Leverage and Price Dynamics in the Housing Market

Sugato Bhattacharyya
Ross School of Business
University of Michigan

Rajdeep Singh
Carlson School of Management
University of Minnesota

June 17, 2017
(Preliminary Version)

We are grateful to Patrick Bolton, Dennis Capozza, Avinash Dixit, David Frame, Jonathan Parker and seminar participants at the Universities of Michigan and Minnesota and the Hong Kong University of Science and Technology for their helpful comments. The usual disclaimer applies. Correspondence to: Sugato Bhattacharyya, Ross School of Business, University of Michigan, 701 Tappan, Ann Arbor MI 48109-1234, (734) 763-9777, sugato@umich.edu or Raj Singh, CSOM, 321-19th Ave S., University of Minnesota, Minneapolis, MN 55455, (612) 624-1061, rajsingh@umn.edu.
Leverage and Price Dynamics in the Housing Market

Abstract

The paper presents a model of the housing market where sellers optimally post listing prices above their reservation value in the hope of landing a buyer with a higher valuation. The optimal listing price in the presence of fixed rate mortgage financing is shown to be increasing in the seller’s leverage. Thus, levered sellers post higher prices and wait longer to sell. Housing downturns increase the loan-to-value ratio of houses and lead to higher inventory levels. The paper provides an explanation for the downward stickiness of housing prices without recourse to downpayment constraints or behavioral biases.
1 Introduction

In the aftermath of the real estate bust and financial crisis of 2007 – 2008, policy makers have grappled with the question of how to revive the housing market. Much attention has focused on measures which seek to reduce interest rates and, thereby, stimulate demand for housing. In particular, the latest phase of Quantitative Easing has explicitly focused on the Federal Reserve’s purchases of mortgage-related securities in a direct effort to influence mortgage rates. Case (2008) notes that the downward stickiness of housing prices is typically associated with homeowners sitting on fixed-rate mortgages. In this paper, we present a model in which listing prices for housing are sticky downward in the presence of fixed-rate mortgage financing. Moreover, we show that the degree of stickiness increases with the leverage of the seller.

Falling real estate prices have long been known to be associated with significant increases in the inventory of unsold homes on the market. Genesove and Mayer (2001) document this phenomenon for the Boston condominium market during the 1980s when sharp swings prices were accompanied by large changes in the volume of housing offered. Miller and Skarz (1986) document similar price-volume patterns for housing markets in Hawaii and Salt Lake City. The reluctance of sellers to decrease prices in a falling market gives rise to an accompanying decline in sales volume and accounts for a positive price-volume correlation in the housing market. Such a correlation is often regarded as an anomaly from the perspective of efficient asset markets since, on the face of it, lower volumes should be associated with higher prices. In addition, the asking price for housing has been shown to bear a positive relationship to the leverage outstanding in the financing of the home. Genesove and Mayer (1997, 2001) show that this relationship is both statistically and economically significant in the Boston condominium market in the 80s. This connection between the price of an asset and its financing has also been interpreted as being anomalous from the perspective of an efficient asset market. Taken together, such observations have led to both behavioral and institutional arguments which have tried to offer explanations for these patterns.

In this paper, we argue that assets that are traded in markets characterized by costly search are quite likely to display the characteristics that have been established as descriptive of housing markets. Specifically, when sellers choose posted prices which may or may not be
acceptable to potential buyers who arrive sequentially, the financing structure of the asset
is an important input into the seller’s choice of a price to post. Also, since falls in real
estate prices will, in general, give rise to increases in the loan-to-value ratios when values are
measured by aggregates, we show that the reluctance of sellers to lower prices will indeed
induce a positive correlation between prices and volumes. Thus, this paper shows that the
basic institutional features of the housing market easily account for these findings which
have sometimes been interpreted as anomalous.

The basic relationships between prices and volumes in the housing market have been
model in which sellers of residential units plan to purchase new housing and, hence, require
a down-payment for the new house. Sellers are assumed to face borrowing constraints. Since
a lowering of the selling price directly corresponds to the reduction of the sale’s contribution
towards the down-payment, Stein (1995) argues that this down-payment constraint makes
sellers reluctant to reduce prices in line with general declines. Genesove and Mayer (1997)
analyze data from the Boston condominium market and report that prices for owner-occupied
properties show a positive correlation with the loan-to-value ratio. They argue that such
a correlation can be explained by the model in Stein (1995) since a higher level of the
outstanding loan would imply a lesser contribution toward the down payment from a sale
at any given price. However, Genesove and Mayer (1997) also report that prices of investor-
owned properties also exhibit a similar sensitivity to loan-to-value ratios. Since investors
are unlikely to be constrained by down payment requirements for new homes, Genesove and
Mayer (1997) argue that such sensitivity is explained by costs associated with default.

