PRICES AND TRADING VOLUME IN THE HOUSING MARKET: A MODEL WITH DOWN-PAYMENT EFFECTS*

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This paper presents a simple model of trade in the housing market. The crucial feature is that a minimum down payment is required for the purchase of a new home. The model has direct implications for the volatility of house prices, as well as for the correlation between prices and trading volume. The model can also be extended to address the correlation between prices and time-to-sale, as well as certain aspects of the cyclical behavior of housing starts.

This paper seeks to address two fundamental and related questions about the housing market. (1) What accounts for fluctuations in house prices, and (2) why is it that there appears to be more intense trading activity (i.e., a higher volume of sales, and a shorter average waiting time from listing to sale) in rising markets than in falling markets?

The standard theoretical approach to the first question (as exemplified by Poterba [1984]) treats the housing market much like any other asset market. In this framework, house prices are forward looking and depend solely on such current and future "fundamentals" as user costs of capital, rents, and construction costs.

However, this "efficient markets" approach to house price determination has encountered empirical difficulties. Case and Shiller [1989, 1990] present evidence that changes in house prices are forecastable, based on both past price changes and on such fundamental-based measures as rent-to-price and construction-cost-to-price ratios.[1] Furthermore, there have been a number of dramatic boom-to-bust episodes at both the country and regional levels that appear to be difficult to explain—even retrospectively—with the standard model.[2] Many observers have concluded from

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1. See also Cutler, Poterba, and Summers [1991] and Meese and Wallace [1991].

2. Poterba [1991] gives a number of examples (at both the city and national level) of dramatic price swings. Case [1986] argues that the run-up in home prices in Boston in the mid-1980s cannot be explained based solely on changes in fundamentals.

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these sorts of data that house prices are in part driven by nonfundamental speculative phenomena such as fads or bubbles.

While the issue of house pricing has at least had the benefit of a well-accepted benchmark model to guide inquiry, the same cannot be said for questions surrounding the level of trading activity. Of the informal stories that are used to explain trading activity, many appear to involve less than fully rational behavior. For example, the observed correlation between house prices and trading volume is often attributed to sellers who have slowly adapting expectations or who simply refuse to "recognize reality" in depressed markets and therefore do not cut prices to appropriate levels. A similar line of reasoning is also advanced to explain why houses tend to stay on the market longer in times of falling prices.

The theory of the housing market that is developed in this paper can help to explain both large price swings as well as a correlation between prices and trading activity. The theory is predicated on rational behavior and does not rely on fads or bubbles. It takes as its starting point two sets of observations.

1. The purchase of a house typically requires a significant down payment. This implies that the demand for houses will be affected by buyer liquidity.[3] Moreover, in order to support strong housing demand, it is necessary that the liquidity be broad based. One buyer with ten units of liquidity will probably not demand as much housing as ten buyers with one unit each, since there is diminishing marginal utility from owning houses. Thus a few "deep pockets" in the economy cannot counteract a widespread liquidity shortage.[4] This stands in contrast to other asset markets (e.g., equities) where diminishing returns to ownership are not so pronounced, and where a few deep-pocket arbitrageurs can thus absorb large supplies with relatively small price concessions.

2. Houses represent a substantial fraction of household net worth. According to the Federal Reserve, owner-occupied homes had a value of $4.6 trillion in 1990, or roughly 27 percent of household net worth. Furthermore, approximately two-thirds of all American households own their own houses.[5] This means that

3. Using micro data, Linneman and Wachter [1989] present direct evidence that down-payment requirements can act as a substantial constraint on the purchase of a home. See also Zorn [1989] and Jones [1989].

4. Implicit in this statement is the notion that renting is not a perfect substitute for owner-occupied housing. If it were, there would be no diminishing returns from owning a house. A single deep pocket arbitrageur could own most of the housing stock, and rent it out to those who are liquidity-constrained. This issue is discussed in detail below.

5. See Smith, Rosen, and Fallis [1988].

an exogenous shock to house prices can have a large and broad-based impact on household liquidity.

Taken together, these two sets of observations would seem to imply that there can be self-reinforcing effects from shocks to house prices. Suppose that an initial shock knocks prices down. The ensuing loss on their existing homes compromises the ability of would-be movers to make down payments on new homes. This in turn leads to a lack of demand that further depresses prices, and so on.

A couple of further pieces of data strengthen the presumption that these self-reinforcing effects could be quantitatively important. First, for repeat buyers the average percentage of their down payment coming from the proceeds on the sale of their old home has ranged from 38 percent to 57 percent over the years 1987–1990. In other words, the value of their old home is likely to have a critical impact on the ability of a repeat buyer family to make a down payment. Second, roughly 60 percent of all home sales are to repeat buyers.[6]

The model that is presented below captures in a simple fashion the potential for self-reinforcing effects that run from house prices to down payments to housing demand back to house prices. In some cases, it turns out that these effects do indeed have significant consequences for house price behavior. First of all, they can lead to within-equilibrium multiplier effects from changes in fundamentals.[7] Second, they can create the potential for multiple equilibria; i.e., for a given level of fundamentals there may be more than one price level that equates supply and demand.

The existence of multipliers and multiple equilibria suggest that the model can rationalize house price volatility that might appear excessive relative to the standard efficient markets framework. The multiple equilibria seem to fit especially well with the notion of dramatic boom-to-bust movements in prices. However, these conclusions about price volatility appear to be sensitive to parameter values. For certain distributions of initial liquidity in the population, down-payment effects have very little effect on house prices.

The model also provides a simple (and much more robust)

6. The sources for these facts are Chicago Title and Trust Company's Annual Surveys of Recent Home Buyers.

7. More precisely, the comparative-static effect on prices of a shift in housing demand is amplified, relative to a model where down-payment considerations are absent.

explanation for the observed positive correlation between the level of house prices and trading volume. As house prices fall, some potential movers find their liquidity so impaired that they are better off staying in their old house rather than attempting to move. To take a concrete example, imagine a family with a house initially worth \$100,000, an outstanding mortgage of \$85,000, and no other assets. Suppose further that the family would like to move to the next town, say because the public schools are better. The purchase of a new house requires a minimum down payment of 10 percent. If house prices stay where they are, the family can sell its old house, pay off the mortgage and still have more than enough (\$15,000) to make a down payment on a new house of comparable size.

But if house prices fall by 10 percent, the family will only have enough to make a down payment of \$5000. Rather than moving to a much smaller house, they may rationally choose to stay where they are. Or, they may try "fishing"; listing their current house at an above-market price in the (low-probability) hope of getting lucky and raising enough money to make a reasonable down payment. Given that the alternative to fishing in this low-liquidity scenario is not moving at all, fishing will have very little opportunity cost. In contrast, when prices are higher, the alternative to fishing is moving to the desired location more promptly and with certainty. Thus, fishing will be much less attractive. These arguments suggest that both the volume of trade and the length of time on the market will be related to the level of prices.

