

Homeownership in an Uncertain World with Substantial Transaction Costs

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Abstract

This paper presents a dynamic model of residential real estate tenure decisions that takes into account the substantial transaction costs and the uncertain time paths of rents and prices. By temporarily postponing decisions, buyers and sellers obtain additional information and may avoid transactions that are costly to reverse. One implication is that the combination of high transaction costs and substantial uncertainty can create a large wedge between a household's reservation prices for buying and selling a home, which can explain why households do not switch back and forth between owning and renting as home prices fluctuate.

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Homeownership in an Uncertain World with Substantial Transaction Costs

Residential real estate can be viewed as investment, much like corporate stock, in that the owner expects to receive a cash flow over many years. Shareholders receive dividends; homeowners receive housing services that they would otherwise have to pay for by renting. An important difference between stocks and homes is that people don't try to time the market by switching back and forth between owning and renting homes the way they jump in and out of stocks. Renters who become homeowners typically remain homeowners unless there is a substantial change in their lives. Anily, Hornik, and Israeli (1999) estimate that the average homeowner will live in their current residence for 13 years, while Bogle (1999) estimates that the average mutual fund investor has a holding period of around 1 year.

Even when people sell their homes, they usually buy another home. In Ortalo-Magné and Rady's (1998) life-cycle model, households rent until they can accumulate the downpayment needed to buy a starter home, and then trade up to larger houses, until a possible downsizing later in life. It has been estimated that sixty percent of all home sales are to people moving from one home to another (Stein, 1995). We believe that most home purchases and sales are for socio-demographic reasons or for trading up or down, rather than attempts to time the market by moving back and forth between owning and renting in response to changes in the relative costs.

This paper uses a dynamic model of the tenure decision with an uncertain cash flow and large transaction costs to show that there is a substantial option value to delaying real estate transactions (buying or selling). Considerable uncertainty and high transaction costs create a large wedge between a household's buy and sell reservation prices, so that once a household goes from renting to owning (or vice versa) it will, *ceteris paribus*, take a large change in the price/rent ratio to justify reversing this transaction for financial reasons.

1. OWNING AND RENTING

Owning and renting have sometimes been analyzed as demands for different commodities, so

that people with different preferences separate into owners and renters. Rosen (1979, p. 7) wrote that, ““In many cases it is difficult (say) to rent a single unit with a large backyard. Similarly, it may be impractical for a homeowner to contract for the kind of maintenance services available to a renter.” A decade later, Goodman (1988, p. 335) observed that, “Until recently, it was easier to purchase small (large) amounts of housing by renting (owning). As a result, households with tastes for small (large) units would rent (buy).”

Today, it is still true that rental and purchase properties differ, on average, in location and attributes. But, on the margin, similar properties are often available for purchase or rent. Smith and Smith (2006) looked at single-family homes that were rented or purchased in 10 metropolitan areas in the summer of 2005 and found around 100 pairs of newly rented and purchased homes in each city that were very similar in size, bedrooms, bathrooms, location, and other identified characteristics.

We consequently view owning and renting as viable alternatives. If a household has the opportunity to buy or rent very similar properties (perhaps even the same property), then it can decide whether to pay for its housing services by owning or renting.

Some households have compelling reasons for renting. Someone who knows their residence will be brief (a college student living off-campus senior year, a consultant staying in a city for six months) should not incur the large transactions costs involved in buying and then selling a home. Someone who doesn't have a sufficient downpayment will not be able to finance the purchase of a home. Our concern here is with households that have the means and motives to buy a home, but want to consider the possibility that renting is financially advantageous. For such households, the question we consider here is why they do not switch back and forth between renting and owning when price/rent ratios fluctuate.

One factor is the large transaction costs in the real estate market. But transaction costs alone do not provide a compelling explanation. Suppose that transaction costs are 6 percent of a

home's price. If so, a renter who buys a home because the price/rent ratio has become marginally attractive would switch back to renting if the price/rent ratio rose by more than 6 percent. In practice, price/rent ratios frequently change by much larger amounts without inciting a large exodus from owning to renting or renting to owning. In Boston, for example, the ratio of the Office of Federal Housing Enterprise Oversight (OFHEO) repeat-sales home price index to the Bureau of Labor Statistics (BLS) owner-equivalent rent index rose by more than 60 percent between 1983 and 1987, fell by more than 20 percent between 1987 and 1993, and rose by 40 percent between 1996 and 2003. There were comparable swings in Los Angeles, San Francisco, and other areas.

