreme sensitivity of optimal housing quality strategy to alterations in the homeowner's socio-psycological relationship wth neighbors is demonstrated.

e) While yielding conventional predictions consistent with the limited empirical evidence in the area, the model also provides a theoretical explanation for other observed behaviors which cannot be explained by previous models.

The paper first outlines the pure theoretical model, specifying the basic elements of utility functions, transformation functions, and the choice of optimum housing quality. Next, the richness of the model is demonstrated by using it to explain several realistic scenarios in both comparative static and dynamic contexts. Its predictions will be compared to those of previous models and to available empirical evidence.

The Model

The behavior to be analyzed is the decision of an owner-occupant of a single family home whether to improve the quality of the structure, maintain quality at the current level, or allow quality to decline (either by passive undermaintaining or by active downgrading of the dwelling). Maintaining or improving structural quality may be seen as increasing utility gained from "consuming" (i.e., living in) the dwelling, but it requires a sacrifice of income which could be spent otherwise. Reducing its quality, on the other hand, sacrifices such housing-related utility but allows for greater non-housing consumption, especially if the generation of added income accompanies the quality decline. A secondary consideration likely for owner households is the wealth effect of such activity. If some utility is placed on the value of the durable housing package as an asset beyond its current value as a consumer good, it will alter the calculus of the housing quality decision. The decision is further complicated by the fact that the overall quality of the housing package consumed and its asset value are not only a product of its structural quality but also of numerous physical, economic, and socio-psychological dimensions of the surrounding neighborhood which are beyond the individual homeowner's control. Thus, for any given time period, the household's utility-maximizing choice of housing vs. nonhousing consumption will be determined by a variety of factors shaping household preferences (socio-economic and demographic characteristics of the household, their neighborhood physical condition and housing price levels and their socio-psychological relationships with neighbors) and by those delineating the various budgetary, technological, and neighborhood physical and socio-psychological constraints involved (prices of housing inputs, age and type of structure, neighborhood physical quality and socio-psychological dimensions). Given this brief introduction, the formal model follows. For the reader's convience, a glossary of all symbols used is found in the Appendix.

Utility Function Specification

The utility of the owner-occupant household is given by:

$$(1) \qquad U=f(H,Z) \qquad \text{s.t. } H \geqslant H_m \quad Z \geqslant Z_m$$

where H is a homogeneous unit of a composite bundle of housing-related characteristics which is considered in more detail below, and Z is a homogeneous unit of a composite bundle of non-housing related consumption items. H_m and Z_m are the minimum quantities of H and Z needed for household survival. It is assumed that both H and Z are normal goods and demonstrate diminishing marginal utility, whence the first and second partial derivatives of U with respect to its arguments have the following signs:

$$U_H, U_Z > 0 \qquad U_{HH}, U_{ZZ} < 0 \qquad U_{ZH} = U_{HZ} > 0$$

The concept of the H good necessitates further consideration. Previous maintenance theories have utilized a related concept of "housing services" [5, 6, 7, 14, 19, 21, 30] but have not clearly distinguished between the characteristics of the structure and parcel (which are affected by owner occupant maintenance decisions) and the locational/physical features as well as the socio-psychological aspects of the neighborhood (which are not).[2] In the model H is formulated as a multiplicative function of: HS, the physical attributes of the housing structure and parcel; HN, the locational/physical attributes of the neighborhood including such aspects as accessibility, demographic, racial, and socioeconomic composition, quality of structures, environment, and public services, etc.; and HA, the level of socio-psychological "attachment" to the neighbors and/or neighborhood held by the owner occupant. It is presumed that "attachment" would be directly related to the homeowner's degree of familiarity, interaction, and identification with neighbors, and to the aggregate level of the neighborhood's social cohesiveness, identity, or pride. For a more detailed explication of this concept, see [10].

Symbolically:

$$(2) \qquad H=(HS)j(HN)k(HA)$$

where $HS, HN, HA \geqslant 0$; $j(HN), k(HA) \geqslant 0$; $j', k' > 0$; $j'', k'' = 0$. The j and k functions are used in order to avoid loss of generality via restricting H to a particular weighting scheme of the three sets of attributes.[3]

Behaviorally, what is being suggested by the above specification of H is that the level of "housing services" or "quality" being consumed is not merely determined by the attributes of the individual dwelling and parcel, which are subject to the owner occupant's control. Rather, this level is modified by two

[2] Deldine and Massey [7] view housing services as being solely a function of the quantitative aspects of the structure and parcel. Locational and amenity characteristics of the neighborhood are seen as influencing the price of housing services. Ingram and Oron consider physical attributes of structure and neighborhood, but not social-psychological ones [14, p. 275].

[3] An analogous concept of housing is presented in Smith [26]. There is little theory to suggest whether additive or mulitplicative specifications of H should be used. The multiplicative specification has been suggested by several empirical studies [5, 8, 14, 15]. The overall thrust of the model is not dependent on this assumption of multiplicativity, but the richness of results would be reduced without it.

other sets of factors involving neighborhood quality and attachment, neither of which are significantly affected by intentional actions of the individual homeowner. Of these two modifying sets of factors, the former has been more widely recognized as a significant component of housing quality [3, 4, 14, 15, 24, 26]. Yet, there are growing claims of the importance of the latter, too, although the concept of HA has variously been described as "psychological investment" [1, p. 7-9], "neighborhood identity" [26, p. 77], or "social cohesiveness" and "pride in neighborhood" [23, p. 20]. The well-established role of social interaction, commonality, and perceived friendliness of the neighborhood in the process of residential satisfaction [9, 17, 18] would also suggest that the HA element be included in the definition of H. Yet, no attempt has previously been made to integrate this concept within framework of a formal model of maintenance and housing quality changes.