The remainder of the paper is organized as follows. Section I briefly reviews some related work. Section II presents and analyzes a simple model of the housing market that captures the importance of down-payment effects. For the purposes of this section, it is just assumed that there is an exogenous down-payment requirement that new homebuyers must satisfy. In Section III, however, it is briefly sketched how such a down-payment requirement might arise endogenously from adverse selection problems in the loan market. Section IV discusses the model's empirical implications. Section V concludes.

I. Related Work

There are a number of papers in the real estate and public finance literatures that emphasize the importance of down-payment requirements in the housing market. Unlike in this paper, however, the focus is not typically on the implications of such requirements for variables like trading volume and price volatility. Instead, earlier work has explored the interaction between down-payment requirements and consumption-savings decisions, the rent versus buy choice, and the tax code.

Slemrod [1982] is a noteworthy example. In his paper, much as in this one, families seeking to buy a house must put up a fixed fraction of the purchase price as a down payment. Among other things, Slemrod shows that this can lead families to distort consumption downwards early on in the life-cycle in an effort to save enough to be able to buy a house.[8] However, his model has the feature that once a family buys a first house, they never have the opportunity to trade it; in other words, all sales are to first-time buyers. By definition, this rules out the sort of issues that are of central concern here, since these issues only arise when prospective buyers already own another home.

On the empirical front, work by Linneman and Wachter [1989], Zorn [1989], and Jones [1989] all provide support for one of the key premises of the model in this paper, namely, the notion that down-payment requirements can significantly constrain households in their purchase of a home. However, given that their primary interest is in individual household behavior, none of these papers go on to consider the impact of down-payment requirements on market equilibrium prices.

In terms of its focus on marketwide equilibrium, and on the positive feedback from house prices to buyer liquidity to housing demand, this paper is more closely related to recent work by Shleifer and Vishny [1992], who study the market for corporate asset sales. They begin with the assumptions that many corporate assets have a higher operating value when resold to buyers in the same industry, and that capital market imperfections make it necessary for such buyers to put up some of the purchase price themselves. The interaction of these two factors can lead asset values to be very sensitive to certain sorts of shocks. For example, an initial shock to the price of oil will not only make the fundamental value of oil-producing properties fall, but it will also impair the ability of others in the oil industry to bid for these properties, thereby further depressing the price at which the assets can be sold.[9]

8. See Engelhardt [1991] for evidence supporting this hypothesis.
9. See also Kashyap, Scharfstein, and Weil [1990] and Kiyotaki and Moore [1993] for closely related work.

II. The Model

A. Assumptions

The model has three time periods, 0, 1, and 2, and a continuum of families, indexed by i. At time 0 each family is endowed with one unit of housing stock, as well as with some outstanding mortgage debt secured against the house. There is heterogeneity across families in the amount of debt outstanding. In particular, family i owes an amount K_i, and the K_i's are distributed on an interval $[K^L, K^H]$ according to the cumulative distribution function $G(K)$. The debt is denominated in units of the numeraire good, "food." I allow for the possibility of negative values of K_i, i.e., it is possible that $K^L < 0$. This can be interpreted as some families having liquid assets at time 0 above and beyond their houses.

At time 1 families can trade houses with each other. The housing stock is assumed to be divisible, so it is possible for any family to own more or less than one unit after moving. It is also assumed that the housing stock is fixed at its time 0 level; no new houses are built at time 1. The per unit price of housing at time 1 is P, so the cost of buying a house of size H is PH.

I make three crucial assumptions about the trading process. First, when a family sells their old house, they must repay the outstanding debt immediately, leaving them with net liquid assets of $P - K_i$. Second, a minimum down payment is required to buy a new house. Specifically, if the new house costs PH, the down payment must be at least γPH, with $0 < \gamma < 1$. Once this minimum down payment requirement is met, a buyer is able to borrow the rest of the purchase price at the riskless rate of interest, which for simplicity is normalized to zero. Third, there is no rental market: the only way a family can occupy a house is by owning it directly.

Taken together, the no-rental assumption and the down-payment requirement imply that the only way for a family to consume new housing (i.e., a house different from the one they were initially endowed with) at time 2 is to put some of the money up ahead of time, at time 1. For the moment, these assumptions are taken to be exogenous to the model. However, in Section III, I briefly illustrate how they might arise endogenously in response to adverse selection problems. The basic idea is that, in addition to the families discussed above, there is also a set of "defaulters" who would not make good on any loan or rental payments. By requiring enough of a down payment, one can screen these defaulters out of the market.

The arguments in Section III notwithstanding, it should be emphasized that both the no-rental assumption and the form of the down-payment requirement are more restrictive than they need to be to generate the basic results. First, while a down-payment requirement of some sort is clearly essential, the particularly simple formulation adopted here—with the proportion γ independent of all other variables in the model, and with no interaction between interest rates and the size of the down payment—is not necessary. Rather, it is chosen to make the analysis more tractable. Loosely speaking, all that is really required for the results to go through is that the maximum loan size be an increasing function of the market value of the house. (Here, the maximum loan size is simply $(1 - \gamma)$ times the market value of the house.)

Similarly, it is also not necessary to completely assume away the existence of a rental market to generate the basic results below. There need only be some "imperfections" in this market. That is, a rental just must be a less than perfect substitute for owner-occupied housing. Or said differently, one does not really need to make the strong assumption that the *only* way for a family to consume new housing is by putting money down at time 1. It is enough that this be the *most efficient* way to consume new housing.

There are a couple of reasons why a rental is unlikely to be a perfect substitute for owner-occupied housing. The first is the tax code, which, as is well-known, imparts a favorable bias to owner-occupied housing. The second is moral hazard—an owner will be more inclined to take actions that preserve or increase the value of the house than will a tenant. Both of these considerations suggest that renting will be less efficient (at least from a private perspective) than direct ownership.[10]

In the Appendix an extension of the model is presented that incorporates this feature. In particular, it is assumed that renting—which has the advantage of allowing a family to occupy a house with no money down—is feasible. However, the trade-off is that renting a unit of housing costs $P(1 + T)$, where T represents the added cost of renting versus homeownership. The Appendix demonstrates that the results for this extended version of the model

10. Williams [1993] argues that moral hazard is especially important in explaining why single-family houses are optimally owned by their occupants. Moreover, he notes that about 85 percent of single-family houses in the United States are in fact owner-occupied.

parallel those presented in the text very closely. Indeed, for $T > 0.28$, all the results reported in the simulations below are completely unchanged: the rental sector endogenously drops out of the picture.

Given the down-payment requirement, there will be a limit to the size of the house that any family i can buy at time 1. The constraint is given by

$$PH_i \leq (P - K_i)/\gamma. \quad (1)$$

At time 2 families get labor income (in units of food), settle all their outstanding debts, and enjoy utility from their consumption of both food and housing services. Family i's labor income L_i is equal to $1 + K_i$. This implies that each family's total net income (including the initial time 0 endowment and the time 2 labor income) is the same, and is equal to one unit of housing plus one unit of food. The only difference across families is that those with higher values of K_i are effectively more liquidity-constrained, since their income is more back-loaded.