The model in this paper does not rely on either down-payment requirements or costs
of default to explain the observed patterns in the data. In fact, since many mortgages on
individual units in the residential market are coupled with promissory notes which enable the
lender to claim the face value of the outstanding mortgage balance in the absence of explicit
bankruptcy, we do not allow borrowers to default in our model. Even in the absence, then,
of any benefits or costs of default, we show that the price posted by a seller generically
depends on the degree of leverage outstanding against the property being sold. In a market
characterized by search and sequential arrivals, we show that the seller faces a tradeoff
between setting a higher price and risking a longer wait versus setting a lower price and
expecting a quicker sale. Given that proceeds from the sale are credited to the seller net of the outstanding loan amount, the tradeoff thus faced by the seller is with respect to this net amount. However, the seller recognizes it is the (gross) price charged that determines both the probability of a sale and the amount that a buyer would be willing to pay. Hence, the tradeoff imposed at the buyer’s level is not one pertaining to net amounts that the seller obtains after paying off the lender. It is this wedge that is responsible for the seller setting a higher price for a property when it has a high loan amount outstanding. Consequently, we should expect the outstanding leverage to affect the selling price quoted by the seller.

Not only does our model help to rationalize price and volume patterns already found in the existing literature on housing markets, it also yields new predictions that can be taken to the data. In particular, it predicts that, for fixed rate mortgages, the sensitivity of posted prices to seller financing should vary depending on the history of mortgage rates. With floating rate mortgages, such path dependence is predicted to be weaker or non-existent. In addition, our model allows for the possibility of greater leverage dependence of prices of less financially constrained sellers. This possibility is at odds with the predictions of models that rely on borrowing constraints to explain the impact of seller financing on prices.

The paper proceeds as follows. Section 2 first presents a benchmark model without leveraged financing where sellers optimally determine their listing prices. It then introduces leveraged financing and presents the principal results in a simple one-period setting. Section 3 extends the analysis to a multi-period context by endogenizing expectations of future prices in a recursive context. Section 4 compares and contrasts the results of our model with extant studies on the subject, while Section 5 concludes.

2 The Single-Period Model

In this section, we first present a benchmark model of housing sales in the absence of leveraged financing. We show that the sellers’ optimally chosen listing price perfectly adjusts to market conditions such that the inventory of unsold houses is insensitive to general market conditions. We then introduce leveraged financing and show that leverage may inhibit the perfect adjustment of list prices to general market conditions. To keep things simple and transparent, we restrict ourselves in this section to a stylized, one period model. The next
section extends our analysis to the multi-period case.

2.1 The Benchmark Case

A risk-neutral owner of a residential property with no outstanding mortgage decides, for exogenous reasons, to put up her house for sale. The value of the property to each potential buyer is composed of a common component reflecting the opportunities available in the market as a whole and a buyer-specific (private) component determined by individual tastes or needs. For simplicity, the common component, $V$, is assumed to be common knowledge\(^1\).

The assessed value of each buyer is denoted by $v = \beta V$, where $\beta$, a private parameter, is distributed on the interval $[1 - \Delta, 1 + \Delta]$ with a distribution function $F(\beta)$. $F(\cdot)$ is assumed to have an increasing hazard rate\(^2\) and the associated density function, $f(\beta)$, is assumed to be differentiable and strictly positive everywhere in its domain. The expectation of the assessed value is equal to the common component: $E(\beta) = 1$.

Once the seller lists the property for sale, a single buyer emerges with a private component of value drawn from the distribution for $\beta$. If the asking price of the house is below the buyer’s assessed value, $\beta V$, the sale goes through at the asking price. If the buyer’s value estimate is below the asking price, there is no sale. For now, we assume that in the absence of a sale the seller expects to sell the house at the end of the period to obtain an expected revenue of $\bar{\beta} V$. If the seller occupies the property for the period following the listing, she also benefits from an usage value. Correspondingly, for an investor-owned property, a per-period rental income is generated. For simplicity, we do not explicitly distinguish between these situations and denote either by $R$. We also adopt the convention that this benefit accrues at the end of the period. It should be noted, however, that rental income and use value may very well diverge.