The form of the utility function f is influenced by such conventional factors as the age, life-cycle stage, and socioeconomic class of the homeowner [8], and also by an added element unique to this model: social-psychological interactions within the neighborhood. It is reasonable to expect, for instance, that a homeowner who is strongly "attached" to a cohesive neighborhood environment characterized by strong pressures to conform to "minimally acceptable" standards of neighborhood housing quality would tend to manifest lower (absolute) marginal rates of substitution of H for Z than in another situation, so as to avoid social stigmatization. Or, in a more positive sense, such preferences would be likely for a household who had close personal ties with neighbors and/or shared in strong community feelings of pride [10]. Besides influencing the overall marginal rate of substitution, these socio-psychological dimensions might also be viewed as imposing an effective lower bound on H which is well above the biological minimum, H_m. This minimum "socially acceptable" level of H, below which the household would not consider falling, is defined at $\bar{H}$. Of course, this socially acceptable minimum housing quality need not exist for all homeowners or in all neighborhoods, and can vary over time within a given neighborhood.

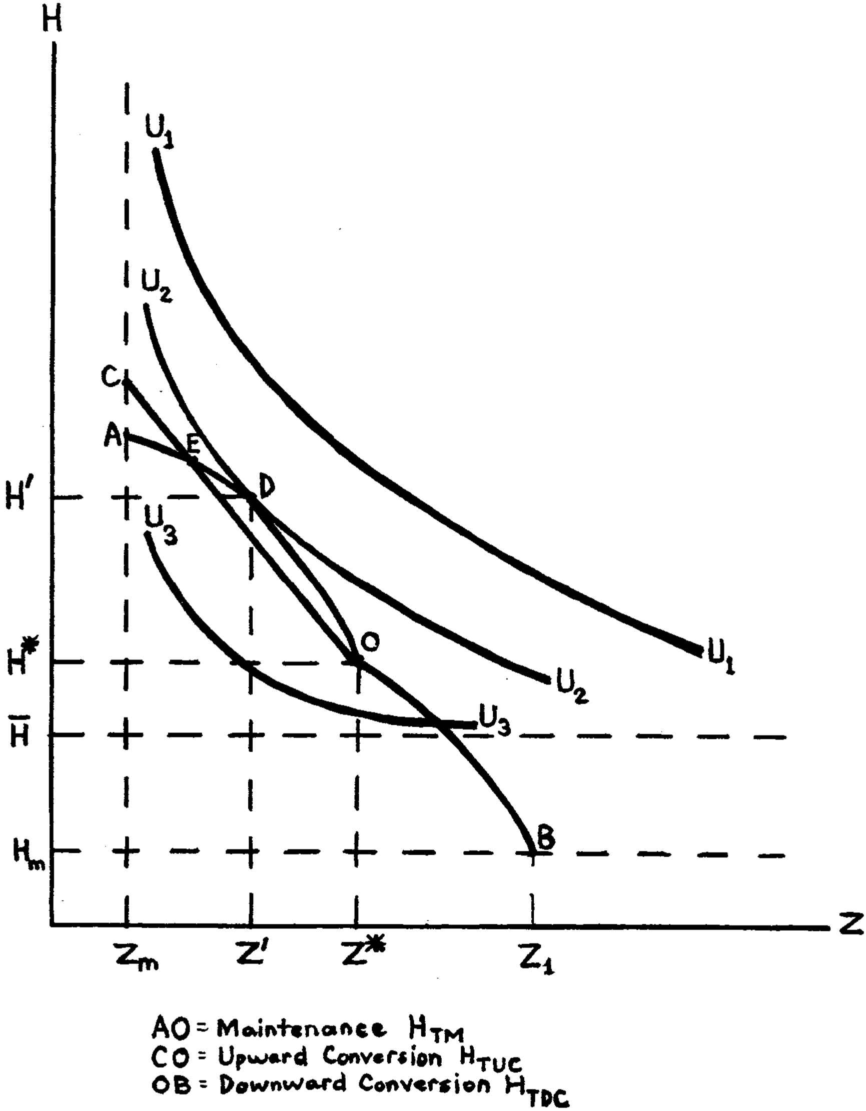
If the household gains utility not only by consuming H directly but also by the asset value of H, $P_H H$, (where P_H is the current price per unit H prevailing in the neighborhood)[4] the relative weight assigned to H by f could be appropriately modified depending on the current and expected furure P_H value. P_H is modelled as a parameter, not an argument, of f since the household can only affect H and not the overall P_H.[5] It would be reasonable to posit that utility placed on asset value is directly related to the owner's time horizon and expected length of stay in the structure.

Three representative indifference curves representing the preferences of a given hypothetical homeowner in a particular neighborhood, at a particular time and P_H, are graphically portrayed in Figure 1. Note: for illustration, a minimum socially acceptable housing quality level, $\bar{H}$, is specified as a lower limit for H toward which the indifference curves approach asymptotically.

[4] P_H is not influenced by neighborhood quality (H is), rather by market supply and demand conditions in the neighborhood housing submarket. This differs from the specifications in Deldine and Massey [7], DeLeeuw, and Struyk [6] and Ozanne and Struyk [21].