A family's utility is a function of three things: (1) the amount of food they consume, (2) the size of the house they live in, and (3) whether they were able to move to a new house. In particular, utility is given by

$$U_i = \alpha \ln H_i + (1 - \alpha) \ln F_i + \theta M_i, \quad (2)$$

where F_i is i's food consumption and M_i is an indicator variable that takes on the value one if family i moves at time 1, and zero otherwise. The last term in the utility function is meant to capture in a simple fashion the notion that there are gains from trading in the housing market at time 1. As suggested earlier, one way to motivate this assumption is to imagine that houses have different attributes, and that families' preferences across these attributes shift at time 1. For example, families that have recently had children will wish to move to houses that are closer to good schools, playgrounds, etc.

B. Benchmark Case: $\gamma = 0$

In order to have a benchmark against which to compare the results, it is useful to first work through the "perfect capital markets" case where there is no down-payment requirement; i.e., where $\gamma = 0$. In this case, the constraint in (1) is never binding. It follows immediately from (2) that everybody will trade on the housing market at time 1, since this increases utility by θ.

Since the liquidity constraint is never binding, each family's demand for housing is independent of their initial debt K_i, and depends only on their total lifetime wealth. In units of food, this lifetime wealth has value $1 + P$. By virtue of the Cobb-Douglas form of the preferences, families will wish to spend a fraction α of their wealth on housing. This implies that the per capita demand for housing is given by

$$H_i = \alpha(1 + P)/P. \tag{3}$$

The per capita supply of housing is one unit. Equating supply and demand gives us the price of houses:

$$P = \alpha/(1 - \alpha). \tag{4}$$

Thus, in the benchmark case there is a unique equilibrium in which prices are given by (4), and 100 percent of the population is involved in trading at time 1. In what follows, the parameter α will be interpreted as a measure of housing market "fundamentals." This will allow us to ask two related sorts of questions. (1) Do downpayment effects cause prices to be "excessively" sensitive to changes in fundamentals; i.e., is $dP/d\alpha$ larger in the case where $\gamma > 0$ than it is in the benchmark case? (2) Can there be movements in prices that are completely unrelated to changes in fundamentals?

C. Excess Demand Schedules with Down-Payment Effects

We now turn to the case in which $\gamma > 0$. The method of analysis will be as follows. For any given value of α, and any candidate price P, we can calculate the net excess demand for houses. By varying P, we can then generate an excess demand schedule as a function of price. A necessary condition for equilibrium is that the price be such that net excess demand is zero. As will become clear shortly, there may be more than one price that satisfies this condition. In any case, however, the first task is to derive the excess demand schedule.

To do so, note that at any price P, we can divide the population into three groups, according to the amount of outstanding debt K_i that each family owes. The first group will be called the "unconstrained movers." This group consists of those families whose debt is so low that the down-payment requirement does not affect their behavior. The unconstrained movers have K_i in the interval $[K^L, K^*]$. The breakpoint K^* is determined by equating the unconstrained demand in equation (3) to the constrained demand that obtains when (1) holds with equality. In other words, K^* is given by

$$\alpha(1 + P)/P = (P - K^*)/\gamma P, \tag{5}$$

or

$$K^* = P - \alpha\gamma(1 + P). \tag{5'}$$

The unconstrained movers each unload one unit of housing (i.e., they sell their old house) and demand $\alpha(1 + P)/P$ new units. Therefore, the total population-weighted net excess demand from this group, denoted by $D^1(P)$, is

$$D^1(P) = G(K^*)\{\alpha(1 + P)/P - 1\}, \tag{6}$$

where K^* is defined in (5′) above.

The second group is the "constrained movers." This group has an intermediate level of debt. On the one hand, the debt level is so high that the constraint in (1) is binding. On the other hand, the debt is still low enough that families in this group prefer to move (to a smaller house) so as to be able to capture the gains from trade, θ, rather than remaining in their current house. The constrained movers have debt K_i in the interval $[K^*, K^{**}]$, and the breakpoint K^{**} is determined by equating the utility from moving to the utility from not moving.

The utility from not moving is simple to calculate. If a family does not move, they simply consume their initial endowment of one unit of food and one unit of housing. By (2) this gives a utility level of zero. Therefore, we can think of K^{**} as the level of debt for which moving yields utility of exactly zero.

To economize on notation, let us define H_i^c as the size of the new house bought by a family i subject to the constraint in (1):

$$H_i^c = (P - K_i)/\gamma P. \tag{7}$$

The cost of this house will be PH_i^c, leaving family i with an endowment of $(1 + P - PH_i^c)$ that can be spent on food. Thus, the utility of this family, U_i^c, is given by

$$U_i^c = \alpha \ln(H_i^c) + (1 - \alpha)\ln(1 + P - PH_i^c) + \theta. \tag{8}$$

We can now use equations (7) and (8) to implicitly define K^{**}. K^{**} is that value of K_i for which the utility level U_i^c in (8) is exactly equal to zero. Note that K^{**} is a function of P.

Each constrained mover unloads one unit of housing, and demands H_i^c new units. Therefore, the total population-weighted net excess demand from this group, denoted by $D^2(P)$ is given by

$$D^2(P) = \int_{K_i=K^*}^{K^{**}} (H_i^c - 1)G'(K_i)dK_i. \tag{9}$$

The final group is the "nonmovers." This group has the highest level of debt, in the interval $[K^{**}, K^H]$. Their debt is so high that they find it optimal to remain in their old house (thereby forsaking any gains from trade) rather than having to move to a much smaller new house. Thus, the nonmovers contribute nothing to net excess demand.

We are now ready to look for equilibria of the model. A necessary condition for equilibrium is that the price P be such that the total economywide excess demand for houses, $D(P) = D^1(P) + D^2(P)$, equals zero. In any such equilibrium, the aggregate trading volume can be measured by the combined size of the unconstrained mover and constrained mover groups, i.e., by $G(K^{**})$.

D. Multipliers and Multiple Equilibria

In order to gain further intuition for the forces that generate multipliers (i.e., higher values of $dP/d\alpha$ than in the benchmark perfect capital markets case) and multiple equilibria, it is useful to examine the formula for the derivative of excess demand with respect to price, dD/dP. With regard to multiple equilibria, note that if $D(P)$ is monotonically decreasing—i.e., $dD/dP < 0$ everywhere—then the model can have at most one equilibrium. In contrast, if $D(P)$ is not monotonic, it is possible that there are several values of P that satisfy $D(P) = 0$.

Even in the neighborhood of any single equilibrium, there can be multiplier effects if dD/dP is sufficiently small in absolute magnitude compared with the value that prevails in the benchmark case; in other words, if excess demand is relatively insensitive to changes in prices. More precisely, it can be shown that there will be a local multiplier effect if and only if the following inequality is satisfied in equilibrium:

$$-\left(\frac{1}{G(K^*)}\right)\left(\frac{dD}{dP}\right) < \frac{\alpha}{P^2}, \tag{10}$$

where the quantity on the right-hand side of (10) is the absolute value of dD/dP that obtains in the benchmark case.

