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## **Faculty Working Papers**

THE SELLING PERIOD FOR SINGLE-FAMILY HOUSING

Peter F. Colwell and C. F. Sirmans

#442

**College of Commerce and Business Administration**  
**University of Illinois at Urbana-Champaign**



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ABSTRACT

THE SELLING PERIOD FOR SINGLE-FAMILY HOUSING

Peter F. Colwell and C. F. Sirmans

This paper develops a Wicksellian investment theory of an optimal selling period for single-family housing. A sample of recent single-family housing sales is used to test a key feature of the theory, expected market value increasing at a decreasing rate with the selling period. The test confirms this hypothesis. Finally, an estimate of the optimal average selling period is derived and compared with the actual average of the sample.



# THE OPTIMAL SELLING PERIOD FOR SINGLE-FAMILY HOUSING

## 1. Introduction

A widespread belief among real estate practitioners as well as the lay public is that residential property can sell too quickly or not quickly enough. Implicit in the definition of market value used by appraisers is that the property is on the market for a "reasonable" length of time (Boyce, p. 137). Unfortunately, the literature has largely ignored the impact of the selling period on market value let alone the more complex issues of the existence and an estimate of the optimal selling period.<sup>1</sup> The literature which does exist is conflicting. Zerbst and Brueggeman (1976) argue that there is no reason why longer selling periods would on average yield higher market values. On the other hand, Miller (1977) theorizes that such a reason does exist and finds a direct, linear relationship between market value and selling period.

This paper develops a Wicksellian point input-point output investment theory of an optimal selling period for single-family housing.<sup>2</sup> An essential element of the theory is tested on a sample of housing sales. Finally, an estimate of the optimal average selling period is derived and compared with the actual average of the sample.



## 2. The Theory

When a house is put on the market, the seller faces a distribution of offers.<sup>3</sup> The shape of this distribution is, at best, only dimly discernable to the broker and is especially unclear to the typical seller.<sup>4</sup> So the seller, with the help of his broker, searches the distribution for a satisfactory offer. On the average, the first offer would be the expected value of the offer distribution. A hypothetical density function is shown on the left side of Figure 1 along with the expected value,  $\bar{O}$ . Assuming that search consists of a constant rate of sampling the offer distribution, the path of the highest offer to date,  $\hat{O}$  in Figure 1, would, on the average, increase at a decreasing rate.<sup>5</sup> It may be irrational for the average seller to wait for a very high offer (e.g., keep his house on the market until  $t_1$  in Figure 1) if the seller has a substantial discount rate or faces some search and transaction costs which are associated with selling period.

Search and transaction costs,  $C$  in Figure 1, have a component which is unrelated to selling period and market value (e.g., deed preparation). However as selling period increases, search and transaction costs increase as shown in Figure 1. For example, the potential broker's fee and tax stamps would increase with  $\hat{O}$ . The total cost of bridge loans, extra maintenance and cleaning, disruption of routine while the house is being shown, and grief certainly increase with the selling period.





