

# Rental Housing and the Natural Vacancy Rate

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## Abstract

This study uses 1989–2005 data for the Seattle metropolitan area to test the natural vacancy rate hypothesis for rental housing markets using a new methodology. Findings support the existence of a natural vacancy rate for apartments that varies over time, and in some cases across apartment submarkets. Results show a decline in the natural vacancy rate in the time period following the introduction and growth of the Web. Results also show significant differences in natural vacancy rates for different geographic subareas. No significant differences in the natural vacancy rate are found for different apartment types.

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According to the natural rate hypothesis, fluctuations in apartment rents are driven by deviations in the vacancy rate from equilibrium or “natural” levels. One reason to estimate natural vacancy rates is to confirm this hypothesis. Beyond that, however, estimates of the natural vacancy rate for a rental housing market provide information that is potentially useful for investors, lenders, and other real estate professionals. Comparing the natural rate at a point in time to the actual vacancy rate provides some indication of future rent movements in that market. In addition to its effect on the movement of rents, the level of the natural vacancy rate has direct implications for the return on property investment. In long-run equilibrium, the lower the natural vacancy rate, the greater the amount of rent generated by a given rental property, everything else held constant. If the natural vacancy rate declines over time, the return on rental property investment will rise, *ceteris paribus*.

Housing markets are often modeled as a series of separate but related submarkets, with differing supply and demand conditions in each. In the case of a rental market, there may be separate submarkets for different apartment types (one-bedroom, two-bedroom, etc.), and for different geographic locations. If submarkets exist, it is possible that natural vacancy rates will vary by submarket. In that case, information on natural vacancy rates is made more useful if available at the submarket level.

Empirical support for the existence of a natural vacancy rate in rental housing dates back to Smith (1974). Since then, a number of studies have focused on

variations in the natural rate across both space and time. For example, Gabriel and Nothaft (1988) provide evidence of substantial variation across major metropolitan areas in the United States. In a more recent paper, Gabriel and Nothaft (2001) find the duration and incidence of vacancies, and the natural vacancy rate, to vary across metropolitan areas with a number of factors including housing costs, heterogeneity of the housing stock, tenant mobility, and population growth.

This study estimates natural vacancy rates using 1989–2005 data from a biannual survey of apartment properties in the Seattle area. We focus on two questions. First, to what extent do natural vacancy rates for rental housing vary by submarket? To address that question, we define submarkets on the basis of apartment type, and on the basis of geographic subarea, and estimate natural vacancy rates for each submarket. A second question relates to changes in natural vacancy rates over time, and whether the introduction and growth of the Web has played a role. Improvements in the apartment search process brought about by this innovation may have caused the natural vacancy rate to decline. To date, no research has addressed this question.

To estimate the natural vacancy rate, both across submarkets and over time, we use a model that relates rent change to the rate of excess demand for housing. At any point in time there are both vacant apartments and households in the process of search. The rate of excess demand depends both on the number of vacancies and on the number of households engaged in the search process. While the latter is not directly observable, there is a functional relationship between vacancies and seekers in the form of a “Beveridge curve” for housing. A specification of the natural vacancy rate is developed that incorporates this relationship between vacant apartments and households seeking apartments.

The following section provides a review of the literature on the natural vacancy rate. The next two sections describe the methodology and data, and present the empirical results. A final section provides a summary and conclusions.

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## The Natural Vacancy Hypothesis

### *The Rent Change Model*

The hypothesis that vacancy rates affect rents is attributable to Blank and Winnick (1953). Smith (1974) was the first to develop an empirically testable model of rent change, incorporating the notion of an optimal or natural vacancy rate—the rate at which there is neither excess supply nor excess demand, and thus rent is at its long-term equilibrium level. Due to factors such as search costs, variability of demand, costs of holding inventory, and costs of recontracting, the optimal or “natural” vacancy rate for rental housing is likely to exceed zero.