2. TENURE CHOICE MODELS

The joint tenure choice decision and demand for housing services are generally modeled as depending on the costs of owning and renting, household income, and socio-demographic variables (for example, Goodman 1988; Mayo 1981). These models tend to view the buy/rent decision as an equilibrium with some households temporarily out of equilibrium (for example, Ihlanfeldt, 1981; Dynaski, 1988).

Although tenure choice models are generally static, Goodman (1989, 1990) analyzes a two-period model with infinite transaction costs and Amundsen (1985) analyzes the optimal number and timing of moves when a household has perfect foresight regarding income and housing prices. We analyze an infinite-period model with finite transactions costs and substantial uncertainty about future housing rent and prices.

Others have analyzed the effects of income and price uncertainty on risk-averse households' demand for housing services (for example, Robst, Dietz, and McGoldrick, 1999; Ioannides, 1979). We have in mind a very different consequence of uncertainty that affects both buyers and sellers and that, as far as we can tell, has not been addressed in this literature. A household considering a housing transaction—either buying or selling—should consider the possibility that

delaying the transaction may make available opportunities that are even more decisively favorable, or may allow it to avoid making a transaction that it will subsequently regret but is expensive to undo. These concerns affect both the timing and nature of transactions.

Titman (1985) uses a two-period, two-state model to explain why vacant land may be left undeveloped, even in desirable urban areas. Uncertain of the returns from construction projects of different sizes or uses, landowners may choose to keep the land vacant until they know more about future economic conditions. The vacant land is implicitly a real option to construct a building at some future date. Capozza and Helsley (1990) analyze a similar model in which a developer chooses the optimal time to build a pre-specified project. Capozza and Li (1994, 2002) allow the developer to choose the amount of development per unit of land. These dynamic models are concerned with housing construction. Nordvik (2000) uses a real options model to analyze a landlord's decision to sell or rent out a home the landlord is not living in.

We have not found any analogous models of housing demand. Just as developers have an option to build houses on vacant land, so renters have an option to buy a home instead of renting. Just as the option value can persuade developers to leave land vacant, so the option value can persuade households to continue renting. Just as the option value can persuade a landlord to hang on to a rental property, so the option value can persuade an owner-occupier not to sell.

There are many uncertainties that create an option value for renters and homeowners, including uncertainty about future income, marital status, family size, job location, tax laws, interest rates, rents, and housing prices. We focus on uncertainty about future rent and housing prices because these quantitative variables can be modeled in a relatively straightforward way. The same principles and conclusions apply to all of the uncertainties that might affect decisions to buy or sell houses.

3. MODELING UNCERTAINTY

The intrinsic value of a stock is the present value of its cash flow. The same is true of a home.

The implicit after-tax cash flow from a home is the rent a homeowner would otherwise have to pay to live in this home minus the expenses associated with home ownership. As with stocks, uncertainty is a key aspect of the housing market. One enormous difference between stocks and real estate is that the transaction costs are minor for the former and substantial for the latter. Brokerage fees on home sales are traditionally 6 percent of the sale price, though lower fees can be negotiated. Other closing and relocation costs can easily add another 1 to 3 percent. This combination of substantial uncertainty and high transaction costs has interesting implications for tenure choice because, in addition to the costs of the initial transaction, uncertainty creates the possibility that, at some future date, a home buyer or home seller may want to undo the transaction and thereby incur additional transaction costs.

Even if a home currently has a positive net present value, a potential buyer may want to wait to obtain more information about future rents and prices. For example, delaying the purchase may be profitable if there is a price decline that exceeds the cost of renting during the interim. Delaying can also be profitable if the rent falls enough to make renting less expensive than owning—so that buying the home turns out to be a mistake that is costly to reverse. Analogous arguments apply to a homeowner considering a sale. Delaying the sale may be profitable if the price increases substantially or if the rent increases enough to make renting more expensive than owning. Thus the combination of uncertainty and transaction costs can be powerful arguments for being cautious about switching from renting to owning, or vice versa.

A household considering the purchase of a home faces uncertainty regarding both the potential rent savings and the home's future price. It should weigh the benefits from buying immediately against the costs of doing so, including the cost of exercising the purchase option and thereby forfeiting the benefits from waiting for more information about the evolution of rent and prices.

There will always be uncertainty, but the price/rent ratio may change enough during the waiting period to persuade a household to switch from renting to owning, or vice versa. For

example, if there is a substantial decline in the price/rent ratio, there will still be uncertainty about future rents and prices, but the price/rent ratio may now be low enough to justify buying a home because it provides a cushion against unfavorable future movements.