[5] Mendelsohn [16] specifies seprate arguments for the consumption and asset roles of H and, thus, P_H implicitly appears as an argument.

FIGURE 1
Optimal Housing Given Utility and Transformation Functions



Constraint Specification

Given that the owner-occupant household under consideration has pruchased its home at some previous time, there will be certain "sunk costs" associated with occupying the home. Such fixed expenses as interest/mortgage payments, property taxes, utility bills, etc. per some arbitrary unit of time, P_0H_0, are an unavoidable claim on household per period income, Y. If no additional expenditure is made during the period on the structural HS component of H (the only component alterable by the household) the level of housing quality which will be consumed is defined as H^*. The associated level of non-housing consumption which can be obtained, Z^*, given price per unit Z, P_z, is:

(3) $$Z^*=(Y-P_0H_0)/P_Z \qquad \text{s.t. } H=H^*$$

Assuming that the homeowner has decided not to move to another dwelling, various housing strategies are available during the period,[6] each associated with particular budgetary, technological and neighborhood physical and socio-psychological constraints:

a) make no additional housing expeditures and consume (H^*, Z^*)
b) sacrifice non-housing consumption $(Z<Z^*)$ in order to improve housing quality $(H>H^*)$ via either:
   i. minor maintenance within the basic HS structural features
   ii. Major alterations of the basic HS structural features
c) sacrifice housing quality $(H<H^*)$ in order to consume more non-housing goods $(Z>Z^*)$ via either:
   i. removal and sale of HS features, i.e., "cannibalizing" the structure
   ii. major subdivision and rental of part of HS, i.e., creating a multiple-unit structure from a single family one.

The household must decide which type a degree of strategy to pursue in order to reach the optimum feasible (H,Z) combination, While easily incorporated into the present model, option c) i. is deemed irrelevant for virtually all homeowners and thus is omitted from further consideration for the sake of brevity.

Formally, the problem becomes on of maximizing utility subject to a piecewise-continuous envelope of "housing transformation functions" which are expected to exist during the period and define the feasible HS, Z tradeoffs. Specification of these transformation functions is the task of the next two subsections.

Maintenance Transformation Function: H_{TM}

The maintenance transformation function delineates the feasible relationships between tradeoffs in H and Z when activities involved in altering HS are conducted within the confines of the existing dwelling and parcel, with no major, discontinuous structural changes being made. In other words, this function deals with changes in housing which are more qualitative than quantitative in nature. With "maintenance" an amount of Z which potentially could have been consumed is foregone in order to improve the quality of HS components (via such activities as painting, redecorating, repairing, landscaping, etc.) over the level of HS that would have existed during the period in the absence of maintenance, HS^*. The amount of improvement in HS due to such maintenance, HM, is given by:

[6] Here the period is defined so that there is no need to worry about the intra-period timing of housing expenditures or converting all estimates to present discounted values. It is beyond the scope of the present work to model the mobility decision endogenously with the optimal housing quality choice.

(4) $$HM = g(M)$$

where HM=0 when M=0, $0 < dHM/dM \leq 1$, $D^2HM/dM^2 < 0$, and M is a homogeneous unit of maintenance activity, having price per unit of P_M. P_M can vary across owner occupants depending on the value of leisure time foregone if the work is done by the owner or the price of professional labor if the work is contracted out.[7]

The g function embodies the technological constraints in maintenance, and is primarily determined by the structure's architectural and construction material type, age, and quality beginning the period. It is also influenced by the skill and physical attributes of the individual(s) performing the maintenance; i.e., the conversion of a given amount of paint or construction materials into HM depends on the productivity of the worker.[8] The assumption of diminishing returns from M is both conventional [7, 14, 19, 21, 30] and reasonable, since a housing structure is far from a perfectly malleable "putty" type of capital.

The maximum amount of M which may be purchased during the period is given by the rewritten budget constraint:

(5) $$M = (Y - P_0H_0 - P_ZZ)/P_M \qquad Z_m < Z < Z^*$$

The level of H which will be consumed during the period given some maintenance is, via substitution of (4) into (2):

(6) $$H \Big|_{Z_m \leq Z \leq Z^*}^{M} = (HS^* + HM)j(HN)k(HA) = (HS^* + g(M))j(HN)k(HA)$$

Substituting (5) into (6) and differentiating via the chain rule we derive the tradeoffs between Z and H feasible with maintenance:

(7) $$\partial H/\partial Z \Big|_{Z_m \leq Z \leq Z^*}^{M} = -(P_Z/P_M)j(HN)k(HA)\, dHM/dM < 0$$

Notice, then how the slope of the transformation function embodies the budgetary (P_Z/P_M), technological (dHM/dM), and neighborhood physical (HN) and socio-psychological (HA) constraints.

From (5), (6), (7) the transformation function for maintenance, H_{TM}, is given by:

(8) $$H_{TM} \Big|_{Z_m \leq Z \leq Z^*}^{M} = A - (P_Z/P_M)j(HN)k(HA)(dHM/dM)Z$$

where $A = [HS^* + g((Y - P_0H_0M)/P_M)]j(HN)k(HA)$. Graphically, a representative H_{TM} is portrayed by line A0 in Figure 1.

[7] The decision whether to contract out work is explicitly modelled by Mendelsohn [16] and Ozanne-Struyk [21].

[8] Varying productivity of workers not only refers to differences between owner occupants who perform M themselves but also between professionals who may be hired by occupants. Of course, such differences may also be associated with differences in labor costs comprising P_M. Birch [4] has found that skilled craftsmen homeowners undertake more maintenance activities, as would be expected with their higher productivity, ceteris paribus.