We assume that the seller prefers receiving proceeds from sale earlier rather than later and denote her per-period delay cost by $\delta < 1$. These costs may represent the time value of money and could also represent the seller’s eagerness to sell: higher the eagerness to sell, lower is the delta. When convenient, we shall characterize the sellers eagerness to sale by the

\(^1\)This component could correspond roughly to the notion of appraised value that would be assessed by an unbiased real-estate professional or taxing authority.

\(^2\)That is, $\frac{f(\beta)}{1-F(\beta)}$ increases in $\beta$. 

5
associated discount rate, \( d \), where \( \delta = \frac{1}{1+d} \). Thus, a higher value of \( d \) denotes a higher value attached to present consumption. At first glance, when the seller is financially unconstrained, it may be reasonable to assume that \( d \) is equal to the prevailing interest rate. In general, however, a decision to sell usually is taken when there are other valuable opportunities to pursue. For example, the seller may have available to her the (temporary) opportunity to buy a more suitable property. Or the seller may anticipate a decline in housing prices and may, therefore, be in a hurry to liquidate her position in real estate. In such situations, the level of \( d \) will be strictly higher than the current level of the interest rate.

We denote the seller’s posted price in this benchmark case by \( p_{bm} \). For expositional ease, we also define the number \( \beta_{bm} \): \( p_{bm} = \beta_{bm} V \) to facilitate comparison between the benchmark case and the case with leveraged financing. With this notation, the seller’s decision is to choose a \( \beta_{bm} \) (or equivalently, \( p_{bm} \)) to maximize

\[
\Pi_{bm} = F(\beta_{bm}) \delta [\beta V + R] + (1 - F(\beta_{bm})) [\beta_{bm} V]
\]

The first order condition for the problem is given by

\[
f(\beta_{bm}^*) \delta [\beta V + R] - f(\beta_{bm}^*) \beta_{bm}^* V + (1 - F(\beta_{bm}^*)) V = 0
\]

\[
f(\beta_{bm}^*) (\delta [\beta V + R] - \beta_{bm}^* V) + (1 - F(\beta_{bm}^*)) V = 0
\]

Using \( \rho = \frac{R}{V} \) to denote the rental/usage yield, we can simplify this expression as

\[
\beta_{bm}^* = \delta [\bar{\beta} + \rho] + \frac{(1 - F(\beta_{bm}^*))}{f(\beta_{bm}^*)}
\]

To interpret equation (1), note first that the discounted value of benefits for an unsold house is given by \( \delta [\bar{\beta} + \rho] V \). This, then, is a seller’s reservation value, in that a sale at this posted price today makes her indifferent between a sale today and a disposition a period later.\(^3\) Clearly, no seller would set a price below this reservation value. For convenience we

\(^3\)We assume \( 1 - \Delta < \delta [\bar{\beta} + \rho] < 1 + \Delta \), so that a seller has no reason to engage in a fire sale and does not choose a list price so high as to guarantee no sale.
denote this reservation value by $\beta_{\text{res}} V$.

What equation (1) tells us is that the seller optimally sets a list price strictly above her reservation value and trades off obtaining a higher price conditional on sale with the benefits she expects if the sale does not go through. The lower the costs associated with a non-sale, the higher the price she is willing to post. In particular, if she expects price appreciation in the future (higher $\bar{\beta}$), she posts a higher price today and is willing to risk a greater chance of a sale not going through today. Similarly, a higher usage/rental yield makes her choose a higher listing price. The seller’s optimally chosen listing price, then, does not guarantee sale.

With multiple sellers and buyer values drawn independently from a common distribution, optimal seller behavior generates a list of unsold houses at the end of the selling period. Equation (1) shows that, with the assumptions in our benchmark case, the proportion of unsold houses is independent of the value of $V$. That is, the proportion of unsold houses is invariant to the level of house values today, conditional on future expectations. A drop in house values that leaves rental yields and the dispersion of buyer values unaffected does not change the proportion of unsold houses. In particular, a 10% drop in appraised values leads to a 10% drop in listed prices. In other words, posted prices fully adjust to general valuation shocks and listing behavior is unaffected. We characterize the benchmark case in the following lemma.