Thus, down-payment effects can only lead to multipliers or multiple equilibria to the extent that they exert a sufficiently positive influence on dD/dP. This derivative can be written in simplified form as

$$\frac{dD}{dP} = \frac{-\alpha}{P^2} G(K^*) + G'(K^{**}) \frac{dK^{**}}{dP} [H_i^c(K^{**}) - 1] + \frac{\{G(K^{**}) - G(K^*)\}}{\gamma P^2} \{E(K|K^* \leq K \leq K^{**})\}. \tag{11}$$

The derivative has three terms. The first term represents the change in demand due to the unconstrained mover group; its sign is negative. If it were just for this term, the two sides of (10) would be identically equal, and hence there would be no multipliers. Intuitively, if there are only unconstrained movers active in the market, prices are determined in exactly the same way as in the benchmark case. This is true even if the aggregate trading volume associated with the unconstrained movers, $G(K^*)$, is small relative to that in the benchmark case: fewer families may trade, but pricing is unaffected.

The second term represents the change in demand that arises from families that switch from being nonmovers to constrained movers as P rises. Before the rise in P, these families contributed nothing to excess demand. Now, as they move into the housing market, they each sell their old houses, and buy $H_i^c(K^{**})$ units of new housing. This term will also be negative in the neighborhood of any candidate equilibrium, since in any equilibrium it must be that $H_i^c < 1$. Thus, the second term does not help to generate multipliers: indeed, it tends to offset them.

The third term is positive, and hence is the one that creates the tendency for multipliers and multiple equilibria. Indeed, for either to exist, the third term must be larger in absolute magnitude than the second term. The third term represents the change in demand of the constrained mover group. Their demand actually increases as prices rise, because higher prices relax their liquidity constraints. Naturally, this third term will be relatively more important in regions where there are a large number of constrained movers relative to unconstrained movers.

Figures I through V illustrate the effects at work in the model. Figures I and II begin by investigating the potential for multiple equilibria, plotting excess demand as a function of price, for the case where $\alpha = 0.5$, $\gamma = \theta = 0.1$. In Figure I the distribution of initial debt levels in the population is quite dispersed: in particular, K_i is uniform on the interval $[-0.2,1]$. In Figure II, there is a greater concentration of debt at higher levels: 99 percent of the

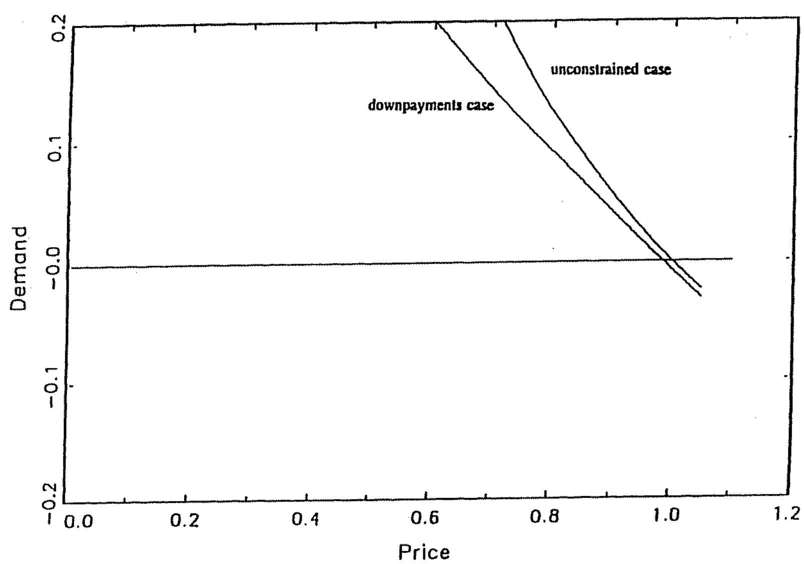

FIGURE I
Excess Demand versus Price

Note. For this figure, the parameter values are $\alpha = 0.5$, $\gamma = 0.1$, $\theta = 0.1$; K_i is uniform on $(-0.2, 1)$.

population has K_i uniform on [0.6,1], while 1 percent of the population has no liquidity constraint whatsoever.[11] In both figures, the excess demand function corresponding to the benchmark case of no down-payment requirement is also included as a point of reference.

In Figure I with widely dispersed initial debt levels, the effect of down-payment requirements on the excess demand schedule is modest. The schedule is flatter than in the benchmark case, but not remarkably so. Moreover, the schedule is monotonically decreasing. Thus, there is no possibility of multiple equilibria. The consequences of a down-payment requirement are not very pronounced in this example because of the dispersion of debt levels. At no point is the ratio of constrained movers to unconstrained movers ever very high.

Figure II provides a sharp contrast. Here the schedule is not only much flatter in the neighborhood of the benchmark equilib-

11. This unconstrained 1 percent is just a device for avoiding an even greater multiplicity of equilibria. Without it, excess demand would be exactly equal to zero for *all* prices below a certain threshold level.

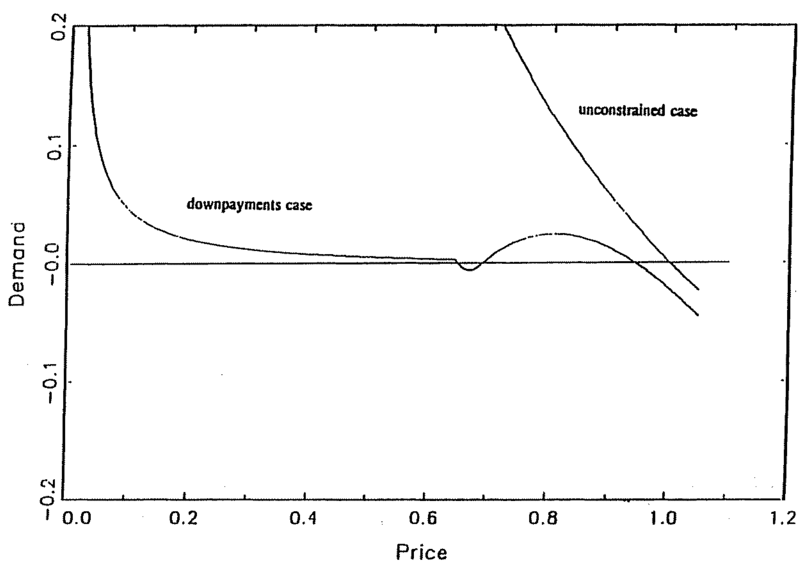

FIGURE II
Excess Demand versus Price

Note. For this figure the parameter values are $\alpha = 0.5$, $\gamma = 0.1$, $\theta = 0.1$; 99 percent of the population has K_i uniform on (0.6, 1), and 1 percent is never liquidity constrained.

rium, it actually changes slope and crosses the axis where $D(P) = 0$ more than once. Both the right- and left-most crossing points would seem to be stable equilibria, since they occur on downward-sloping portions of the schedule. Intuitively, what makes Figure II different is that, as prices fall toward 0.6, the relative concentration of constrained movers in the population becomes very high. This tends to impart a strong upward tilt to the excess demand schedule.