To make these arguments more concrete, we analyze the rent/own decision for a single household that takes the rent, price, interest rate, and other relevant variables to be exogenous. This household assumes that the evolution of rent C (net of expenses) for a specific home can be described by this geometric Brownian motion equation:

$$\frac{dC}{C} = \alpha dt + \sigma dz$$

where α is the trend rate of growth of rent and dz is the increment of a standard Wiener process. The cost P of buying this home is also assumed to evolve according to geometric Brownian motion with an expected growth rate β :

$$\frac{dP}{P} = \beta dt + \theta dz$$

The correlation coefficient between the stochastic terms in the rent and price equations is ρ . Housing prices and rents are tied together by the fact that the theoretical value of a home depends on the anticipated rents, in the same way that the theoretical value of a stock depends on its cash flow. Many economic factors—such as land prices, construction costs, population, and income—have similar effects on rents and housing prices. However, just as stock prices are not tied rigidly to earnings, so housing prices are not tied rigidly to rents. One explanation (which we do not pursue here) is that changes in interest rates are likely to have different effects on rents and home prices. Another possibility is that an area's changing demographics (for example, a growth or decline in the number of students or other short-term residents) may change the intensity of demand for renting and owning. Another possibility is that speculative bouts of optimism or pessimism may change price/rent ratios in the same way that they change

price/earnings ratios in the stock market.

The BLS has a consistent index for owner's equivalent rent of primary residence back to 1983; the OFHEO has repeat-sales price indexes for this same period. Over the period 1983-2006, the average annual growth rates of the national rent and price indexes were 3.7 percent and 5.4 percent respectively, with a 0.03 correlation between the residuals about these growth rates. The divergence between rent and price indexes is even larger in some narrower geographic areas. In Boston, for example, the annual growth rates of rent and price indexes were 4.3 percent and 7.8 percent respectively, with a 0.25 correlation between the residuals.

If a household believes that the price/rent ratio is unlikely to change, it might assume that $\alpha = \beta$ and that ρ is close to 1. Nordvik (2000) assumes that prices and rents have the same expected growth rates with independent stochastic terms (in our model, these assumptions are $\alpha = \beta$ and $\rho = 0$). Our model allows for different expected growth rates and possibly correlated disturbance terms in order to generalize the analysis.

The purchase of a home costs P and provides a present value V of the expected cash flow:

$$(1) \quad V = \frac{C}{R - \alpha}$$

where R is the required rate of return, assumed here to be constant. We assume that R is greater than both α and β in order to avoid bubble solutions. If you require a 10 percent return, no price is too high to pay for an asset with a cash flow that grows by 15 percent a year forever, or with a price that increases by 15 percent a year forever.

There are transaction costs for both buyers and sellers, including brokerage fees, closing costs, and moving expenses. A seller also incurs fix-up costs preparing the home for sale and disruptions caused by maintaining the home in showing condition. A buyer may incur costs for breaking a lease and fix-up costs to reclaim a deposit. We assume that only sellers have transaction costs in order to demonstrate that seller transactions costs affect buyers too—since,

before committing to a purchase, buyers should consider the possibility that they may someday be sellers.

We know from the real options literature that the simple investment rule of buying when V is larger than P and selling when V is smaller than P is inappropriate in an uncertain world where it may be profitable to postpone making investments that are costly to reverse (Jensen, 1982; Pindyck, 1988, 1991; Dixit and Pindyck, 1994).

If you decide to buy a home, you may regret this decision if rents subsequently fall because it is costly to sell the home you just bought. There is consequently an option value to waiting to see how rents and prices evolve. If rents increase substantially, it will be safer to buy the home because you will be less likely to regret your decision. If rents decline substantially, you will be thankful that you did not make an expensive mistake by buying the home. Similar considerations apply to a homeowner who might sell a home.

A household considering buying (or selling) a home should compare the anticipated financial gains from acting now with the anticipated financial gains if it waits to make a decision. Of course, the postponed decision will depend on how conditions have changed and, for each of the many possible situations, the household should again compare the anticipated gains from acting at that point with the anticipated gains from waiting a bit longer. The analysis seems quite daunting because of all the possibilities to consider, but it can be done by dynamic programming because the decisions in each possible future scenario have a similar structure.

Following Nordvik (2000), we assume the household is risk neutral, which simplifies the analysis and also demonstrates that a hesitation to switch housing tenure in our model is not due to risk aversion but rather to the option value of waiting for additional information.

We begin with a renter who is considering buying. The value $F[C, P]$ of the option to postpone the decision to buy a home depends on the rent and price. The first step in valuing this option is the Bellman equation:

$$RFdt = E[dF]$$

The left-hand side is the rate of return that the household requires on this option; the right-hand side is the expected rate of increase in the value of the option. The household will not be willing to hold the option unless the expected rate of increase in the value of the option provides its required return.