In the Smith model, the level of vacancies is given by:

$$VL = S - D, \quad (1)$$

where  $S$  is the supply of rental housing units (assumed fixed in the short run) and  $D$  is the demand for rental housing units (derived from the demand for rental housing services). Demand can be expressed as:

$$D = d(R, U, Y, P, Z), \quad (2)$$

where  $R$  is nominal rent,  $U$  is the user cost of home ownership,  $Y$  is real income,  $P$  is the price level, and  $Z$  is a vector of demographic variables. The vacancy rate is then given by:

$$V = VL/S = 1 - (1/S)d(R, U, Y, P, Z). \quad (3)$$

Based on the hypothesis that excess supply or excess demand, defined as deviations in the actual vacancy rate from the natural vacancy rate, determine the rate of change of rent, the rent adjustment mechanism can be expressed as:

$$nr = f(e, v^* - v), \quad (4)$$

where  $nr$  is the rate of change of nominal rent,  $e$  is the rate of change of total operating expenses (reflecting nominal price influences on  $nr$ ), and  $v^*$  is the natural vacancy rate. Assuming a constant natural vacancy rate over the period of estimation, the estimating equation is specified as:

$$nr_i = b_0 - b_1v_i + b_2e_i + u_i, \quad (5)$$

where  $u_i$  is the error term.

Almost all subsequent studies estimate a similar rent change equation, in some cases modified to include additional variables (Eubank and Sirmans, 1979; Rosen and Smith, 1983; Shilling, Sirmans, and Corgel, 1987; Frew and Jud, 1988; Gabriel and Nothaft, 1988; Reece, 1988; Wheaton and Torto, 1988; Ellis and Brown, 1989; Jud and Frew, 1990; Belsky and Goodman, 1996; Hendershott, 1996; Sivitanide, 1997; and Tse and McGregor, 1999). An exception is Voith and Crone (1988), who lack the required data, and thus use an alternative methodology.

Beginning with Wheaton and Torto (1988), a common practice is to use the change in real rent (vs. nominal rent) as the dependent variable. The use of real rent allows the operating cost variable to be excluded, given that real rent reflects inflationary increases in operating costs. Thus the typical equation to be estimated is written as:

$$r_i = b_0 - b_1 v_i + u_i, \quad (6a)$$

where  $r$  is the rate of change of real rent. Other variables such as city dummy variables can be incorporated into the specification. Typically the vacancy rate used for purposes of estimation is the rate lagged one period (given the lagged response of price changes to market conditions). The natural vacancy rate,  $v_i^*$ , is found by setting  $r_i = 0$  and solving for  $v_i$ , which yields:

$$v_i^* = b_0/b_1. \quad (6b)$$

### Results of Empirical Studies

Hendershott and Haurin (1988), Sirmans and Benjamin (1991), Jud, Benjamin, and Sirmans (1996) and more recently Hendershott, MacGregor, and Tse (2002) survey the empirical literature on rents and vacancies. With few exceptions, the literature provides empirical support for the existence of a natural vacancy rate, in commercial office space markets as well as in apartment markets.

The magnitude of the natural vacancy rate is generally found to vary significantly across cities (Rosen and Smith, 1983; Gabriel and Nothaft, 1988, 2001; Reece, 1988; Wheaton and Torto, 1988; and Voith and Crane, 1988). For example, natural vacancy rates estimated by Gabriel and Nothaft (1988) for 16 cities over the 1981–1985 time period vary from 3.9% to 10.0% when estimated exogenously, and from 6.9% to 12.0% when estimated endogenously from a model of natural vacancy rate determinants. In a more recent study, Gabriel and Nothaft (2001) provide estimates of natural vacancy rates for 29 metropolitan areas that fall within a narrow range—most between 4% and 4.5%—for the time period 1987–1996. They caution that their estimates are not directly comparable to previous estimates for a number of reasons. One obvious reason is that unlike previous studies, their data aggregate apartments and single-family rental houses. A full 58% of their sample consists of single-family rentals, which typically have much lower vacancy rates.

Wheaton and Torto (1988) allow the natural vacancy rate to vary in a linear fashion with time, and find a significant upward trend. Voith and Crane (1988) allow for

variation over both time and space. They find significant variation in natural vacancy rates for office space across cities, between suburban and central city markets, and over time. More specifically, they find an increase in natural vacancy rates during the 1980s. Zhou (2008) tests for unknown break points in the natural vacancy rate over time. In the only study to estimate natural vacancy rates for apartments at the sub-metropolitan level, Jud and Frew (1990) test the “Haurin hypothesis” that the natural vacancy rate for a particular apartment unit is determined by the “atypicality” of the unit (Haurin, 1988). The more “atypical” the unit, the higher the natural vacancy rate. Using 1988 and 1989 rent and vacancy data for 88 apartment projects in the Greensboro/High Point/Winston-Salem MSA, Jud and Frew identify 246 submarkets based on the atypicality of the unit—the deviation of its characteristics from local market means—and find the natural vacancy rates to vary as expected.