One interpretation of the multiple equilibria displayed in Figure II is that they create the potential for "catastrophes," i.e., situations in which small changes in fundamentals can lead to large, discontinuous jumps in prices. This is illustrated graphically in Figure III. This figure begins with the same excess demand schedule shown in Figure II. It then demonstrates that when the fundamental α is reduced slightly, from 0.50 to 0.455, the higher-price equilibrium (point A) suddenly ceases to exist. The only possible outcome is now the new lower-price equilibrium, given by point B in the figure. Thus, if the housing market was initially in the higher-price equilibrium, the necessary consequence of the small change in fundamentals is a dramatic fall in prices.

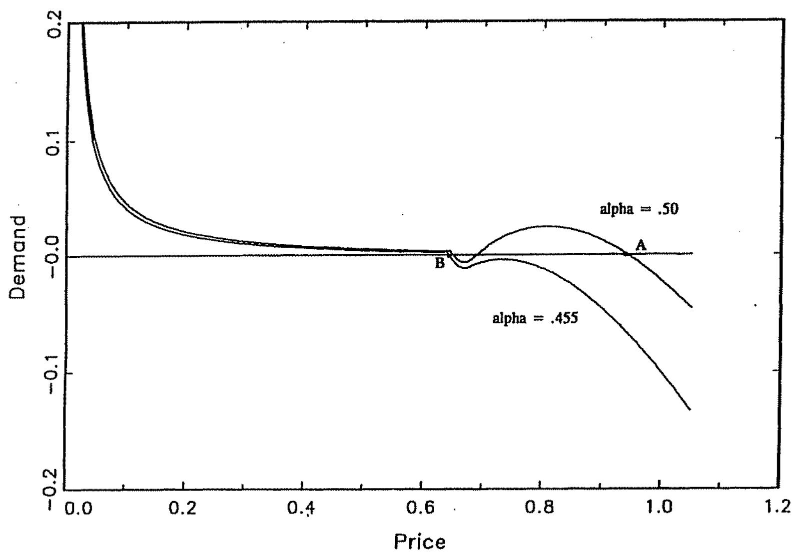

FIGURE III
Excess Demand versus Price

Note. For this figure the parameter values are $\gamma = 0.1$, $\theta = 0.1$; 99 percent of the population has K_i uniform on (0.6, 1), and 1 percent is never liquidity constrained.

Even when the market is not in a region of the parameter space where such catastrophic events can occur, there can nonetheless be more modest multiplier effects from changes in fundamentals. Figure IV examines this possibility. The figure uses the same parameter values as Figure II, but instead plots equilibrium prices as a function of α.[12] As can be seen, there are noteworthy multiplier effects. That is, even if we restrict ourselves solely to the higher-price equilibrium, prices are significantly more sensitive to changes in α than in the benchmark case. Thus, for this set of parameter values, there are two senses in which one can think of down-payment effects as generating a higher degree of volatility: they lead to both multiple equilibria (and the accompanying potential for catastrophic price movements) *and* within-equilibrium multiplers.[13]

Finally, Figure V illustrates the correlation between prices and

12. Since there can be two equilibria for these parameters, the figure only focuses on what happens in a neighborhood around the higher-price equilibrium, and restricts attention to values of α for which this equilibrium continues to exist.

13. In contrast, if one uses the parameters of Figure I, not only is there a unique equilibrium, multiplier effects are also almost completely absent.

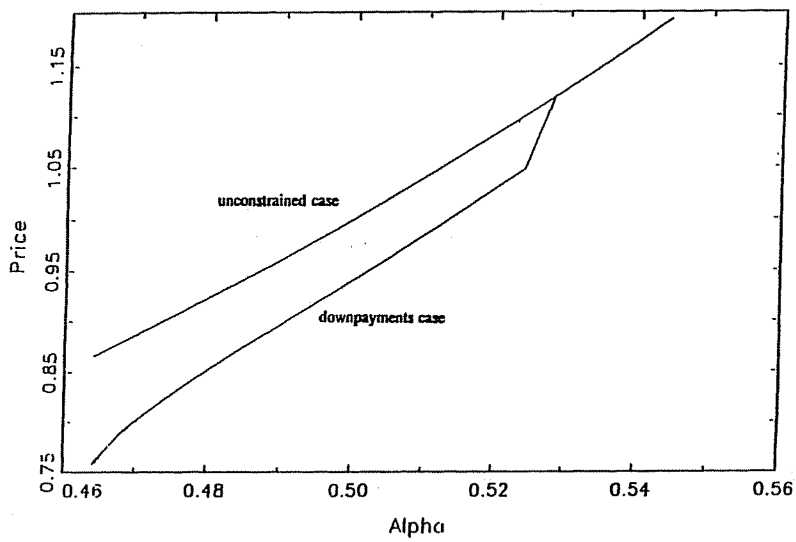

FIGURE IV
Price versus Alpha

Note. For this figure the parameter values are $\gamma = 0.1$, $\theta = 0.1$; 99 percent of the population has K_i uniform on (0.6, 1), and 1 percent is never liquidity constrained.

trading volume. Here, the parameter values are the same as in Figure I, but now the trading volume measure $G(K^{**})$ is plotted as a function of price. The striking conclusion that emerges from this figure is that even though there is little action in terms of price volatility for these parameters, there *is* a very pronounced correlation between prices and trading volume.[14]

Overall, the figures suggest that the model's implications for the price-volume correlation are somewhat more robust than its implications for volatility. Indeed, it is precisely *because* of the strong price-volume correlation that the volatility results are not always so striking. The intuition that was given in the Introduction—that price declines lead to reduced liquidity and reduced demand, and thereby feed on themselves—is actually incomplete. As prices fall, those families with the most impaired liquidity drop out of the market completely. Thus, they *do not* contribute in a negative way to excess demand. For some parameter values, the

14. The correlation is even more pronounced when one considers the parameters used in Figure II.

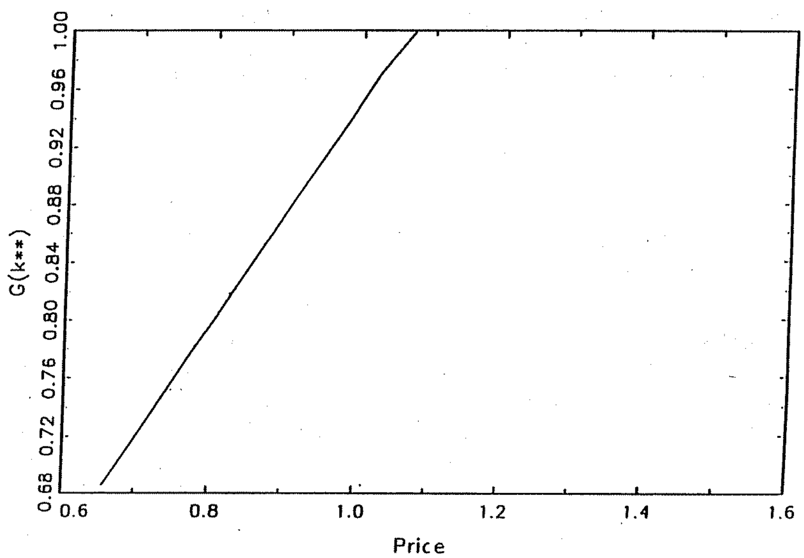

FIGURE V
Trading Volume versus Price

Note. For this figure the parameter values are $\gamma = 0.1$, $\theta = 0.1$; K_i is uniform on $(-0.2, 1)$.

ability of low-liquidity families to opt out of the market acts as a safety valve that tends to cut off downward price spirals.