Next, we use Ito's Lemma to expand dF and obtain this differential equation for the region in which this household is waiting to buy:

$$0 = 0.5 \left(\sigma^2 C^2 \frac{\partial^2 F}{\partial C^2} + 2\rho\sigma\theta CP \frac{\partial^2 F}{\partial C\partial P} + \theta^2 P^2 \frac{\partial^2 F}{\partial P^2} \right) + \alpha C \frac{\partial F}{\partial C} + \beta P \frac{\partial F}{\partial P} - RF$$

A natural assumption [Dixit and Pindyck, 1994, p. 210] that makes the analysis tractable is that the option value is homogeneous of degree one: $F[C, P] = Pf[C/P]$; that is, if the rent and price both double, this will double both the value of homeownership and the cost of buying the home, and should consequently double the value of the option. The substitution of the requisite partial derivatives into our differential equation yields

$$0 = 0.5\phi \left(\frac{C}{P} \right)^2 f'' + (\alpha - \beta) \frac{C}{P} f' - (R - \beta)f$$

where $\phi = \sigma^2 - 2\rho\sigma\theta + \theta^2$.

This is a homogeneous second-order linear differential equation whose solution has the form

$$f[C/P] = A_1(C/P)^a + B_1(C/P)^b$$

where

$$a = 0.5 + \frac{\beta - \alpha}{\phi} + \sqrt{\left(0.5 + \frac{\beta - \alpha}{\phi}\right)^2 + \frac{2(R - \beta)}{\phi}} > 1$$

$$b = 0.5 + \frac{\beta - \alpha}{\phi} - \sqrt{\left(0.5 + \frac{\beta - \alpha}{\phi}\right)^2 + \frac{2(R - \beta)}{\phi}} < 0$$

We simplify by noting that as the rent/price ratio approaches 0, the value of the buy option does too; because the parameter b is negative, the term $B_1(C/P)^b$ does not approach 0 unless $B_1 = 0$.

Therefore,

$$(2) \quad f[C/P] = A_1(C/P)^a$$

A similar option valuation equation can be derived for a household that owns its home. The value $G[C, P]$ of the home includes the cash flow C and the value of the option to sell if the rent/price ratio falls sufficiently. Assuming this value to be homogeneous of degree one, $G[C, P] = Pg[C/P]$, the differential equation in the region where the home is held is:

$$0 = 0.5\phi\left(\frac{C}{P}\right)^2 g'' + (\alpha - \beta)\frac{C}{P}g' - (R - \beta)g + \frac{C}{P}$$

The general solution has the form

$$g[C/P] = A_2(C/P)^a + B_2(C/P)^b + \frac{C/P}{R - \alpha}$$

As the rent/price ratio increases, the value of the sell option approaches 0; therefore, $A_2 = 0$:

$$(3) \quad g[C/P] = B_2(C/P)^b + \frac{C/P}{R - \alpha}$$

Finally, we can identify the borderline values of the rent/price ratio by imposing restrictions derived from the known values of the buy and sell options when the household is on the borderline between acting and waiting. A household that is waiting to buy will keep waiting as long as the rent/price ratio is below the threshold λ_1 , which is therefore the household's reservation ratio. At this threshold, the value of the option must be equal to the value of owning the home net of the purchase price:

$$\begin{aligned} F[C, P] &= G[C, P] - P \\ f[C/P] &= g[C/P] - 1 \end{aligned}$$

Thus

$$(4) \quad f[\lambda_1] = g[\lambda_1] - 1$$

The first derivatives are also equal at the threshold:

$$(5) \quad f'[\lambda_1] = g'[\lambda_1]$$

Similarly, a homeowner waiting to sell will do so when the rent/price ratio falls to the threshold λ_2 , which is consequently the reservation ratio for selling. At this threshold, the value of the sell option is equal to the value of the buy option plus the sale price net of the proportional sales cost γ ,

$$\begin{aligned} G[C, P] &= F[C, P] + (1 - \gamma)P \\ g[C/P] &= f[C/P] + (1 - \gamma) \end{aligned}$$

Thus

$$(6) \quad g[\lambda_2] = f[\lambda_2] + (1 - \gamma)$$

and the first derivatives are also equal at the threshold:

$$(7) \quad g'[\lambda_2] = f'[\lambda_2]$$

The substitution of the differential equations (2) and (3) into conditions (4) - (7) gives these four equations, which can be solved for the thresholds λ_1 and λ_2 and the differential-equation parameters A_1 and B_2 :

$$\begin{aligned} 0 &= A_1 \lambda_1^a - B_2 \lambda_1^b - \frac{\lambda_1}{R - \alpha} + 1 \\ 0 &= aA_1 \lambda_1^{a-1} - bB_2 \lambda_1^{b-1} - \frac{1}{R - \alpha} \\ 0 &= A_1 \lambda_2^a - B_2 \lambda_2^b - \frac{\lambda_2}{R - \alpha} + (1 - \gamma) \\ 0 &= aA_1 \lambda_2^{a-1} - bB_2 \lambda_2^{b-1} - \frac{1}{R - \alpha} \end{aligned}$$

Our intuition is aided by working with the threshold price/rent ratios $1/\lambda_1$ and $1/\lambda_2$.