Upward Conversion Transformation Function: H_{TUC}

Besides the above maintenance alterations, the owner occupant has two additional options for transforming HS via major alterations in the size of and/or facilities available in the dwelling. Initially, there exists "upward conversion" (UC) wherein a room, bathroom, garage, porch, etc. is added, a swimming pool is built, central air conditioning or a new heating system is installed, etc. The assumption here is that the new construction entailed in upward conversion is perfectly malleable and that the upward conversion "production function" does not noticeably exhibit diminishing returns (as did the g maintenance function above). The only constraint on converting Z into positive increments in HS via upward conversion, HUC, is thus budgetary:

(9) $$HUC=(Y-P_0H_0-P_ZZ)/P_{HS} \qquad Z_m \leqslant Z \leqslant Z^*$$

where P_{HS} is the cost per unit of structural improvement, HUC, for the period at hand.

It is likely that the undertaking of a sizeable UC necessitates borrowing by the homeowner, whence borrowed income, YB, would be added an term in the numerator of (9).[9] Should a particular homeowner be unable to obtain the requisite loan (either due to the owner's credit-unworthiness or discriminatory/"redlining" action by lenders) a UC would need to be financed from current income, as given in (9). Such would, of course, be more binding and would likely elminate upward conversion as the optimal quality mode chosen by the homeowner.

The H associated with various degrees of positive HUC is given by:

(10) $$H \Big|^{UC}_{Z_m \leqslant Z \leqslant Z^*} = (HS^* + HUC)j(HN)k(HA)$$

Substituting (9) into (10) and differentiating so as to obtain feasible H, Z tradeoffs:

(11) $$\partial H/\partial Z \Big|^{UC}_{Z_m \leqslant Z \leqslant Z^*} = -(P_Z/P_{HS})j(HN)k(HA) \quad < 0$$

Note that upward conversions are again constrained by budgetary and neighborhood constraints.

The transformation function for upward conversion, H_{TUC}, is thus given by:

(12) $$H_{TUC} \Big|^{UC}_{Z_m \leqslant Z \leqslant Z^*} = C- (P_Z/P_{HS})\, j\,(HN)k(HA)Z$$

where $C = [HS^* + (Y-P_0H_0)/P_{HS}]j(HN)k(HA)$. A representative H_{TUC} is shown as CO in Figure 1.[10]

[9] With such an increment to sunk costs, in future periods the Z^* will become: $Z^*=(Y-P_0H_0-P_{YB0}/P_Z)$ where YB_0 is the per period repayment on the home improvement loan.

[10] There is no necessary reason that CO intersects AO; CO may lie entirely above or below AO in particular situations.

Downward Conversion Transformation Function: H_{TDC}

"Downward conversion" (DC), the second alternative for major structural changes, becomes a transformation of some HS previously consumed by the owner occupant of a single family unit into a distinct, new package(s) which can be rented and thus provide funds to finance more Z. In making such a decision the homeowner becomes an owner occupant in a multiple-unit structure. Such downward conversions usually take the form of partitioning the dwelling into distinct units, perhaps adding kitchen and bath facilities and a separate entrance, etc.

The technological capability of transforming structural features of the dwelling (HDC) into homogeneous units of housing suitable for renting (R) via downward conversion is given by:

$$HDC = i(R) \tag{13}$$

where $HDC=0$ when $R=0$, $dHDC/dR<0$, $d^2HDC/dR^2<0$.

The specification of the diminishing returns again seems mandated. Clearly, the easiest means of DC would be to rent an unused room, with relatively little sacrifice to the owner occupant. Progressively more complicated partitioning and subdividing would become increasingly constrained by the structural features of the dwelling. The specific form of i would be determined by such attributes of the dwelling as the existence of an unused, reasonably isolated bedroom, multiple bathrooms or stairways, layout of rooms, etc., as well as the specific mode of conversion anticipated.

The market value of the R bundle created through DC would equal to that commanded by comparable dwellings embodying the same degree of structural and neighborhood components, (HS)j(HN). The price per unit of such housing service is P'_R, whence from (13) the market value per unit R would equal $i^{-1}(P'_R)$.[11] From this value must be subtracted the amortized cost per unit R of DC for labor, materials, etc., yielding a net price per unit R, P_R. The budget "constraint" for R thus becomes:

$$R=-(Y-P_0H_0-P_ZZ)/P_R \qquad Z^* \leqslant Z \leqslant Z_1 \tag{14}$$

The above technological and budgetary relationships may be augmented by an added constraint in certain circumstances. If the dwelling in question is located in a jurisdiction with rigidly-enforced housing codes a new lower bond on the magnitude of certain types of DC may be imposed. Thus, Z may be constrained at $Z_2<Z_1$, where Z_2 is the consumption feasible from disposable income $(Y-P_0H_0)$ plus the maximum rental income associated with the creation of new dwelling units which minimally meet code.

[11] The implicit assumption throughout is that all quality levels of the housing market are in long run equilibrium and that a common P_R holds everywhere. If one conceives the housing market of being partitioned into various semi-autonomous "submarkets" [6, 11, 13] then the situation becomes more complicated. Suppose, e.g., the household via DC creates a rental unit in a lower quality submarket having a slightly different P_R than that existing in the submarket of the original dwelling prior to DC. In such a case it is the P_R existing in this destination submarket, and not that in the origin submarket, which enters into the equations. Note k (HA) is not a saleable quality attribute generally, being a product of the idiosyncratic buyer/neighborhood interactions after occupancy.