III. Endogenizing the Down-Payment Requirement

Thus far, the down-payment requirement has been taken as exogenous to the model. Although such a requirement (or something quite like it) certainly seems to fit with what is observed in reality, the question arises of whether it can be explained in the context of a model with rational participants.

Suppose that, in addition to the families described above, there are a large number of "defaulters" in the economy. Defaulters differ from other families in a number of ways. First, and most importantly, they have no observable income at time 2. Thus, they can never be made to repay any loan that is extended to them at time 1. (Implicitly, the model above has assumed that all the time 2 income of the other families is publicly observed, so that they can always be held to their debts.)

Defaulters also own one unit each of housing stock at time 0, and have no outstanding debts at this time. They can either consume their "old" house at time 1, or they can attempt to move to a new house. The utility of a representative defaulter, U_d, is given by

$$U_d = H^{\text{old}} + \beta H^{\text{new}}, \tag{12}$$

where $0 < \beta < 1$. Thus, defaulters have linear utility, and would prefer to stay in their old houses if the shadow price of new and old houses were the same.

However, defaulters may view new houses as effectively cheaper, if they can borrow to buy them and then default on the loan. For example, suppose that $\beta = 0.5$, $P = 1$, and the down-payment requirement γ is only 0.2. In this case, a defaulter can sell the old one-unit house for 1, take the proceeds and make a down payment on a new *five-unit* house, and then not repay the loan. This will yield a utility of $0.5 \times 5 = 2.5$, which exceeds the utility of one that the defaulter gets from staying in the old house.

This suggests that if lenders cannot distinguish defaulters from other families ex ante, and they wish to screen out defaulters, they must set $\gamma > \beta$. This will deter defaulters from attempting to pool with other families by buying a new home and taking out a loan.

The required down payment can be made smaller if it is possible to punish defaulters in some way ex post. Following Diamond [1984], one might imagine that a nonpecuniary penalty (time spent in court, harassment from collection agencies, social stigma, etc.) is imposed on those who do not repay their loans. If the utility value of this cost is given by z, then the minimum down payment that deters defaulters from borrowing need only satisfy $\gamma > \beta/(1 + z)$.

In this very simple formulation the down-payment requirement and the no-rental feature emerge as essentially one and the same thing. There are two key assumptions: (1) some families cannot be held to their obligations, and (2) houses have no residual value once lived in. These two assumptions together imply that a family must put up some money ahead of time to occupy a new house. If not, there would be nothing to prevent the defaulter types from occupying a house (thereby fully depreciating it) and then walking away. Thus, *any* scheme, be it purchase or rental, that involves occupancy with no money down is precluded.[15]

15. More realistically, one might want to model from first principles a situation where there is a meaningful distinction between ownership and renting. For example, one might wish to derive the sort of setup that is simply assumed in the

IV. Implications of the Model

A. The Behavior of House Prices

The fact that the model can generate both multiple equilibria as well as within-equilibrium multipliers suggests that down-payment effects may cause house prices to be more volatile than in a standard efficient markets setting. However, some care must be taken when interpreting the model in light of the empirical literature on the time series behavior of house prices, as the model is essentially a static one. Thus, it would be something of a stretch to claim that the model in its current form can help explain, say, the Case and Shiller [1989, 1990] finding that house price changes are positively correlated at short horizons but negatively correlated at longer horizons.[16]

In a somewhat different vein the model may be able to explain why boom-to-bust cycles are more pronounced in some cities than in others. A key conclusion of the theory is that the potential for volatility depends critically on the initial distribution of debt levels. Thus, a city where the majority of homeowners have high loan-to-

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Appendix, where renting allows for occupancy with less money down than ownership, but is less efficient in other ways. This might be done by adopting the concept of ownership advanced by Grossman and Hart [1986]. Suppose that the residual control rights associated with *owning* a house allowed the occupant to "customize" the house, while customization is not possible for renters. Suppose further that customization has two effects: (1) it raises the utility of the current occupant; but (2) at the same time, it lowers the resale value of the house. This suggests that ownership will require a larger down payment than renting, since ownership tends to reduce the collateral value of the house. At the same time, for those who are not liquidity-constrained, ownership is more efficient than renting.

16. In order to obtain more precise predictions about such time series behavior, the model would have to be extended to explicitly incorporate intertemporal considerations. This may be quite difficult to do, particularly if one wants still to be able to derive the form of the mortgage contract endogenously. In an intertemporal setting, the size of the down payment lenders require today will presumably depend on the collateral value of the house; i.e., how much it will be worth if it is repossessed and sold on the open market tomorrow. The price tomorrow in turn depends on the down-payment requirement that prevails tomorrow, and so on. Thus, the problem quickly becomes very complicated.

Cutler, Poterba, and Summers [1991] have argued that these time-series properties—a tendency toward positive correlation at short horizons, negative correlation at longer horizons, and fundamental reversion—are common across a wide range of asset markets, and can be explained in terms of "speculative dynamics" that operate similarly across these markets. This would seem to suggest that one does not really need to have a housing-market specific theory of price movements. The counter to this view is that it may make little theoretical sense to expect the same speculative dynamics to arise in markets as diverse as those for equities and houses. The models that generate the sort of speculative dynamics which Cutler et al. have in mind, for example, the bubble model of Blanchard and Watson [1982] and the noise trader/positive feedback trader models of De Long et al. [1990a, 1990b] rely critically on agents having short holding periods. This short-horizon assumption may make some sense in the context of the stock market, where trading costs are low and turnover is greater than 50 percent per year, but it is much less clear that it fits the housing market.

value ratios may be more prone to a crash in house prices than a city where there is a wide dispersion of loan-to-value ratios.

One way that a city might acquire a concentration of homeowners with high-loan-to-value ratios is if there is a lot of trading volume during a period when prices are rising. In this sense, some types of housing booms may sow the seeds for a subsequent crash. For example, suppose that initially, demographic factors (e.g., a lot of migration into a particular city) both raise prices and result in a large number of highly leveraged purchases at the new, higher prices. This could make the housing market more "fragile," in the sense of the model of this paper. The market would be now in a region of the parameter space where a relatively small negative shock could have a large effect on prices.[17]

Finally, the model may also be able to shed some light on cross-sectional variations in house prices *within* a given city. This point is most easily understood in the context of an extreme example. Suppose that there are two distinct types of houses: (1) "starter" houses, which are only ever purchased by first-time buyers; and (2) "repeat" houses, which are only ever purchased by buyers who are also selling an existing home. The logic developed above applies only to the repeat market, and not to the starter market, since in the starter market there is no feedback from house prices to buyer liquidity. Thus, one should expect the prices of repeat houses to be more sensitive to changes in fundamentals than the prices of starter houses.[18]

B. Trading Volume

The most robust prediction of the model is that trading volume will be correlated with prices. Figure VI provides some data on the price-volume relationship, plotting the monthly U. S.-wide volume and median real sales price for existing single-family homes between 1968 and 1992. This is a somewhat crude approach: one might expect the correlation between these two variables to be most pronounced at the level of a single city or regional market, so that aggregating over the entire country would blur the relation-

17. Clearly, to make this sort of argument more precise, one would need to have an explicitly dynamic model in which the distribution of loan-to-value ratios in the population evolves *endogenously,* rather than being specified exogenously, as is done here.