Illustrative Calculations

To illustrate this model, we will analyze a baseline case and then gauge the robustness of our results by varying the assumed parameter values over plausible ranges. One difficulty in specifying plausible parameter values is that our model applies to a single household considering the purchase of a single home, but the available historical data are for price and rent indexes, which average data over many houses.

As noted earlier, over the period 1983-2006, the respective average annual growth rates of the BLS rent and OFHEO price indexes were 3.7 percent and 5.4 percent nationally and 4.3 percent and 7.8 percent in Boston. Nordvik (2000) assumes 4 percent growth rates in his Norwegian analysis of a landlord's decision to sell a rental property; Smith and Smith (2006) assume 3 percent growth rates in their analysis of the U. S. housing market. We use 3 percent as our baseline case.

The standard deviations of the rent and price residuals are tricky because these describe a household's uncertainty about a home's future rent and price, and the historical data describe fluctuations in average rents and prices. There is undoubtedly more uncertainty about the future rent and price for a single home than for the average rent and price for a large number of homes. Over the period 1983-2006, the respective average annual standard deviations of the BLS rent and OFHEO price index residuals were 1.5 percent and 3.5 percent nationally and 4.7 percent and 9.0 percent in Boston. Nordvik (2000) assumes a 30 percent standard deviation for rent residuals and a 6 percent standard deviation for price residuals. Cauley and Pavlov's (2002) careful analysis of 15,354 sales in the West Side of Los Angeles County between 1985 and 1997 yielded an estimate of the standard deviation of price residuals somewhere between 8.2 and 21.4 percent. We use 10 percent standard deviations for both rent and price as our baseline case.

The correlation between the rent and price residuals is also tricky because of the distinction between a single home and index averages. In theory, we expect price and rent residuals to be

correlated. For the national and Boston indexes, the correlations were 0.03 and 0.25 respectively. Nordvik (2000, p. 67) assumes no correlation “primarily for convenience.” We use a 0.25 correlation in our baseline case.

Nordvik (2000) uses a 6.12 percent after-tax required rate of return; Smith and Smith (2006) use 6 percent. We use 6 percent here. The transaction cost for home sales includes fixup costs, brokerage commissions, legal fees and other closing costs, and moving expenses. Brokerage commissions have traditionally been 6 percent of the sales price, but there has recently been downward pressure from online brokers and other discounters. Because transaction costs are an important part of our story, we use a conservative 6 percent for the total transaction cost.

Thus our baseline case is $\alpha = 0.03$, $\sigma = 0.10$, $\beta = 0.03$, $\theta = 0.10$, $\rho = 0.25$, $R = 0.06$, and $\gamma = 0.06$. This household believes that this home’s rent and price both have a 3 percent trend growth rate and 10 percent standard deviation, and that the correlation between the rent and price stochastic terms is 0.25. The after-tax required rate of return is 6 percent and the transaction cost for home sales is 6 percent.

Using these parameter values, the present value of the anticipated rent savings is given by Equation (1):

$$V = \frac{C}{R - \alpha}$$

$$= \frac{C}{0.06 - 0.03} > P \text{ iff } \frac{P}{C} < 33.3$$

If there were no transaction costs, the home should be bought when the price/rent ratio is below 33.3 and sold when the price/rent ratio is above 33.3. With a 6 percent sales cost, the threshold price/rent ratios given by the dynamic programming model work out to be $1/\lambda_1 = 25.2$ and $1/\lambda_2 = 45.9$. If this household is renting, it should buy if the price/rent ratio falls below 25.2; if this household owns the home, it should sell if the price/rent ratio rises above 45.9. The reservation price/rent ratio for buying is far below 33.3 because a purchase has the additional cost of

extinguishing the possibility of buying at terms that are even more favorable and also less likely to incur future transaction costs. The reservation price/rent ratio for selling is far above 33.3 because a sale incurs transaction costs and extinguishes the possibility of selling at more favorable terms that are less likely to be reversed sufficiently to persuade the seller to buy again.