Studies not supporting the natural vacancy rate hypothesis include Eubank and Sirmans (1979). In this study, vacancy rates are not significant in the majority of rent change equations estimated; results suggest that operating costs are more important than vacancy rates in determining rent change. More recently, Belsky and Goodman (1994) find a positive correlation between rents and vacancy rates at the national level for the 1980s. They argue that this finding can be explained by a combination of measurement problems, changes in search behavior of landlords and tenants, and an increase in the natural vacancy rate.

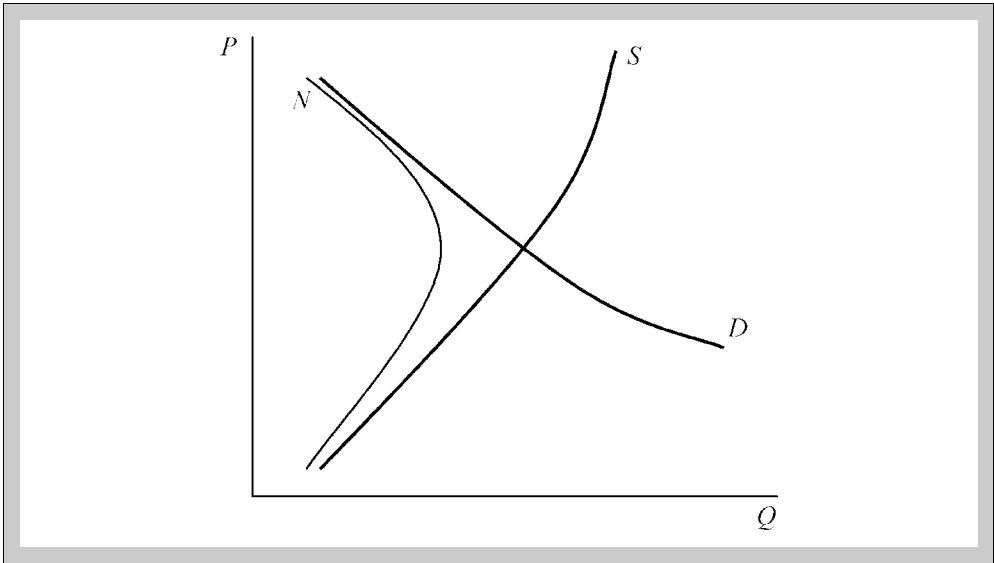
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## Estimating the Natural Vacancy Rate: An Alternative Methodology

### *The Rate of Excess Demand for Housing*

Given frictions in the apartment search process, at any point in time vacant apartments (unmet supply) exist simultaneously with unsatisfied apartment seekers (unmet demand). The actual level of filled apartment units is thus less than both the quantity supplied and the quantity demanded. In short, the number of transactions at a point in time is not equal to the level that obtains on the short side of the market (as assumed in most simple analyses), but rather at some quantity below this, where the divergence is a function of the distance from equilibrium and the efficacy of the matching process. This is similar to what we observe in labor markets, where the search process gives rise simultaneously to unfilled vacancies and unemployed workers. Following Bent Hansen (1970), who provided a simple framework for analyzing this process in labor markets, we can think of the market as consisting of a supply curve, a demand curve, and a transactions function,  $N$ , showing the number of rented apartment units, as seen in Exhibit 1.

The traditional short-side principle holds that transactions occur on the short side of the market, in which case the function  $N$  would be coincident with the demand

**Exhibit 1** | The Transaction Curve "N"

Note: The transactions function,  $N$ , shows the number of rented apartment units. Because of imperfections in the matching process, vacancies may exist even when the market is in equilibrium.

curve above the market equilibrium and would coincide with the supply curve below equilibrium. This traditional approach implies that there are zero vacancies when the market is in equilibrium, which is contradicted by the empirical evidence. The function  $N$  is intended to provide a more realistic representation of actual transactions. Because of imperfections in the matching process, vacancies may exist even when the market is in equilibrium. This is analogous to frictional unemployment in labor markets. With the general form of the transaction function shown in Exhibit 1, the number of vacancies at the market equilibrium is positive, since the number of transactions,  $N$ , is less than the quantity supplied,  $S$ . (The number of unsatisfied apartment seekers is also positive, since  $N$  is less than  $D$ .) Consider a movement away from market equilibrium in the direction of lower prices. As prices fall and excess demand rises, the number of vacancies ( $S - N$ ) declines as  $N$  converges on  $S$ . When there is a high level of excess demand, the number of vacancies will thus be very low. The reverse occurs as prices rise above the equilibrium level. The number of unsatisfied apartment seekers ( $D - N$ ) declines as  $N$  converges on  $D$ . This behavior corresponds well to empirical regularities in markets with search processes, including labor markets and housing markets.