18. In practice, testing this hypothesis is complicated by the fact that the empirical distinction between starter and repeat houses is not perfectly clear-cut. Nonetheless, Smith and Tesarek [1991] and Mayer [1993] provide evidence that is broadly consistent with this prediction.

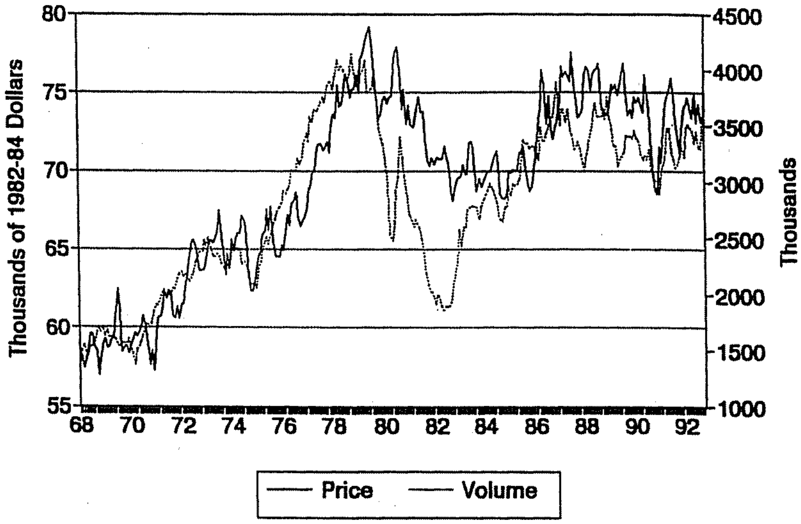

FIGURE VI
U. S.-Wide Volume and Real Median Sales Price of Existing Single-Family Homes

ship somewhat. Nonetheless, the correlation at the national level is visually striking, and some simple statistical exercises confirm the visual impression. I ran a regression of volume against (i) the last year's percentage change in prices and (ii) a linear time trend. The regression produces a coefficient on the former variable that is highly statistically significant, with a t-statistic of 4.9. Moreover, the point estimate suggests that a 10 percent drop in prices reduces volume by over 1.6 million units. Given that total volume has been in the range of three to four million units in the last several years, this effect is clearly of major economic importance.[19]

While these sorts of simple correlations are certainly consistent with the model's predictions, they do not constitute a very sharp test. That is, they do not clearly differentiate between the down-payment effects hypothesis and other alternative hypotheses; e.g., the behavioral explanation that sellers refuse to "recognize reality" and accept low prices in depressed markets.

In recent work Genesove and Mayer [1993] use transaction-level data from the Boston condominium market to provide a much sharper test of the down-payment effects hypothesis. They find

19. I also ran separate regressions for four regions of the country: Northeast, Midwest, South, and West. In each case, the percentage change in price continued to be very significantly related to volume.

that owners with high loan-to-value ratios are significantly less likely to sell their homes than those with low loan-to-value ratios. This is exactly what would be expected according to the model presented above: those with high loan-to-value ratios correspond to the nonmovers in the model. In contrast, this pattern is not implied by the behavioral theory.

C. Waiting Times

Taken literally, the model has nothing to say about the length of time a house sits on the market before it is sold, or about why this waiting time might be correlated with price movements. However, such predictions can be generated by appending a simple search technology to the current model. Rather than presenting such an extension of the model formally, I will just lay out the basic intuition.

The search technology works as follows. A seller can either (1) sell with certainty at the current "auction market" price or (2) fish for a better price. Fishing involves listing the house at an above-auction-market price. The trade-off is that there is a significant probability that the house will not be sold immediately, if ever.

The important insight is that the opportunity cost of fishing is zero for families who would otherwise be nonmovers. If these families do not fish, it is certain that they will have to remain in their old homes. At the same time, fishing holds some potential upside for these families. If they get lucky and sell their house for an above-market price, they may have sufficient cash to make moving worthwhile. Thus, fishing is a no-lose proposition for families who are in the nonmover group.

In contrast, fishing has a positive opportunity cost for families who are in the other two groups. If they fish and are unsuccessful, they give up their opportunity to move to a new house and thereby enjoy the gains from trade. Thus, there should be more fishing when there are more families in the nonmover range; i.e., when prices and trading volume are low. Empirically, the greater concentration of the fishing strategy in the population will show up as more houses sitting on the market for a significant period of time before they are sold. Hence the prediction of this extended version of the model is that waiting times will be negatively correlated with prices and trading volume.[20]

20. In this simple version of the story, the search technology is invariant to the other parameters of the model. However, one can strengthen the argument for a correlation between prices and waiting times by noting that the search technology

Genesove and Mayer [1993] also present results that are consistent with this fishing hypothesis. In their transaction-level data they find that, controlling for a number of other factors, homes that are put on the market by sellers with high loan-to-value ratios have higher sales prices than homes offered by sellers with lower loan-to-value ratios. This fits precisely with the fishing notion of those with more debt holding out for higher prices. It also complements the Genesove-Mayer finding cited above, namely, that a household with more debt has a lower probability of selling its home, *even conditional on listing the home with a broker*.

D. Housing Starts

One reason that it is particularly important to understand the determinants of prices and trading behavior in the housing market is because of the implications of these variables for housing starts, and by extension, for construction and related industries. Housing starts are extremely volatile, with average peak-to-trough declines of 45 percent in eight postwar housing cycles.[21] Topel and Rosen [1988] find that starts are very sensitive to the level of house prices. This is not surprising from a theoretical point of view—it can simply be interpreted as evidence of an upward-sloping supply curve for new construction—but it underscores the economic significance of house-price volatility.

Perhaps more surprising is Topel and Rosen's finding that a measure of trading intensity—specifically, the median time that it takes for a new house to be sold—also has a strong, independent effect on housing starts. However, this correlation between housing starts and waiting times can be explained using a logic very similar to that developed just above to explain the correlation between trading volume and waiting times. Indeed, the story is essentially the same one, with would-be mover families replaced by capital-constrained builders. Suppose that when a builder starts a new project, he needs to put up some of his own money as a down payment on the land, materials, etc. His ability to make such a

itself may work differently in high and low markets. In particular, it seems plausible that matching will be easier in markets with higher trading volume. This "thick markets" effect has been noted by a number of authors. (See, e.g., Diamond [1982].) If this is indeed the case, then it is likely that the average waiting time associated with a search strategy is shorter. Now there is a second channel through which house prices can be correlated to waiting times: as house prices fall, trading volume drops for the reasons outlined above. With lower trading volume those who choose to pursue a search strategy have to make do with a less efficient matching technology, and thus typically must wait longer to sell their houses.