Figure 1 shows how increased transaction costs widen the buy and sell thresholds. These effects are substantial. A price/rent ratio of 33.3 implies that a home with an initial \$20,000 annual net cash flow is worth \$666,000. The 25.2 threshold implies that if this household is renting, it isn't willing to pay more than \$504,000 to buy the home; the 45.9 threshold implies that if this household owns the home, it isn't willing to sell it for less than \$918,000. With no uncertainty, the buy and sell thresholds would differ by the 6 percent transaction cost, and it would take only a 6 percent increase in the price/rent ratio to persuade a household that buys this home to switch back to renting. With uncertainty, the sell threshold is nearly double the buy threshold, and it would take an 80 percent increase in the price/rent ratio to persuade a buyer to switch back to renting. We should emphasize that these reservation prices apply to a single household with possibly unique expectations and socioeconomic circumstances. We are not trying to explain why buyers and sellers may be far apart, but why someone who becomes a homeowner tends to remain a homeowner.

The other *ceteris paribus* comparative static multipliers are reasonable. A higher trend growth rate of rent or price increases the thresholds for buying and selling. This is analogous to growth stocks that trade at high price-earnings ratios. The faster that rent and price are expected to increase in the future, the higher the price/rent ratio at which a household is willing to buy or sell today. Similarly, a higher required rate of return reduces the threshold ratios: for given growth rates, a low current price/rent ratio is needed to give households a high anticipated rate of return.

Rosen, Rosen, and Holtz-Eakin (1984) argue that risk-averse households will be less inclined to buy homes when there is more uncertainty about future home prices, and they present some

empirical evidence showing that homeownership is negatively affected by price uncertainty. Our model shows that even risk-neutral households are less inclined to buy homes when there is more uncertainty about prices and rents. (We increase the standard deviations of price and rent together since more uncertainty about one seemingly implies more uncertainty about the other.)

Larger rent and price standard deviations increase the value of the buy and sell options and thereby make it more attractive to wait to extinguish these options. Households waiting to buy should consider the possibility that, if they do buy now, the rent may subsequently fall, causing them to regret their purchase. They should also consider the possibility that, if they don't buy now, prices may subsequently fall, giving them the opportunity to buy at even more favorable terms that are less likely to be reversed in the future. Homeowners who are waiting to sell should consider the possibility that, if they sell now, the rent may subsequently rise, causing them to regret their sale. They should also consider the possibility that, if they don't sell now, the price may subsequently rise, giving them the opportunity to sell at even more favorable terms that are less likely to be reversed in the future. Thus high standard deviations make waiting more attractive and necessitate a lower price/rent threshold for buying and a higher price/rent threshold for selling.

Figure 2 shows the effects of the standard deviations on the thresholds. As the standard deviations approach 0, the price/rent threshold for buying approaches 33.3 and the price/rent threshold for selling approaches 35.4, a difference equal to the 6 percent transaction cost. With rent and price standard deviations of 10 percent, the price/rent threshold for buying is 45 percent less than the sell threshold. With rent and price standard deviations of 20 percent, the threshold for buying is 60 percent less than the sell threshold.

Sinai and Souleles (2005) argue that owning a home is a hedge against rent volatility and they find that there is, in fact, more home ownership in areas with high rent volatility (they do not control for price volatility). In their model, a household has a fixed horizon over which it will

either own or rent and, if it decides to buy a home, it will do so as soon as possible.

It is certainly true that renting exposes a household to uncertainty about future rents; however, a home purchase that is costly to reverse is risky, too. A household that chooses to rent will regret its decision if future rents are higher than it anticipated; a household that chooses to buy will regret its decision if future rents are lower than it anticipated, since the implicit cash flow from homeownership will be lower than it expected. In our model, uncertainty about future rents and prices is a concern for households thinking of buying or selling. Figure 2 shows that higher volatility of rents and prices is a reason for both renters and owners to be more cautious about changing their tenure choice.

Figure 3 shows that a higher price-rent correlation increases the threshold for buying and reduces the threshold for selling because a high correlation makes it less likely that the price/rent ratio will change significantly in the future. Put another way, the smaller the variability of the price/rent ratio, the smaller is the probability that conditions will be even more favorable in the future and the smaller, also, is the probability that the household will someday want to reverse a decision made today.

Equilibrium Rents and Prices

This is a model of the choices made by individual households. Homes are, of course, bought and sold all the time. Even though the buy and sell reservation prices for a single household may be far apart, they may well overlap the reservation prices of other households with different expectations, tax situations, and other considerations. Many transactions are motivated by socio-demographic factors. We change jobs. We marry and we divorce. We have growing families and our children leave home. Thus, a household may sell a two-bedroom house not because it thinks it would be cheaper to rent a two-bedroom house but because it needs a four-bedroom house. Its reservation price for selling may be far below a reservation price that is based on a comparison of the cost of owning and renting a two-bedroom home. The same is true of a household selling a

home in order to move to another state, a divorcing couple selling a home in order to split the proceeds, an elderly couple moving into an assisted-living facility.