Given the transaction function described above, the level of vacancies at a given price level is thus:

$$V = S - N, \quad (7)$$

where  $N$  is the number of filled units. The level of unsatisfied apartment seekers is:

$$H = D - N. \quad (8)$$

The level of excess demand can be written as:

$$X = D - S = (D - N) - (S - N) = H - V. \quad (9)$$

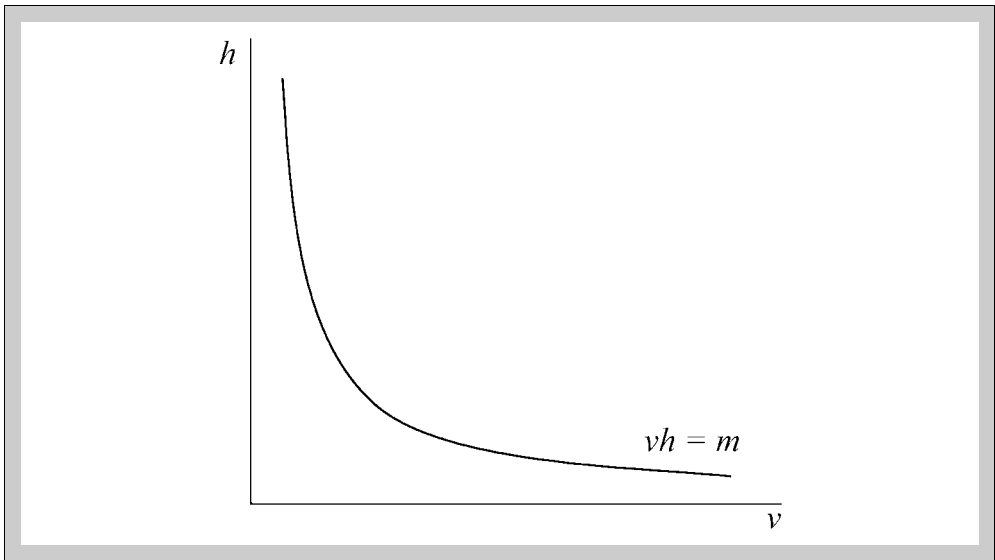
This yields the rate of excess demand:

$$x = (H - V)/S = h - v, \quad (10)$$

where  $v \equiv V/S$  is the vacancy rate and  $h \equiv H/S$  is the rate of unsatisfied seekers.

As the market price changes, the rate of unsatisfied seekers ( $h$ ) and the apartment vacancy rate ( $v$ ) both change. Given the very general specifications of  $N$ ,  $S$ , and  $D$  shown in Exhibit 1, we would expect  $h$  and  $v$  to vary inversely. Moreover, given the general shape of  $N$  in Exhibit 1, we would expect the relationship between  $v$  and  $h$  to be nonlinear and convex from below. Finally, we can preclude negative values of  $v$  and  $h$ . There are a number of functional forms that meet these requirements. Hansen (1970) suggests a rectangular hyperbola. This provides a simple specification of the natural rate for purposes of empirical estimation, particularly when attempting to identify changes in the efficacy of the matching process over time. Using a rectangular hyperbola,  $vh = m$ , where  $m$  is a constant that describes the position of the curve, and reflects the efficiency of the matching process. This parameter proves easy to estimate. A potential criticism of the rectangular hyperbola is that it is symmetric, which is not necessarily implied by the general considerations discussed above. In our empirical work reported below, we try a modified specification that allows us to test for asymmetry, which we are able to reject.

The hypothesized relationship between  $h$  and  $v$  is illustrated in Exhibit 2. In the literature on job vacancies and unemployment, such a relationship is referred to

**Exhibit 2** | The Housing Beveridge Curve

Note: The figure shows the hypothesized relationship between the rate of unsatisfied apartment seekers ( $h$ ) and the apartment vacancy rate ( $v$ ). The parameter  $m$  reflects the efficacy of the matching process.

as a “Beveridge curve.” Exhibit 2 can be thought of as a Beveridge curve for housing.