The relationship between H and various degrees of HDC is given by:

$$(15) \qquad H \Big|_{Z^* \leqslant Z \leqslant Z_1}^{DC} = (HS^* + HDC)j(HN)k(HA) = (HS^* + i(R))j(HN)k(HA)$$

Substituting (14) into (15) and differentiating via the chain rule:

$$(16) \qquad \partial H/\partial Z \Big|_{Z^* \leqslant Z \leqslant Z_1}^{DC} = (P_Z/P_R)j(HN)k(HA)dHDC/dR \quad < 0$$

The transformation function for downward conversion, H_{TDC}, is thus defined as:

$$(17) \qquad H_{TDC} \Big|_{Z^* \leqslant Z \leqslant Z_1}^{DC} = H^* + (P_Z/P_R)j(HN)k(HA)(dHDC/dR)Z$$

A representative H_{TDC} is shown in Figure 1 as Line 0B.

Optimum Housing Consumption

The three transformation functions just specificed form the constraint set for the owner occupant's utility maximization. Unlike usual multi-constraint problems, however, in this case it is the outer envelope or least-contraining segments of the transformation functions which are relevant since the owner occupant is free to choose which transformation (if any) is undertaken.

Recalling this, the formal optimization problem is expressed:

$$(18) \qquad \max U\Big]_{P_H} = f(H,Z) \qquad \text{s.t. } H_{TM}H_{TUC}H_{TDC}$$

Figure 1 provides a graphic portrayal of one such possible set of transformation functions and indifference curves for a homeowner of given income and preferences, living in a particular structure in a particular neighborhood with given HN, HA, and P_H. Segments A0, C0, 0B represent maintenence and upward and downward transformation functions, respectively. Given that the owner occupant will not move to another dwelling during the period, the choices are to either remain at 0 and consume (H^*, Z^*) or to move along the least constraining segments of the transformation function envelope (in this case CEDOB) until utility is maximized. In the example pictured here the optimal choice would be consuming (H', Z') and receiving U_2 level of utility via maintaining the dwelling by an expenditure $X'=P_Z(Z^*-Z')$, since the highest indifference curve is tangent to H_{TM}.

Note that the relative slopes of the transformation functions shown in Figure 1 are arbitrary. It is possible, for instance, that H_{TUC} may dominate H_{TM} for all H, or that H_{TM} and H_{TUC} slopes may be relatively flat compared to that of H_{TDC}, whence the optimum may occur along H_{TDC}. Regardless of along which transformation function segment the optimum lies, the optimum will be characterized by a form of the familiar marginal rate of substitution equals price ratio condition:

$$(19) \qquad -U_Z/U_H = -P_Z/\hat{P}_H$$

But in this case the "price" P_H is defined through both a technological relationship (between H and a particular type of housing transformation activity undertaken) and levels of neighborhood-related attributes HN and HA, as well as the usual budgetary relationship between Y, Z and the amount and price of this transformation activity. The household equilibrium condition involving housing quality thus becomes an amalgam of neoclassical consumption and production theory concepts, with neighborhood physical and psychological dimensions added as well.

Once the household has actually completed making the maintenance expenditure X′ needed to arrive at (H′,Z′) this point becomes the origin from which a new set of transformation functions are defined to form the constraints for future housing quality decisions.

Applications of the Model

Now that the formal model has been specified, its richness will be demonstrated by using it to explain several realistic scenarios. In each case, hypothetical exogenous changes in variables can lead to either continuous alterations in the optimum (H′, Z′) along the original transformation function, or to discontinuous changes with the optimum occurring along a different transformation function. The former instances can be analyzed using comparative static analysis, the results of which are reported in Table 1. Here total expenditures on housing, X, is defined as sunk cost, P_0H_0, plus (minus) any current expenditure (revenue) made via positive (negative) HS quality changes.[12] Whenever possible, the results predicted by the model will be contrasted with those of earlier models and with available empirical evidence.

Owner Income Decline. The situation of owner occupant income decline through layoff, injury, illness, retirement, etc. has been viewed as a crucial factor influencing housing maintenance and, by implication, the quality and stability of an entire neighborhood [4, 20, 23]. Previous models uniformly predict a positive relationship between maintenance and purchasing power of the owner [7, 16, 19, 21, 30, 32]. The results of the present model in no way contradict this conventional view. In Figure 1 an income decline would be portrayed as a leftward horizontal shift in point 0 corresponding to dY/P_Z, with all transformation functions retaining their original slopes. Comparative statics reveal an unambiguous direct relationship between H′, Z′, X′, and Y. Such relationship persists even if income changes created a discontinuous alteration in optimum housing mode.

Increased Maintenance/Construction Costs. Previous models [7, 16, 19] predict that increases in the real price of construction/repair materials and/or labor (P_M or P_{HS}) would have deleterious effects on X′. In this model such is likely, but not necessarily, the case. In Figure 1 such a $P_M(P_{HS})$ rise would flatten the slope of $H_{TM}(H_{TUC})$ with the origin remaining at 0.[13] As the comparative statics prove, H′ would fall but the change in Z′ (and, thus, X′) would

[12] The first and second order conditions for maxima and the exact expressions for the partial derivations are available from the author upon request.

[13] If downward conversion also involved significant amounts of materials and/or labor, price rises of such would steepen the slope of H_{TDC}.