In a general equilibrium model, there is a distribution of diverse households and homes, and housing markets are linked by the multiple opportunities available to households. Such a model should also incorporate landlords and the fact that the prospective after-tax cash flow and reservation price/rent ratios are often lower when considering purchasing a home to rent to someone else than when considering purchasing the same home to live in. A model similar to Nordvik (2000) could be applied to persons considering buying houses to rent and landlords considering selling their rental properties.

A general equilibrium model should also include real estate developers considering the construction of homes that might be owner-occupied or rented. These supply equations could utilize the models analyzed, for example, by Capozza and Helsley (1990) and Capozza and Li (1994, 2002). Households can also move into or out of the area. And financial markets would need to be introduced to determine the interest rate used to discount cash flows.

4. CONCLUSION

A financial analysis of tenure choice should consider the present value of the costs and benefits of home ownership. However, unlike stocks, bonds, and most financial assets, there are very substantial transaction costs in the real estate market. This paper presents a dynamic tenure-choice model where purchases and sales are affected by uncertain projections of rents and prices. The same principles apply to all of the uncertainties that affect housing transactions.

Higher anticipated rent and price growth rates and a lower required return increase the price/rent thresholds for both buyers and sellers. Higher transaction costs, higher standard deviations of rents and prices, and a lower correlation between rents and prices reduce the price/rent threshold for buyers and increase the threshold for sellers.

Waiting maintains an implicit option that may be quite valuable. Thus the combination of

substantial uncertainty and large transaction costs can create a large wedge between a household's reservation prices for buying and selling. This wedge may explain why—unlike the stock market—so many real estate transactions seem motivated by socio-demographic factors, rather than purely economic calculations. In the absence of this wedge, we would expect to see households shifting back and forth between renting and owning the same way that they jump in and out of stocks. Because of this wedge, a renter that buys a home (or a homeowner that decides to rent) will not, *ceteris paribus*, have a persuasive reason for reversing this decision for financial reasons unless there is a very large change in the price/rent ratio.

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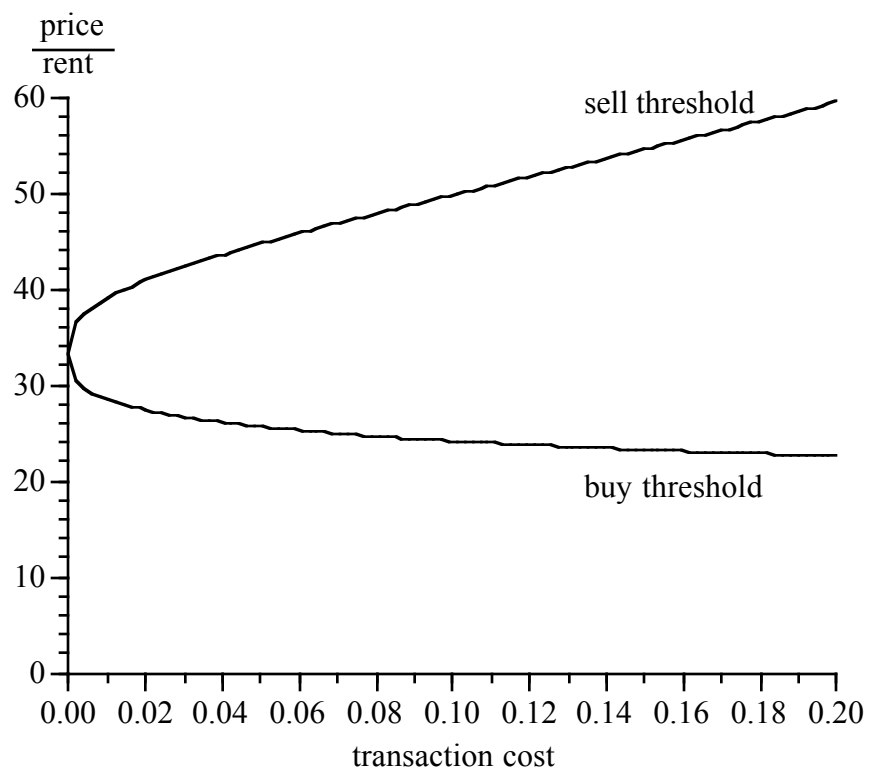