21. See Smith, Rosen, and Fallis [1988].

down payment will depend on the prices he is able to realize on the houses he is just completing. If house prices fall, the builder will do worse than expected on the sale of his current inventory of houses, and will have a more difficult time coming up with the funds to move on to the next construction project.

When liquidity constraints are not very binding, the builder should move from one project to the next without undue delay; that is, he should sell houses promptly as he finishes them, take the proceeds, and use them to move on to the next job. However, if liquidity constraints become very severe, the builder is in a position exactly analogous to the nonmover families in the model above. There would be gains from trade if he could move on to the next project, but if he sells his current house (or houses) at the prevailing market price, he will have insufficient cash to move on. Thus, at some point it will become optimal for the builder to shift to the "fishing for liquidity" strategy.

Until the builder's fishing strategy pays off (i.e., while his finished house sits on the market), he cannot move on to the next project. Thus, one will observe a correlation between waiting times and housing starts. To the extent that the level of house prices is not a perfect summary statistic for the state of builder liquidity—e.g., builder liquidity may also be influenced by recent *changes* in prices—this correlation will show up in a regression even when the level of house prices is added as an additional explanatory variable.

As before, it should be possible to test this hypothesis empirically. The key to doing so would be data on time-to-sale and housing starts that are at least partially disaggregated by builder. If builders' liquidity constraints are a central part of the phenomenon, then we should expect to see a more pronounced correlation between waiting times and housing starts for those builders who are most capital-constrained. Thus, the correlation should be strongest for small, heavily indebted builders. Larger construction companies with a greater degree of access to external finance should have behavior that is less sensitive to waiting times.[22]

22. The following quote, taken from Chaluvadi [1991, p. 13], is suggestive: "The largest builders' share of the single-family market depends largely on the state of the economy. During the booms in the late 1970's and middle 1980's, the top builders' market share decreased. However, in periods of recession, as in the early 1980's, the number of housing starts fell, but the top builders' market share rose. The increase in market share during recessions is partly due to large builders' capability to easily access credit."

V. Conclusions

The model of the housing market developed above is extremely simple and stylized, yet it yields a variety of empirical implications. Several of these appear to be broadly consistent with previously existing evidence. In addition, the recent work of Genesove and Mayer [1993] lends more focused support, confirming some of the model's more distinctive predictions. Still, a number of hypotheses remain that have yet to be carefully tested at this point.

On the theoretical front, there are a number of directions in which the basic model might be extended. For example, it would clearly be desirable to make the model an explicitly intertemporal one, in order to endogenize the evolution of families' debt levels, and to generate sharper predictions about the time series behavior of house prices. Also, if one is interested in pursuing the model's implications for time-to-sale in more detail, it could be useful to make the search technology described above more explicit. Presumably, this would involve adding some degree of heterogeneity to the housing stock, so that not all houses are equally well-suited to all buyers, and there is a substantive matching problem.

Appendix: Adding a Rental Sector to the Model

It is straightforward to add a rental sector to the model. As noted above, for the down-payment constraint to still be relevant, it must be the case that renting is not as efficient as direct homeownership. One simple way to incorporate this is to assume that in order to rent a unit of housing, a family must pay $P(1 + T)$. The advantage of renting is that nothing must be paid until time 2, so that liquidity constraints are not an issue. The disadvantage is the added cost, represented by the parameter T. (This formulation of the distinction between renting and ownership is clearly ad hoc. However, see footnote 15 for a discussion of how something like it might be derived from first principles.)

If a family chooses to rent, it will demand $\alpha(1 + P)/P(1 + T)$ units of housing, and will have utility given by

$$U^r = \alpha \ln(\alpha(1 + P)/P(1 + T)) + (1 - \alpha)\ln((1 - \alpha)(1 + P)) + \theta. \tag{A.1}$$

A family can now fall into one of four groups: "unconstrained buyer," "constrained buyer," "renter," or "nonmover." For any given price P we can distinguish two cases:

Case 1: $U^r < 0$. In this case, renting is less attractive than being a nonmover. Therefore, renting *endogenously* drops out of consideration, and demand is given as in the text. This implies that if a given price P was an equilibrium of the model without a rental sector, and if, at that price P we have $U^r < 0$, then that price continues to be an equilibrium of the expanded model. For example, it is easy to show that for all the simulations reported in the text, nothing changes so long as $T > 0.28$. Thus, there continue to be exactly the same (multiple) equilibria and multiplier effects as before, as well as the same correlation between prices and trading volume.

Case 2: $U^r > 0$. In this case, renting is more attractive than being a nonmover, so that the nonmoving option drops out of consideration. Thus, we can again partition families into three groups: the low-debt unconstrained buyers, the medium-debt constrained buyers, and the high-debt renters. The demands of the families within the first two groups, as well as the cutoff point K^* separating them, are the same as before. The cutoff point between the renters and the constrained buyers, denoted by $\hat{K}^{**}$, is set so as to equate U^r and U_i^c. In this case, the slope of the excess demand schedule is given by

$$\text{(A.2)} \qquad \frac{dD}{dP} = \frac{-\alpha}{P^2}\,\frac{[G(K^*) + (1 - G(\hat{K}^{**}))]}{1 + T} + G'(\hat{K}^{**})\frac{d\hat{K}^{**}}{dP}\,\frac{[H_i^c(\hat{K}^{**}) - \alpha(1 + P)]}{P(1 + T)} + \frac{G(\hat{K}^{**}) - G(K^*)}{\gamma P^2}\{E(K|K^* \leq K \leq \hat{K}^{**})\}.$$

Note that the form of (A.2) is remarkably similar to that of equation (11) in the text. The first two terms are negative, as before. (To see that the second term must be negative, note that the amount of housing demanded by a renter must exceed that demanded by a constrained buyer at the point $\hat{K}^{**}$ where their utilities are equalized.) Most significantly, the third term, which is positive, is identical to the third term in (11), except that $\hat{K}^{**}$ has replaced K^{**}. As long as this third term is large enough in magnitude, price effects similar to those discussed in the text will continue to obtain. The intuition is straightforward: what matters for price volatility continues to be the relative concentration of constrained buyers in the population. Even with an active rental market, there will in general still be such constrained buyers, as long as T is significant. Families with intermediate levels of debt will prefer to accept a constrained quantity at the price P rather than an unconstrained quantity at the price $P(1 + T)$.

The one implication of the model that seems to be changed in Case 2 is the correlation between prices and trading volume. Since there are no more nonmovers, this correlation disappears. However, this is an artifact of the extremely simple way in which the rental sector was added. Once the rental market is used in equilibrium, it completely dominates nonmoving, so that *nobody* finds it attractive to be a nonmover anymore. More realistically, one might assume that there is some heterogeneity across households in the value of θ. Households with a very high value of θ—those who are very eager to move—will become renters when their wealth is sufficiently impaired. In contrast, those with a lower value of θ will become nonmovers. The excess demand function will still have the same general shape as before. Now, however, even when there is an active rental market in equilibrium, it will be the case that a decline in prices leads *some* families to switch into the nonmover range, hence restoring the correlation between prices and trading volume.

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