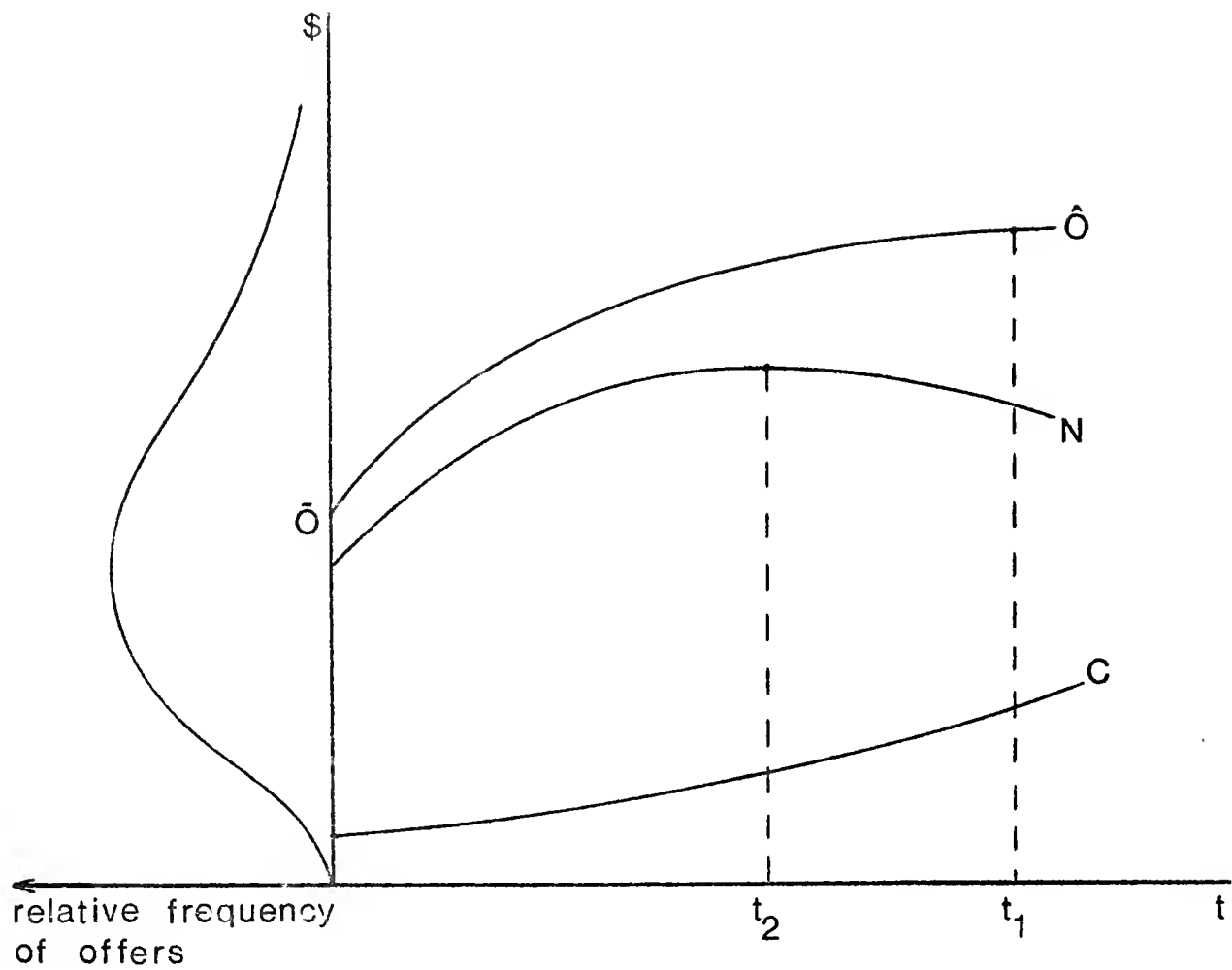


Figure 1

OFFERS, COSTS, AND THE SELLING PERIOD



Subtracting the seller's search and transaction costs,  $C$ , from the highest offer to date,  $\hat{O}$ , yields the seller's net return curve,  $N$  in Figure 1. As will be shown, it would be irrational for the average seller to wait for the maximum net return (i.e., keep his house on the market until  $t_2$  in Figure 1) if the seller has a non-zero discount rate.

In Figure 2,  $P_1e^{rt}$  through  $P_3e^{rt}$  are iso-present-value curves. For any present value,  $P_j$ , there is an equivalent dollar magnitude at each point of time in the future. This magnitude is found by multiplying the present value by the natural constant  $e$  raised to the power  $rt$  where  $r$  is the discount rate and  $t$  is the number of periods in the future. Thus an iso-present-value curve showing all dollar-time combinations with the same present value has this form,  $P_je^{rt}$ . The vertical intercept of an iso-present-value curve is the present value of every other dollar-time combination along its length. Therefore, any point on a higher curve (i.e., having a higher vertical intercept) has a higher present value than any point on a lower curve. For example,  $x$  has a higher present value than  $y$  in Figure 2.

A rational seller will attempt to maximize the present value of his net return from a sale. Geometrically, the seller would want the house on the market long enough to reach the highest attainable iso-present-value curve - and no longer. That is, the seller would want to sell when an iso-present-value curve is just tangent to the net return curve. Thus the optimal selling period is  $t^*$  in Figure 2.