**Lemma 1** A seller with a self-financed home chooses a list price $\beta_{\text{bm}}^* V$ strictly higher than her reservation value. The list price chosen fully takes into account the current state of the housing market to generate a probability of sale that depends only on the seller’s expectations of price appreciation and rental yield.

### 2.2 The Effect of Leverage

We now introduce leverage into our benchmark model by assuming that the property to be listed has outstanding against it a non-assumable debt claim of face value $L$. This mortgage, secured by the value of the house, has to be repaid once the sale goes through. The coupon rate on the mortgage is $i$ and, for simplicity, we assume that the mortgage is an interest-only loan. Thus, the payment of mortgage interest, $iL$ is due at the end of each period the loan
in outstanding. In keeping with the convention in the U.S., we assume that the loan can be refinanced without incurring any pre-payment penalties and assume away any other costs associated with the refinancing process. As a result, the coupon rate on the loan is always less than or equal to the current prevailing mortgage interest rate \( r \).

It is, then, natural to define a loan-to-value ratio by the amount \( \lambda = \frac{L}{V} \). Note that, for all houses which share the same common value of \( V \), different levels of outstanding debt will give rise to a cross-sectional variation of the loan-to-value ratio. Hence, any variation of listing/selling prices with outstanding debt also corresponds to variation with respect to the loan-to-value ratio.

We denote the seller’s posted price this period by \( p = \beta V \). The seller’s problem is, then, to choose an optimal level of \( \beta \), to maximize the following objective function:

\[
\Pi = F(\beta)\delta [\bar{\beta}V + R - (1 + i)L] + (1 - F(\beta)) [\beta V - L]
\]

(2)

The first order condition for a maximum can be expressed as:

\[
\frac{\partial \Pi}{\partial \beta} = f(\beta^*) [\beta_{res}V - \delta(1 + i)L] - f(\beta^*) [\beta^*V - L] + (1 - F(\beta^*))V = 0
\]

which, when simplified, yields:

\[
\beta^* = \beta_{bm}^* + \left[ 1 - \frac{1 + i}{1 + d} \right] \lambda
\]

(3)

Equation (3) immediately shows that the extent of leveraged financing engaged in by the seller has an impact on her choice of listing price whenever the coupon rate on the mortgage is different from her discount rate. As we have argued above, given costless refinancing, the coupon rate, \( i \), must be weakly lower than the prevailing interest rate, \( r \). In turn, given the seller’s preferences and opportunities, her discount rate, \( d \), is strictly higher than the current interest rate. As a result, the fraction, \( \frac{1 + i}{1 + d} \), is strictly less than 1. Consequently, a seller with a higher leverage optimally chooses a higher listing price. As in the benchmark case discussed earlier, the list price increases with anticipated price appreciation and the use
rental yield of the property. We, thus, have the following result.

**Proposition 1** With fixed rate financing and the opportunity to costlessly refinance a mortgage, the optimal listing price for a leveraged seller is (i) higher than that posted by a self-financed seller; (ii) increasing in the loan-to-value ratio.

The benefit to the seller from posting a higher price is clear: a higher price, if realized, increases the money left over after paying off the loan on the property. Posting a higher price, however, also imposes a cost since the probability of a sale this period goes down. How major a cost this is depends on the costs associated with a delayed disposition. As long as the interest cost paid to the lender is lower than the impatience cost of the seller, the existence of a loan decreases the delay cost for the seller. Therefore, an increase in the face value of the loan, *ceteris paribus*, reduces the delay cost for the seller and she posts a higher sale price.

Note that our result that the listing price of the house increases with its outstanding leverage implies that the probability of a sale in the current period also decreases with leverage. This is because an increase in the posted price reduces the probability of arrival of a suitable buyer this period. Hence, it is more likely that the sale is postponed to the next period. Therefore, we have the following corollary:

**Corollary 1** The probability of sale of a house decreases with its loan-to-value ratio.

It should be noted that both the Proposition and its Corollary are consistent with the results in Genesove and Mayer (1997). There, it was established that the posted price of both owner-occupied and investor-owned condominiums in Boston increased with their loan-to-value ratio. In our model, there is no particular distinction between these ownership patterns save, perhaps, for the numerical value of the rental/usage yields. In particular, neither result above depends on the requirement of ponying up a down payment as in Stein (1995), which applies only to owner-occupied housing. Thus, our derivation shows that two separate explanations for patterns in the selling prices for owner-occupied and investor-owned properties, as argued for in Genesove and Mayer (1997), are not required.