TABLE 1
Signs of Comparative Static Derivatives

Endogenous Values Changes

Transformation Functions =	H: H_{TM} or H_{TUC}	H: H_{TDC}	Z: H_{TM} or H_{TUC}	Z: H_{TDC}	X: H_{TM} or H_{TUC}	X: H_{TDC}
Parameters Changed						
Y	+	+	+	+	+	+
P_Z	?	?	-	-	?	?
P_M or P_{HS}	-	NR	?	NR	?	NR
P_R	NR	?	NR	+	NR	?
HS*	+	+	+	+	-	-
HN	+	+	?	?	?	?
HA	+	+	?	?	?	?

?=sign ambiguous
NR=not relevant
H=amount of housing consumption
Z=amount of non-housing consumption
X=total expenditures on housing

depend on the relative magnitudes of the negative "income effect" and the positive "substitution effect" á la the Slusky equation. If (as would be normally expected) Z income effect outweighed the substitution effect, X′ would increase as long as both original and final optima occurred with H′>H*.

The probability grows, however, that as such rises in P_M or P_{HS} continue the optimum will discontinuously shift from a point on either H_{TM} or H_{TUC} to one on H_{TDC}, since the slope of H_{TDC} need not be affected to the degree of either of the former's.[14] While a discontinuous fall in X′ (to minimum of zero) due to a discontinuous change in P_M has been predicted by an earlier model [2], the present model allows for a much greater X′ range of discontinuous changes with even continuous P_M alterations. Thus, results of maintenance cost changes in previous theories become a special case in the context of the present model.

It is interesting to note that it is the elderly owner occupant who would be most likely to respond to increased maintenance costs via cutting X′ or downgrading. For the former response, a substitution effect dominating an income effect implies a willingness on the part of the consumer to marginally substitute comparatively high amounts of H for Z. This is likely for those with short time horizons and lack of investment motivations, i.e., the elderly. For the latter, the elderly may be most likely to occupy a dwelling with unused space

[14] Downward conversion need not involve significant amounts of labor or material. Although the slope of H_{TDC} would rise in absolute value with a rise of P_{HS} (since it is an implicit component of P_R), this change in H_{TDC} would be smaller than that in H_{TUC} since P_R is also influenced by the market value of HN as well as HS.

(now that the children have "left the nest") which could be occupied by a new household with little sacrifice in original H'. In other words, the H_{TDC} function may be comparatively flat for the elderly, suggesting an increased likelihood of an optimum occurring at a downward conversion mode.

Structural Aging and Deterioration

Continued structural aging and resultant increases in tendencies for deterioration would be modelled here as a decrease (vertical shift down from 0) in HS* by the amount (dHS*)j(HN)k(HA). Comparative statics show that such an effect would be associated with a lower optimum (H', Z'), but greater X' expenditures. Persistant or significant declines in HS* may also alter slopes of several transformation functions as well. The slopes of H_M and H_{TUC} would likely flatten (due to heightened technological difficulties of maintaining or improving a badly deteriorated structure) and that of H_{TDC} would steepen (due to the presumed lower P_R associated with a more deteriorated structure). Note that the H_{TM} and H_{TUC} alterations would reinforce the H' decline generated by the HS* decline, but may offset the above Z', X' changes of the Z substitution effect outweighted the income effect.

Thus, while the model normally would predict that older, more deteriorated dwellings would be associated with higher maintenance expenditures, as has been predicted by earlier models [7, 19] and empirically observed for owners in general [5, 19, 30], it is not necessarily the case for all owners. As was true for rising maintenance/construction costs, it is most likely elderly homeowners who would possess the kind of preferences which would lead the model to the opposite prediction.[15] Of course, increased structural aging and deterioration may result in an optimum along H_{TDC} instead of H_{TM} or H_{TUC}, but the bias is not so strongly in this direction as in the case of increased costs. This is so since here H_{TDC} becomes significantly steeper via deterioration's deleterious effects on P_R. In fact, P_R may be eroded in this manner relatively more quickly than the returns implicit in the maintenance g(M) function, whence downward conversion need not necessarily be the predicted fate of older homes in the model.

Perceptions of Reduced Neighborhood Physical Quality.

The comparative statics indicate that homeowner perceptions of deteriorating levels of neighborhood physical quality and housing prices (generated by, e.g., the introduction of noncompatible land uses, the entrance of lower SES groups, the worsening of schools, crime, and public amenities, etc.) would result in lower H' levels. The results for Z' and X' are, again, ambiguous depending on the relative size of income and substitution effects. Such a decline in HN would be shown graphically in Figure 1 as a vertical drop in 0 (by the amount (HS*)dj(HN)k(HA)) and a flattening (steepening) in the slopes of the H_{TM} and H_{TUC} (H_{TDC}) functions, since the ability to transform Z into H and vice versa is attenuated. As such, this situation of HN decline is qualitatively analogous to that of a significant HS* decline described above, thus obviating the need for extended remarks here. It should be noted, however, that the likely possibility of increased X' in the attempt to "compensate" for reduced

[15] Cross-sectional evidence [16, 22, 32] has found that the elderly engage in less frequent and expensive maintenance than younger households, ceteris paribus, thus supporting the predictions of the model.