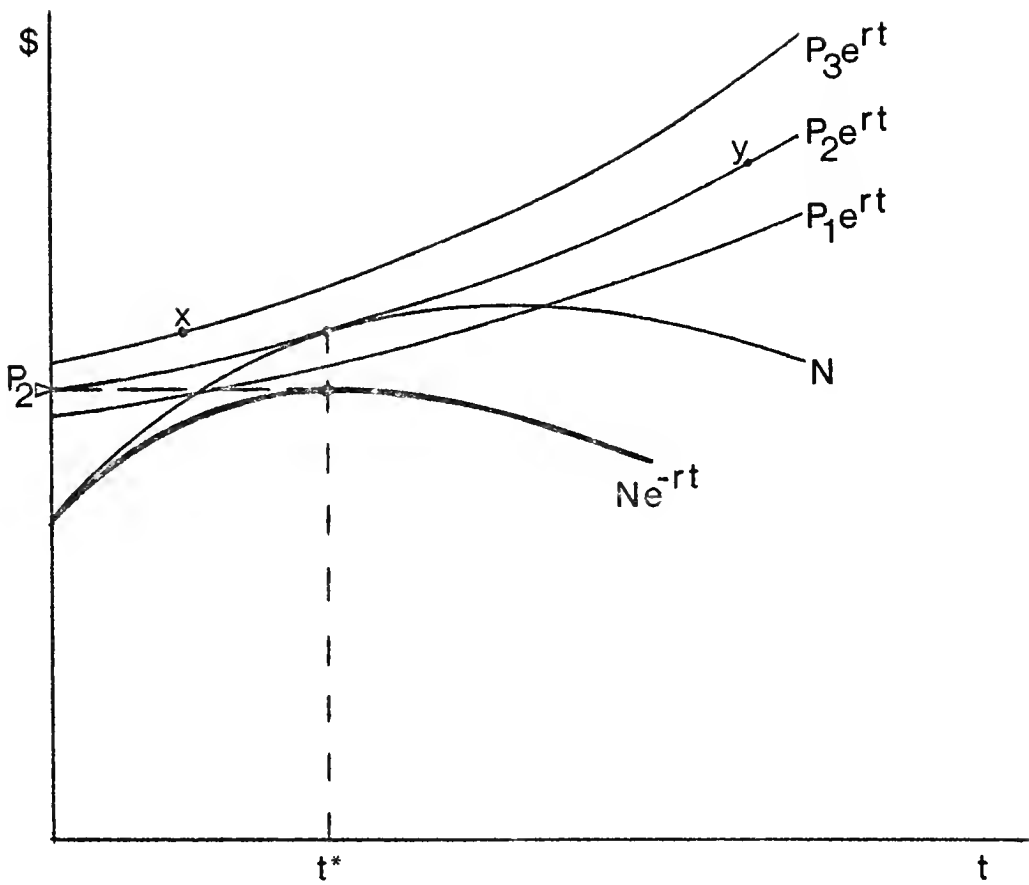


Figure 2

THE OPTIMAL SELLING PERIOD



The curve in Figure 2 labeled  $Ne^{-rt}$  represents the present value of the seller's net return. This curve reaches a maximum at  $t^*$  where  $Ne^{-rt} = P_2$ . Thus an alternative geometric approach to the tangency of an iso-present-value curve with the seller's net return curve is to look for the maximum on the net present value curve to find the optimal selling period.

Suppose that the net return to the average seller,  $N$ , is a concave and at least initially increasing function of selling period as shown in Figures 1 and 2. As long as the discount rate is less than the rate at which  $N$  initially grows (i.e.,  $r < \frac{dN}{dt}/N$ ), there will be a positive optimal selling period. If the discount rate is greater than, less than, or equal to zero, then the optimal selling period is less than, greater than, or equal to  $t_2$  in Figure 1, respectively.<sup>6</sup>

### 3. Market Value Model and Results

The  $\hat{O}$  curve from the theoretical model may be estimated while holding certain important characteristics of the property and the time of sale constant by using the following function:

$$V_i = \beta_0 (BSQF_i)^{\beta_1} (LSQF_i)^{\beta_2} (BATH_i)^{\beta_3} (FPL_i)^{\beta_4} (BI_i)^{\beta_5} \exp(\beta_6 AGE_i + \beta_7 AGE_i^2 + \beta_8 T_i + \beta_9 t_i^{-1}) \quad (1)$$

where:

$V_i$  = market value as evidenced by an actual sale price of the  $i$ th house ( $i=1, \dots, 80$ ),





$BSQF_i$  = the area of the building in square feet,

$LSQF_i$  = the area of the lot in square feet,

$BATH_i$  = the number of bathrooms,

$FPL_i$  = a dichotomous variable where 1=no fireplace  
and e=fireplace present,

$BI_i$  = a dichotomous variable where 1=a ranch or a  
tri-level, and e=a bi-level,

$AGE_i$  = the age of the house in years,

$T_i$  = the number of the month in which the sale  
occurred where 1=January 1976 to 14=February  
1977, and

$t_i$  = the selling period represented by the number  
of days on the market.

The specific form of equation (1) was chosen to capture several hypothesized features of the market value function: 1) the diminishing marginal contribution to market value of the selling period as well as similar contributions of property characteristics such as  $BSQF$ ,  $LSQF$ , and  $BATH$ ; 2) interaction among independent variables (e.g., the partial derivative of market value with respect to  $BATH$  is a function of the magnitude of  $BSQF$  among others); 3) as month of sale and selling period approach zero, market value should not approach zero; 4) a possible n-shaped value-age relationship; and 5) a constant rate of market value "inflation."