While the Proposition above establishes the nature of variation of the posted price along with the loan-to-value ratio, equation (3) also allows us to say something about the magnitude of this effect. In particular, it is easy to see that the effect is larger as the difference
between \( d \) and \( i \) is greater. Thus, for example, if investors eager to sell face only the trade-offs inherent in owning a financial asset, whereas owners face the additional constraint of only being able to move into a more desirable property if the current home can be sold, the differential between \( d \) and \( i \) would be higher for owners than for investors. As a result, owner-occupants would likely display a greater sensitivity to leverage in the posting of prices than investors as, indeed, is found in Genesove and Mayer (1997).

Furthermore, due to the absence of prepayment penalties and consequent incentives to refinance, the distance between \( d \) and \( i \) is likely be lower when interest rates have declined than when they have increased over time. Our model generates the prediction, then, that the sensitivity of posted prices to leverage will be higher when interest rates have increased than otherwise. Note that the down payment constraint model of Stein (1995) has nothing to say about such a pattern.

A final point to note is that with floating rate mortgages, \( i = r \) and, therefore, the distance between \( i \) and \( d \) will be relatively immune to variations in interest rates over time. This is the situation that prevails in mortgage markets like the U.K. and Australia. Our simple model says that posting prices in such environments should respond less to leverage levels. In particular, then, the variation of posted prices over time should be muted in an adjustable rate environment.

Our discussion above is summarized in the following Proposition.

**Proposition 2** With fixed rate financing and no prepayment penalties, the sensitivity of posted prices to leverage will be higher in high interest rate environments. With variable rate financing, the sensitivity of posted prices to leverage will vary less across time periods.

3 The Multi-Period Model

The single-period model of the previous section arbitrarily specified the seller’s expected outcome in the event that the house failed to sell. It is, however, relatively straightforward to extend the logic of the model to a multi-period context where seller expectations are not exogenously specified. In this case, we assume that for every period a posted sale fails to happen, the seller has a choice of either withdrawing from the market or of putting up
the house for sale again in the next period. If we assume that buyer valuations are drawn independently each period from the same distribution, then the seller’s optimal selling policy remains unaltered over periods. That is, she will post an invariant asking price each period. As before, we can denote this price by \( p = \beta^* V \). Note that, given our assumptions, not only is the price quoted each period the house is on the market the same, but the value function, \( \Pi \) remains invariant through time.\(^4\) Formally, the seller’s problem is to choose an optimal level of \( \beta \) to maximize the following objective function:

\[
\Pi (\beta) = \delta F(\beta) \left[ \Pi (\beta) + R - iL \right] + (1 - F(\beta)) [\beta V - L] = \frac{\delta F(\beta) [R - iL] + (1 - F(\beta)) [\beta V - L]}{1 - \delta F(\beta)} \quad (4)
\]

The first order condition for a maximum can now be expressed as\(^5\):

\[
\frac{\partial \Pi}{\partial \beta} = \left( \frac{(\delta (R - iL) - \beta V + L) f(\beta) + (1 - F(\beta)) V}{1 - \delta F(\beta)} \right) + \frac{V (\delta (1 - F(\beta)) (\beta V - L) + \delta (R - iL) F(\beta)) \delta f(\beta)}{(1 - \delta F(\beta))^2} = 0 \quad (5)
\]

which, when simplified, yields:

\[
\frac{\rho}{1 + d} + \lambda \left[ 1 - \frac{(1 + i)}{(1 + d)} \right] = \beta^* \left( \frac{d}{1 + d} \right) - \frac{(1 - F(\beta^*)/(1 + d))}{H(\beta^*)} \quad (6)
\]

Our assumption on the hazard rate, \( H(\cdot) \), ensures that the right hand side of equation (7) is increasing in \( \beta^* \). Hence, an increase in the leverage, \( \lambda \), increases the posted price as before. In this setting, however, we lose the free parameter \( \bar{\beta} \) which characterizes the seller’s expectations about the future. Forcing the seller to have stationary expectations about the

\(^4\)Our results would not change qualitatively if there was learning through time about the distribution of values. However, the posted price would decline with the time the house is on the market.