HN is predicted by the model. Such is not the case in previous theories [7, 19, 21, 32], which unanimously predict that deteriorating neighborhood conditions and other factors lowering rents and property values should result in lower maintenance expenditures. Scanty available empirical evidence [4,22] is supportive of the present model.[16]

Perceptions of Reduced Neighborhood Socio-Psychological Attachment

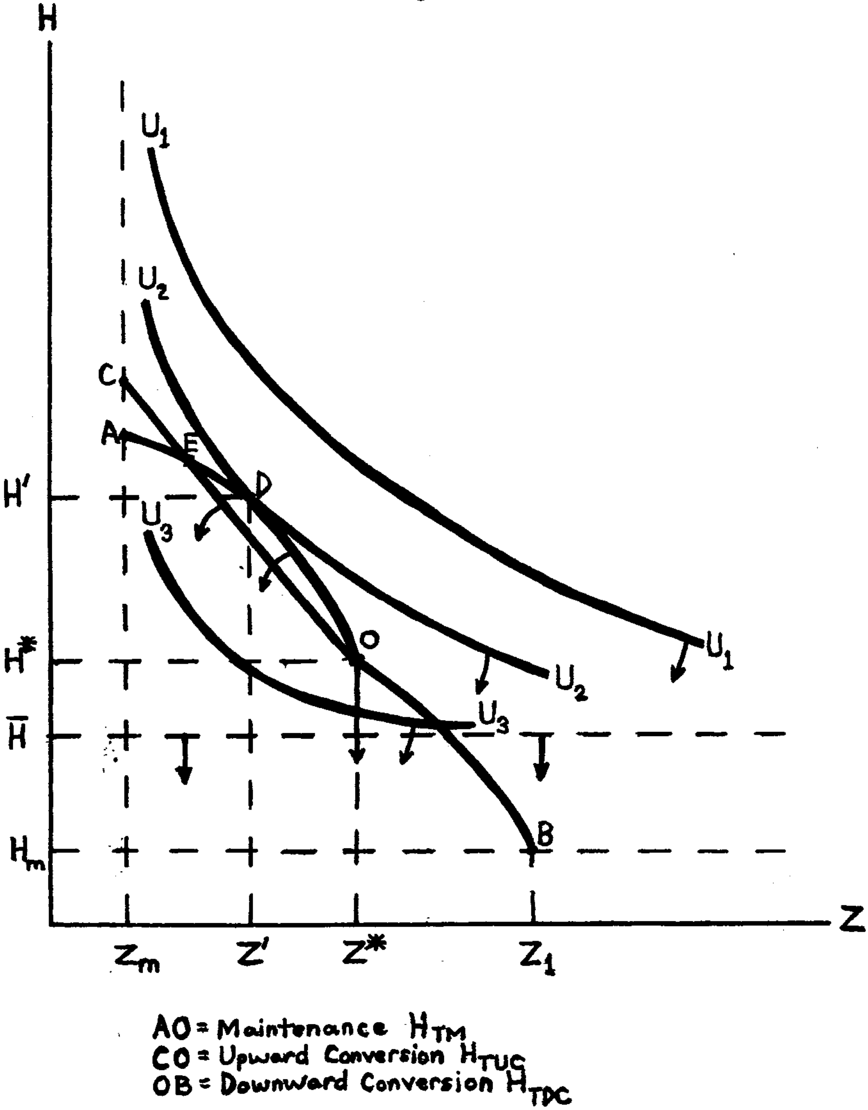
We are all undoubtedly aware of anecdotal cases of tightly-knit, historically-rooted ethnic enclaves maintaining housing quality in the face of structural aging, encroaching blight, increased pollution, etc. There are other instances of neighborhood associations catalyzing neighborhood pride and cohesiveness and spurring an "organic" renovation of an area. Previous maintenance models cannot explain such phenomenon; they are easily understood in the context of present model's specification of HA.

The role of HA can, perhaps, most easily be seen in the hypothetical situation of a reduction in an owner's attachment due to, say, death or out-migration of long-time neighborhood friends. Graphically, the effect is similar to that for HN: a downward shift in 0 by the amount (HS*)j(HN)dk(HA) and flattened slopes of H_{TM} and H_{TUC} due to the lowered Z to H transformation possibilities. There are two crucial differences, however. First, the H_{TDC} function is not changed, since lack of the owner's attachment is not reflected in P_R for any newly-created units, as lower HS* or HN would be. HA is an idiosyncratic element attached to a particular homeowner in a particular neighborhood at a particular time it cannot be priced in the rental market. Second, if HA declines to the point where group pressures on the homeowner cease to be effective, the owner may choose to disregard the "minimum acceptable housing standard," H. All of these alterations are portrayed graphically in Figure 2.

The net effect of these processes just described is to dramatically increase the likelihood of massive neighborhood deterioration and/or downgrading. At the same time that the H_{TM} and H_{TUC} transformation functions flatten, H is reduced, hence the indifference curves tend to steepen since they are no longer constrained asymptotically. This magnifies the chances of the optimum discontinuously switching from a maintenance or upgrading mode to one of downgrading. Even if such a switch did not occur, the steepened indifference curves would tend to reinform the substitution effect and reduce optimum X'. In either event, the lowered quality of the given owner's structure may lower part of the HN component for other proximate homeowners,leading to a reevaluation of their operating strategy as described earlier. This process could easily snowball, with HA, HN, and HS* declines reinforcing one another in a cumulative process across the neighborhood. Such a dynamic has been called the "psychological abandonment of the neighborhood" [23]. It is noteworthy that whereas this phenomenon can be readily explained by the present model, the crucial socio-psychological relationship between homeowner and neighborhood is irrelevant in the context of previous models.