Equation (1) was estimated by taking natural logs of both sides of (1) and using ordinary least squares on a sample of 80 single-family housing sales for a subdivision in Champaign, Illinois. The results were as follows:



$$\ln V_i = 4.622 + .665(\ln \text{BSQF}_i) + .117(\ln \text{LSQF}_i) +$$

$$.136(\ln \text{BATH}_i) + .080(\ln \text{FPL}_i) - .079(\ln \text{BI}_i) +$$

$$.016(\text{AGE}_i) - .0012(\text{AGE}_i)^2 + .004(\text{T}_i) - .036(\text{t})^{-1}$$

Since the sales are from the same neighborhood, a number of locational influences are held constant. Some available housing characteristics (e.g., garage) were excluded from the regression because they were highly correlated with included variables.

All the regression coefficients in equation (2) have readily explainable signs and are significant at the 90% level of confidence; standard errors are in parentheses. the  $\bar{R}^2$  is 86.5%. The coefficients on building square feet, lot square feet, number of baths, and the presence of a fireplace are positive and less than unity, indicating diminishing marginal contributions to market value.

Dummy variables for two of the three styles, ranch and bi-level, were included in an earlier version of the regression. Ranch was combined with tri-level in the reported version, equation (2), because there proved to be no significant difference in their contributions to market value. The bi-level style tends to reduce the market value. This result may be explained by discomfort and aesthetics. With the bi-level, much of the wall area of living space is below ground causing dampness in combination with the local high water table. Alternatively, the taste of market

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participants may be the reason for the bi-level's poor showing.

The results indicate that middle aged housing is more valuable than either new or older housing. The ages of houses in the sample range from 1 to 19 years with the average being nearly 4 years. The age which maximizes value,  $\beta_6/(-2\beta_7)$ , is 6.47 years.<sup>7</sup> At first blush one might expect the newest housing, incorporating the latest features in design and materials, to be the most valuable. Older housing might be expected to show the effects of obsolescence in these features. The age variable, however, may be capturing other effects, such as neighborhood effects, quality of materials, and landscaping. In this particular subdivision, houses are grouped by age. The oldest housing is generally less well cared for, and the newest lacks landscaping and appears to have been built using lower quality materials. So the 6.47 years which maximizes value may be long enough for trees and shrubs to grow enough to soften the hard-edge look of new housing but not so old as to have incorporated many obsolete features.

By taking the derivative of market-value with respect to the month of sale,  $T$ , and dividing it by market value, the monthly rate of change in value is obtained,

$$\frac{\partial V}{\partial T} = V\beta_8, \text{ and } \frac{\partial V}{\partial T}/V = \beta_8. \quad (3)$$

Thus,  $\beta_8$ , the coefficient on  $T$ , is the monthly rate of change. Multiplying this coefficient by 12 yields the annual rate of change of 4.8%.



#### 4. Selling Period Results

As the theory suggests, market value increases at a decreasing rate as the selling period increases. This result is seen by the coefficient,  $\beta_9$ , being significantly negative. That is,

$$\frac{\partial V}{\partial t} = -\beta_9 t^{-2} V. \quad \text{So if } \beta_9 < 0, \frac{\partial V}{\partial t} > 0. \quad \text{And} \quad (4)$$

$$\frac{\partial^2 V}{\partial t^2} = \beta_9 t^{-4} V + 2\beta_9 t^{-3} V. \quad \text{So if } \beta_9 < 0, \frac{\partial^2 V}{\partial t^2} < 0. \quad (5)$$

The value-selling period relationship,  $\hat{O}$  in Figure 1, increasing at a decreasing rate indicates that an optimal average selling period exists.

In the sample, the number of days on the market ranged from 1 to 251 with the actual average being 54.58. A numerical example of the optimal average selling period can be developed and compared with the actual average. In order to obtain the estimate of the optimal average selling period, it will be necessary to specify the seller's cost function and select a discount rate.