\(^5\)In the Appendix, we demonstrate that the first order condition characterizes a strict maximum.
future, thus, imposes an additional constraint on her decision-making procedure compared to our single-period model. It should be clear, however, that the results we establish below have their ready counterparts in the simpler, unconstrained set-up.

While the analysis above shows that asking price will, in general, vary with leverage, the multi-period model also exhibits the property that a decline in market-wide prices leads to a fall in the number of houses sold. In our model, a market-wide decline in prices is easily proxied by a decline in the common component \( V \). For any outstanding amount of loan, \( L \), this implies that the leverage level \( \lambda \) rises. Inspection of equation (7) shows that, with the rental yield \( \rho \) unchanged, the left hand side unambiguously increases. Equality can only be restored by an increase in the right hand side and this is achieved by an increase in \( \beta^* \). If, on the other hand, the rental or use value does not fall proportionately with the fall in \( V \), this only accentuates the effect. It requires a very sharp fall in the rental or use value for \( \beta^* \) to decrease. Note, however, that this does not imply that the actual posted price rises in absolute magnitude. In fact, as we show in the following Proposition, the posted price is adjusted downward in response to the reduction in the common value component.

**Proposition 3** A decrease in the common component of value leads to:

1. An increase in \( \beta^* \) and, consequently, a fall in the probability of sale of the property.
2. A decrease in the asking price, \( \beta^*V \).

**Proof.** The first part of the proposition follows from the arguments above: a fall in \( V \) causes a rise in \( \lambda \) and leads to a rise in \( \beta^* \). Consequently, the chances of a sale decrease in any period.

For the second part of the proposition suppose the common component of value falls from \( V_H \) to \( V_L \). Let \( \beta^*_H \) and \( \beta^*_L \) be the optimal \( \beta \) given \( V_H \) and \( V_L \) respectively. Rearranging equation (7) we can write,

\[
\lambda \[d - i] = d\beta - \left( \frac{d + 1 - F(\beta)}{H(\beta)} + \rho \right)
\]
\[ L[d - i] = \beta_H^* V_H \left[ d - \left( \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} + \rho \right) \frac{1}{\beta_H^*} \right] \]
\[ L[d - i] = \beta_L^* V_L \left[ d - \left( \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} + \rho \right) \frac{1}{\beta_L^*} \right] \]

which implies

\[ \beta_H^* V_H \left[ d - \left( \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} + \rho \right) \frac{1}{\beta_H^*} \right] = \beta_L^* V_L \left[ d - \left( \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} + \rho \right) \frac{1}{\beta_L^*} \right] \quad (8) \]

We next show that

\[ \left[ d - \left( \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} + \rho \right) \frac{1}{\beta_L^*} \right] > \left[ d - \left( \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} + \rho \right) \frac{1}{\beta_H^*} \right] \]
\[ \iff \left( \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} + \rho \right) \frac{1}{\beta_L^*} < \left( \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} + \rho \right) \frac{1}{\beta_H^*} \]
\[ \iff \left( \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} + \rho \right) < \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} \]
\[ \iff \frac{d + 1 - F(\beta_L^*)}{H(\beta_L^*)} < \frac{d + 1 - F(\beta_H^*)}{H(\beta_H^*)} \]

This inequality is true because \( \beta_L^* > \beta_H^* \) (part 1) and \( H(\cdot) \) and \( F(\cdot) \) are increasing in \( \beta \).

Combining with (8) we obtain

\[ \beta_H^* V_H > \beta_L^* V_L \]

What the Proposition above establishes is that, the seller’s listing price only partially adjusts to a decline in the general level of house values. Thus, the response to a overall decline in values is both (i) a decline in listing prices and (ii) a decline in the probability of sale. Therefore, the optimal seller response in the face of declining housing values results in an increase in the inventory of unsold houses.

The intuition behind this result becomes clear when one recognizes that a general decline in values gives rise to a greater debt overhang problem. From Myers (1977), we know that when a junior claimant faces a debt overhang problem, his incentive to undertake a positive NPV project goes down, since the debt holders have a prior claim on cash flows.
In the current situation, the posting of a higher price ensures that, if the price is accepted, there is more left over for the junior claimant. Without bankruptcy, when the price is not accepted, the sale is postponed. So long as the cost of carry of debt is low enough, this outcome is preferable to having a quicker sale and earning less from it. Thus, compared to an unencumbered home owner, a debtor enjoying a favorable interest rate has a greater incentive to postpone sale and take advantage of the implicit subsidy being offered by the essentially cheaper debt.