As noted above, the parameter  $m$  reflects the efficacy of the matching process. A lower value of  $m$  implies a smaller number of unsatisfied apartment seekers at a given vacancy rate, which in turn implies a more efficient matching process. The value of  $m$  might differ by apartment type (as a function of the “thinness” of the market), and could differ by area as well. The empirical specification used below allows  $m$  to be identified by submarket.

### The Natural Vacancy Rate

An expression for the natural vacancy rate can be derived from the rent change equation:

$$r = ax = a(h - v), \quad (11)$$

where  $r$  is the rate of change in real rent and  $a$  is a constant. Using the specification given above for the relationship between  $h$  and  $v$ , this becomes:



$$r = am(1/v) - av. \quad (12)$$

The natural rate,  $v^*$ , is defined as the value of  $v$  for which  $r = 0$ :

$$am(1/v^*) - av^* = 0. \quad (13)$$

Solving for  $v^*$ , we have:

$$v^* = m^5. \quad (14)$$

This can be estimated using the following equation:

$$r_i = am(1/v_i) - av_i + u_i, \quad (15a)$$

which yields estimates of the coefficients  $am$  and  $a$  (where  $u_i$  is the error term). Setting  $r_i = 0$  yields the natural vacancy rate  $v_i^*$ :

$$v_i^* = (am/a)^5. \quad (15b)$$

For purposes of comparison, results using the conventional specification are also presented below. As will be shown, the specification can be made more complicated by interacting other variables, such as dummy variables for geographic subarea, with the variable  $v_i$ , which allows  $m$  to vary by subarea. Finally, we note that given the lagged response of prices to market conditions, the estimation procedure uses the lagged vacancy rate instead of the contemporaneous rate.

## Data

The source of the rent and vacancy data is biannual surveys of apartment complexes with 20 or more units in Seattle and surrounding King County. The surveys are conducted in March and September by Dupre + Scott Apartment Advisors of Seattle, Washington. The number of apartment complexes surveyed by Dupre + Scott varies from period to period; in a typical survey, the surveyed

complexes represent 70% of all units in 20-unit or larger rental properties in King County. The database used for this study contains 35 biannual periods, beginning in September 1988 and ending in September 2005.

For purposes of estimating the natural vacancy rate, we define an observation to be the average percentage change in rent and the average lagged vacancy rate for a particular type of apartment in a particular geographic subarea of King County. Prior to computing the percentage change in rent, rents were deflated using the semi-annual Seattle CPI—All Urban Consumers. Particular apartments are included in the aggregation (and hence the estimation) only when data are available for two consecutive survey periods; thus the percentage change in real rent measures the percentage change over a six-month period. Both the vacancy rate ( $v$ ) and inverse vacancy rate ( $1/v$ ) variables are lagged one period, and thus reflect the vacancy rate in the period six months earlier. The apartment types used—one bedroom, two bedroom/one bath, and two bedroom/two bath—are the three most common in the Seattle market, accounting for 83.1% of individual apartments in the September 2005 survey. The geographic subareas used—North, Central, East, South, and Southeast—are combinations of census tracts. Given five subareas, three apartment types, and 33 time periods remaining after computing the percentage change in rent and lagged vacancy rate, aggregation of the data yielded 495 observations.

Exhibit 3 shows descriptive statistics for our sample. For the sample as a whole, the average lagged vacancy rate for the 33 time periods is 6.51%, and the average percentage change in real rent is  $-0.31\%$ .

**Exhibit 3** | Descriptive Statistics

Variable	Unit type	# of Apt.		Std.			
		Surveys	$n$	Mean	Dev.	Min.	Max.
Ave. lagged vacancy rate ( $v_{t-1}$ )	Full sample	2,795,282	495	6.51	2.83	1.47	29.79
	1 bedroom	1,313,149	165	5.64	1.90	1.47	9.97
	2 bedr/1 bath	725,544	165	6.83	2.56	1.60	17.20
	2 bedr/2 bath	756,589	165	7.04	3.57	2.10	29.79
Ave. % change real rent ( $r$ )	Full sample	2,795,282	495	-0.31	1.65	-7.79	5.38
	1 bedroom	1,313,149	165	-0.19	1.36	-3.01	3.91
	2 bedr/1 bath	725,544	165	-0.25	1.70	-4.40	5.38
	2 bedr/2 bath	756,589	165	-0.49	1.84	-7.79	3.43

*Note:* The sample of apartments in Seattle and surrounding King County covers the period September 1988 to September 2005. An “apartment survey” is defined as one apartment surveyed once.