The seller's transaction costs are the sum of his broker's commission, (i.e., 6% of market value), transfer tax (i.e., .05% of market value), and a lawyer's fee assumed to be \$125.

$$C = .0605 V + 125. \quad (6)$$

In this example, it is assumed that the seller has no search costs. Thus the net return to the seller is the market value minus transaction costs,





$$N = V - C = .9395 V - 125. \quad (7)$$

Multiplying (7) by  $e^{-rt}$  yields the present value of the seller's net return,

$$Ne^{-rt} = .9395 V e^{-rt} - 125e^{-rt}. \quad (8)$$

The present value is maximized by taking the derivative of equation (8) with respect to  $t$  and setting it equal to zero,

$$\frac{\partial Ne^{-rt}}{\partial t} = .9395(-\beta_9 t^{-2} - r)Ve^{-rt} + 125re^{-rt} = 0. \quad (9)$$

By assuming magnitudes for the variables and utilizing the estimates of the coefficients obtained in the regression, one may compute the selling period which maximizes the present value of the seller's net return.<sup>8</sup> This example assumes the average house sale (i.e., of average building area, lot area, number of baths, and having a fireplace, being other than a bi-level, and sold during July of 1976). Since a direct solution of (9) is hardly trivial, this optimal selling period might best be, and was, determined using numerical methods.

Assuming that the discount rate is 9%, the optimal average selling period was calculated to be 12.13 days. If the discount rate is 3%, the optimal average selling period increases to 21.01 days. On the other hand, the actual average selling period was 54.58 days. So that if the actual were optimal, it would imply that the discount rate is slightly less than .5%. Thus it appears that houses in this neighborhood are kept on the market too long. This conclusion is reinforced by the fact that the cost function excludes search costs



thereby extending the calculated optimal average selling period. Assuming that the cost function is nearly correct during the first month, the estimate of the optimal average selling period hinges on the selection of an appropriate discount rate. Because this model holds the month of sale constant while examining the selling period, the appropriate discount rate is probably a real rather than a nominal rate. The distinction between these two types of rates is that the nominal rate equals the real rate plus the anticipated rate of inflation. Therefore, the 3% discount rate and 21 day optimal average selling period are probably more reasonable estimates than 9% and 12 days.

Although the possibility that the discount rate is below .5% and the actual average selling period is optimal cannot be completely excluded, it does seem unlikely. One explanation of sub-optimal average behavior is that the expectations of sellers are typically unrealistically high. These unrealistic expectations may be broker induced (i.e., in order to get listings) or may be the result of biased anecdotes that sellers have heard about sales in the neighborhood (i.e., because selling low tends to cause the seller to keep quiet whereas selling high may be cause for bragging).

After 1 day on the market, the expected market value from an average sale (i.e., described above) is \$46,967.10, while it approaches \$48,697.97 asymptotically. This difference of \$1,730.87 demonstrates that selling period has a substantial impact on market value. After an optimal



selling period of 21.01 days, the expected market value is \$48,614.16; whereas it is \$48,665.91 after the average selling period of 54.58 days. One of these last two values ought to be the value sought by appraisers (i.e., a sale after a "reasonable" time on the market). The lower magnitude seems more appropriate, because it represents a higher net present value (i.e., at discount rates above .5%).

##### 5. Summary and Conclusions

The purpose of this paper has been to explore the concept of an optimal selling period for single-family housing. Using point input-point output investment theory, a theoretical model of an optimal selling period was developed. In this model, the average seller faces a path of his highest offer to date which increases at a decreasing rate. He attempts to maximize his net return from a sale, offers minus transaction and search costs, by keeping his house on the market for an optimal selling period. A sample of recent single-family housing sales was used to test a key feature of the model, expected market value increasing at a decreasing rate with the selling period. The test confirmed this hypothesis.

The recent work by Zerbst and Brueggeman (1976) argues that there should be no reason why sellers who keep their homes on the market longer should on average realize higher market values. To the contrary, this paper demonstrates theoretically and empirically that there is a strong, direct



relationship between selling period and expected market value. This, in turn, gives rise to an optimal selling period. An estimate of the optimal average selling period indicates that the actual average selling period of the sample possibly exceeds the optimal.









selling period and thereby links the expected maximum offer to the selling period. Alchian (1969) has shown the form of this path for a normal offer distribution.

<sup>6</sup>One can conceive of a similar model being developed for buyers of single-family housing. They face a distribution of offers to sell and, on average, a path of the expected minimum offer which decreases at a decreasing rate with the search period. The difference between the mean of the offer to sell distribution and the path of the expected minimum offer is the buyer's gross saving from search. Subtracting the buyer's search and transaction costs from his gross saving yields the buyer's net saving from search curve. The average buyer should attempt to get on the highest possible iso-present-value curve by moving along this net saving from search curve. The average buyer then has an optimal search period.

<sup>7</sup>The age of housing which maximizes value is found where  $\frac{\partial V}{\partial AGE} = (\beta_6 + 2\beta_7(AGE))V = 0$ , therefore  $AGE = \beta_6 / (-2\beta_7)$ .

<sup>8</sup>This model assumes that the optimal selling period is a function of the other variables. Larger bundle sizes of the composite good, housing, result in longer average optimal selling periods.



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