Introduction of bankruptcy in this framework allows for the possibility of the seller walking away. This only makes the problem even worse. An easy way to introduce the main feature of limited liability into this model is to assume that it corresponds to a higher value of \( d \). This corresponds to the notion that unless a sale at a favorable price is made this period, revenues from any sale matter little to the owner. To the extent that this captures, in a stylized fashion, the main choices facing an owner who faces the imminent prospect of bankruptcy, the analysis above shows that such an owner would have an higher incentive to post a higher price and take a gamble. This intuition is developed more fully in Bhattacharyya and Singh (1999).

4 Distinguishing Between Explanations

As we have mentioned earlier, the primary explanation for the established price patterns in housing markets has relied to date on down-payment constraints. In addition, Genesove and Mayer (2001) have shown that, in addition to leverage, the absolute value of price declines also is significant in explaining the queue of unsold homes. They attribute this effect to loss-aversion and suggest that such this could be the primary reason behind sellers’ reluctance to reduce prices in the face of a general price decline. It would be nice, then, to have the possibility of distinguishing between these various explanations.

A distinction between our explanation and the one based on down-payment constraints may, indeed, be possible to make if one focuses on the cross-section of housing prices. In particular, we know that more expensive houses are owned by richer people. In addition, ownership of financial assets like stocks is also disproportionately concentrated among the wealthier sections of society. Therefore, it is likely that down-payment constraints would
affect sellers of lower priced homes more than those of higher priced ones. In contrast, our explanation does not rely on such constraints and makes no such predictions. Thus, an analysis of the differential effects of leverage on posted prices across levels would serve as a distinctive test between these competing explanations. To our knowledge no one has performed a test of this nature.

In addition, from anecdotal evidence, it seems that the queue of unsold houses during downturns in the housing market is higher for higher priced homes. Such an outcome, if established, would seem to contradict explanations based on down-payment constraints. However, such a pattern is easy to explain in our structure. To do this, note that in our model, the range of variation in buyer values has been kept constant, in proportional terms, across the range of the appraised value. Noting that this variation is primarily due to the dispersion in buyer tastes, it is quite likely that the extent of variation is more for larger, higher priced homes than for smaller, lower priced ones. After all, the possibilities of customization of a ten-bedroom mansion are far higher than that for a single-bedroom house! If we were to relax the assumption of similar (proportionate) distribution of private values across price levels, we can show that it is possible in our setup to have smaller adjustment of individual house prices to general declines for more expensive homes. For the sake of brevity, we omit a detailed derivation of this result. But, briefly, a larger dispersion with a similar distribution function would be characterized by a lower hazard rate at a given proportionate distance from the mean $\beta = 1$. This, in turn, would imply that the level of $\beta$ would have to be higher for the first order condition to hold. Therefore, the probability of sale of a higher priced home would be more severely affected by a general decline in prices.

Coming now to loss-aversion, we should first note that in markets characterized by pronounced cyclicality like those for housing, it is hard, if not impossible, to distinguish between loss-aversion and behavior based on expectations of price reversals. Thus, for example, it can be argued that larger the decline in house prices, the greater is the expectation of a large price increase associated with waiting. An inspection of equation (7) then shows that realized declines in the price level will be associated with a higher $\bar{\beta}$ and, therefore, with a higher level of $\beta^*$ and a lower probability of sale. While Genesove and Mayer (2001) interpret their findings as support for the loss-aversion hypothesis, it is worth pointing out that their test is not as tightly constructed as it possibly could be. To see this, one has only to realize that
the actual loss faced by a seller is better accounted for by taking into account her leverage before prices declined. In other words, a more highly leveraged seller faces a greater loss in wealth for a level of decline in prices than a less leveraged one. In such a situation, a more definitive test of the loss-aversion hypothesis can be had by examining the significance level of the interaction term which combines the actual loss and the pre-existing leverage level. Unfortunately, Genesove and Mayer (2001) do not report the results of such a specification. Since our model already takes into account the actual payoffs to the seller, it would predict that such an interaction term would be insignificant as an explanatory variable. Thus, a test of this nature may help to distinguish our explanation from one based on loss-aversion.