[16] Birch [4] found that middle and upper income owners spent more on maintenance in marginal neighborhoods than in other areas. Peterson [22, Chs. 4, 5] found that homeowners in downward transitional neighborhoods rehabilitated and maintained their houses as frequently and at the same percentage of market value as those in stable neighborhoods.

FIGURE 2
Shifts Associated with Neighborhood Attachment Decline



Summary and Conclusions

This paper has presented a model of the housing maintenance and quality alteration behavior of owner occupants of single family dwellings which synthesizes elements of neoclassical economic consumer and producer theory and socio-psychological concepts. The relationship between the homeowner and both physical and socio-psychological dimensions of the neighborhood was emphaized. The central concept was that the owner occupant chooses a particular level of housing quality (having both consumption good and investment asset characteristics), which is attainable by a particular type of maintenance or conversion strategy, so as to maximize utility. The choices are limited by an envelope of transformation functions which embody the budgetary, technological, and neighborhood physical and socio-psychological constraints in the transformations of expenditures into housing quality.

It has been shown that the model offers several advances over previous models of housing maintenance behavior. While its predictions are consistent with existing empirical evidence on the relationship between maintenance expenditures and household income, maintenance/construction costs, and structural aging/deterioration, the model leaves open the possibility that certain household types with particular preferences may not follow the aggregate patterns. It is, thus, more general. More importantly, the model provides a clear framework within which effects of altered homeowner perceptions of neighborhood physical quality and socio-psychological attachment may be comprehended. In this regard, previous models either generate predictions which are contrary to the evidence, or leave no place whatever for such neighborhood considerations.

Several propositions were derived from the model which are amenable to direct empirical testing. To summarize:

a) Lower homeowner income should be associated with lower maintenance/improvement expenditures, with an increased probability of a downward conversion mode, ceteris paribus.
b) Higher costs of maintenance/construction should, for non-elderly homeowners, be associated with increased maintenance/improvement expenditures (with the opposite being likely for elderly) and with an increased probability of a downward conversion mode (regardless of age).
c) Increased structural aging/deterioration and/or declining neighborhood physical quality should, for non-elderly homeowners, be associated with increased maintenance/improvement expenditures (with the opposite being likely for elderly), but with no increased probability of a downward conversion mode.
d) Neighborhoods experiencing rapid population turnover, increased heterogeneity, or other factors which may erode homeowner's attachment to the neighborhood should be associated with lower maintenance/improvement expenditures. They also should have higher rates of discontinuous switches from maintenance/upgrading to downgrading modes than in neighborhoods which are otherwise comparable but attachment remains strong.[17]

In conclusion, the model presented here offers a robust theoretical framework in which a wide range of homeowner maintenance/conversion behavior can be understood. It must, of course, be viewed as only a first step in need of several improvements. The model is essentially static, and longer-run effects of short-term maintenance decisions are not explicitly considered. It takes as given that homeowners have chosen to remain in their dwelling for the period

[17] Some initial empirical tests have been made in this area, and have supported the hypothesis [10].

under analysis, and does not model the mobility choice process endogenously. Finally, the mechanism by which homeowner's expectations are created and transmitted to utility functions is not specified. It is hoped that theoretical and empirical work in such areas can further enrich and extend the basic framework outlined.

Appendix: Glossary of Symbols

U: utility or well-being level of owner occupant

Z: a unit of a composite bundle of non-housing goods consumed by homeowner

Z_m: minimum quantity of Z which must be consumed; "necessity" level

Z^*: amount of Z obtainable by homeowner during period of no expenditure made on housing beyond fixed cost

H_m: minimum quantity of H which must be consumed; "necessity" level

H: socially-defined minimum-acceptable H level in a neighborhood

H^*: level of H which would be present during period in absence of any homeowner activity or expenditure beyond fixed costs

HS: a unit of a composite bundle of physical attributes of the housing structure and parcel

HN: a unit of a composite level of locational/physical attributes of the neighborhood surrounding structure

HA: a unit of socio-psychological "attachment" which homeowner has to neighbors and/or neighborhood

HM: a unit of improvement in HS due to maintenance

$HUC=UC$: a unit of improvement in HS due to upward conversion activities involving major structural alterations

$HDC=DC$: a unit of decline in HS due to downward conversion activities which subdivide the original structure; the units of HS previously consumed by owner in original home sacrificed in order to create new rental unit(s) in the home

H_{TM}: transformation function of expenditures into changes in H due to maintenance of existing structure

H_{TUC}: transformation function of expenditures into changes in H due to major upward conversion of structure

H_{TDC}: transformation function of changes in H into income due to creation of rental unit(s) in home via downward conversion

M: a unit of a composite bundle of maintenance labor and materials

P_H: price per unit of housing quality, H, prevailing in neighborhood during period

P_0H_0: fixed or "sunk" costs of housing incurred by homeowner during period

P_M: price per unit of maintenance activity, M

P_{HS}: price per unit of structural improvement, HS, obtained via upward conversion

P_Z: price per unit of non-housing consumption, Z

$P_R'(P_R)$: gross price (price net of amortized costs of conversion) per unit of rental housing quality, R

R: a unit of H embodied in a rental dwelling within the former single-family home, created by a downward conversion during period

X: total per period expenditure on housing maintenance or upgrading, less any revenue gained from downward conversion

Y: homeowner per period disposable income

Y_B: principal on home improvement loan obtained by homeowner during period

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