Figure 1 The Effect of Transaction Costs on Thresholds

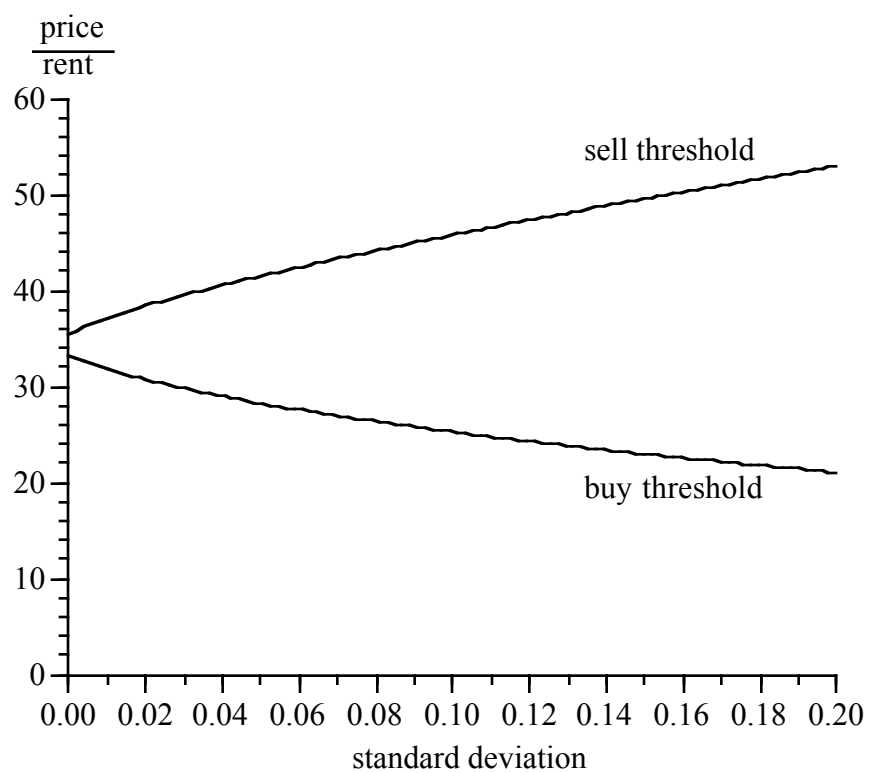


Figure 2 The Effect of Uncertainty on the Thresholds

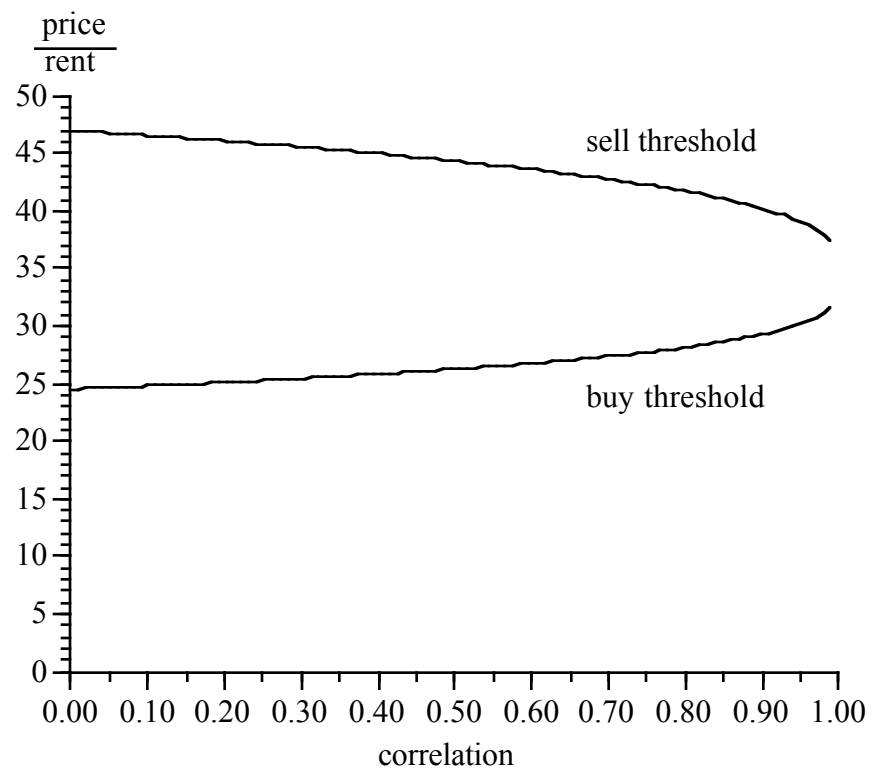


Figure 3 The Effect of the Rent-Price Correlation on the Thresholds