5 Conclusion

We have shown that it is possible to explain puzzling patterns in prices in the housing market without recourse to borrowing constraints or to behavioral hypotheses like loss-aversion. Our explanation relies on the existence of a private component to valuation coupled with a sequential arrival process of buyers in the market necessitating the posting of binding prices by the seller. It is, of course, possible to have a more complete model in which sellers and buyers bargain after being matched. Indeed, Novy-Marx (2002) provides an explanation the sensitivity of housing prices to change in fundamentals like income based on the impact of such changes on bargaining power\(^6\). However, we do not think that the explicit incorporation of bargaining into our model would change our main results significantly.

Finally, it is perhaps worth emphasizing that our analysis applies to all markets characterized by a component of buyer-specific valuation and sequential search. As a result, we anticipate that some of the insights of the current model would apply to the sale of assets of financially distressed firms. In particular, this analysis may have some bearing on the reluctance of heavily leveraged Japanese banks to restructure by liquidating assets and reducing leverage as per the prescription of many analysts.

\(^6\)See also Lamont and Stein (1999) for an analysis of the sensitivity of housing prices to leverage in the presence of income and endowment shocks.
6 Appendix

The Appendix demonstrates that the first order approach indeed characterizes a maximum. We establish this result in the context of the multi-period model. It is easy to adapt the proof to the case when \( \bar{\beta} \) is a free parameter.

As in the text, the expected profit is given by:

\[
\Pi = F(\beta)\delta[\Pi + R - iL] + (1 - F(\beta))[\beta V - L]
= \frac{[1 - F(\beta)](\beta V - L) + F(\beta)\delta[R - iL]}{[1 - \delta F'(\beta)]}
\]

By our assumptions, the objective function is twice differentiable in the interior of the domain/range.

The first derivative can be written as:

\[
\frac{\partial \Pi}{\partial \beta} = f(\beta)[\delta (\Pi + R - iL) - \beta V + L] + F(\beta)\delta \frac{\partial \Pi}{\partial \beta} + (1 - F(\beta))
= f(\beta)[\delta (\Pi + R - iL) - \beta V + L] + F(\beta)\left[\delta \frac{\partial \Pi}{\partial \beta} - 1\right] + 1
\]

Setting the first derivative to zero yields

\[
f(\beta)[\delta (\Pi + R - iL) - \beta V + L] = -(1 - F(\beta))
\]

Also, differentiating the first derivative yields:

\[
\frac{\partial^2 \Pi}{\partial \beta^2} = f'(\beta)[\delta (\Pi + R - iL) - \beta V + L] + f(\beta)\left[\delta \frac{\partial \Pi}{\partial \beta} + \delta \frac{\partial \Pi}{\partial \beta} - 1\right] + F(\beta)\delta \frac{\partial^2 \Pi}{\partial \beta^2}
\]

But, at a point where the F.O.C. holds, we must have \( \frac{\partial \Pi}{\partial \beta} = 0 \). Thus,

\[
\frac{\partial^2 \Pi}{\partial \beta^2}[1 - \delta F'(\beta)] = f'(\beta)[\delta (\Pi + R - iL) - \beta V + L] - f(\beta)
\]
But, we have already shown that the F.O.C. implies that

\[
[\delta (\Pi + R - iL) - \beta V + L] = -\frac{(1 - F(\beta))}{f(\beta)}
\]

Substituting this in the equation above, we have:

\[
\frac{\partial^2 \Pi}{\partial \beta^2} [1 - \delta F(\beta)] = -\frac{f'(\beta) (1 - F(\beta))}{f(\beta)} + f(\beta)
\]

\[
= -\frac{1}{f(\beta)} [f'(\beta) (1 - F(\beta)) + f(\beta)^2]
\]

\[
= -\frac{(1 - F(\beta))^2}{f(\beta)} \frac{\partial}{\partial \beta} 1 - F(\beta)
\]

\[
= -\frac{(1 - F(\beta))^2}{f(\beta)} H(\beta)
\]

Given that the hazard rate is assumed to be increasing the above implies that \(\frac{\partial^2 \Pi}{\partial \beta^2} < 0\) when \(\frac{\partial \Pi}{\partial \beta} = 0\).

Thus, whenever the F.O.C. is satisfied, the objective function is concave. Since the objective function is twice differentiable everywhere in the interior of the interval \([1 - \Delta, 1 + \Delta]\), this implies that the F.O.C. characterizes a maximum.
References