Empirical Results

Rent change equations were estimated using a conventional specification, as well as the specification developed above. Both specifications use  $r$  (the percentage change in real rent) as the dependent variable. In the conventional specification, the independent variables include a constant term,  $c$ , and the lagged vacancy rate,  $v_{t-1}$ . Regression results are shown in Exhibit 4. In both regressions, coefficients have the expected signs and are significant at the 1% level. For both specifications, our results provide additional empirical support for the natural vacancy rate hypothesis.

Both regressions imply a natural vacancy rate close to 5% for the King County market. For the new approach in Exhibit 4, the coefficient on  $1/v_{t-1}$  corresponds to  $am$  in equations 15a and 15b. The coefficient on  $v_{t-1}$  corresponds to  $-a$ . Following equation 15b, the estimate of the natural vacancy rate for the new approach is found by taking the square root of the negative of the ratio of the coefficients. This yields an estimated natural vacancy rate of 4.97%. For the conventional specification in Exhibit 4, the coefficient for the constant term corresponds to  $b_0$  in equations 6a and 6b, and the coefficient on  $v_{t-1}$  corresponds to  $-b_1$ . Following equation 6b, the estimate of the natural vacancy rate is found by taking the negative of the ratio of the coefficients, yielding an estimated natural vacancy rate of 5.25%. It is interesting to note that a 5% vacancy rate is frequently cited in the local media as the vacancy rate that is “considered balanced” for this market (e.g., Rhodes, 2006).

**Exhibit 4** | Regression Results: New Approach vs. Conventional Approach

	Coeff.	t-Stat.
<b>New Approach</b>		
$1/v_{t-1}$	3.821	8.328*
$v_{t-1}$	-0.155	-11.833*
Adj. R <sup>2</sup>	0.192	
<b>Conventional Approach</b>		
$c$	1.294	7.662*
$v_{t-1}$	-0.246	-10.343*
Adj. R <sup>2</sup>	0.177	

Notes: This table shows the results of regressions to test the natural vacancy rate hypothesis. The dependent variable in each approach is the percentage change in real rent ( $r$ ). For both approaches,  $n = 495$ . For the New Approach, the estimated natural vacancy rate is 4.97%; for the Conventional Approach, the estimated vacancy rate is 5.25%.  
\*Significant at the 1% level.

As discussed above, the use of a rectangular hyperbola simplifies the interpretation of the regression results, but imposes the assumption of symmetry in the Beveridge curve for housing shown in Exhibit 2. To test for deviations from symmetry, we tried an alternative specification in which  $1/v_{t-1}^2$  was included in the specification. This allows the basic hyperbola to be “stretched” or “squished” into a different shape (depending on the coefficient), which could in principle provide a better fit than a simple rectangular hyperbola. The coefficient on the new variable was not statistically significant, suggesting that a symmetric specification yields a reasonable approximation.<sup>1</sup>

## Natural Vacancy Rates over Time and Across Submarkets

### *The Effect of the Web*

In the rent change equation given above (equation 15a), the parameter  $m$  reflects the efficacy of the matching process between apartment seekers and unfilled apartments. A lower value of  $m$  implies a smaller number of unsatisfied apartment seekers at a given vacancy rate, which in turn implies a more efficient matching process, and a lower natural vacancy rate. Over time, the efficiency of the matching process is likely to vary with the cost and quality of market information. This is one of the factors identified by Belsky and Goodman (1996) as a determinant of the duration of vacancies, and thus the equilibrium vacancy rate across time, space, and structure type. With the introduction and increased usage of the Web in the early 1990s and beyond, it is likely that the cost of information has fallen. A lower cost of providing information about vacant apartments allows landlords to provide more and higher quality information for a given expenditure. For apartment seekers, the Web provides lower-cost access to high-quality information such as maps, property overviews, photos, and floor plans. Cheaper and better market information serves to reduce the number of units that must be physically inspected by apartment seekers, leading to a reduced duration of search.

Given this potential of the Web to improve the apartment search process, we hypothesize that the introduction and growth of the Web has caused the natural vacancy rate to decline. To test this hypothesis, we include a variable designed to match the market penetration of the Web, as defined in terms of household usage. We estimate the rent change equation as:

$$r_i = am(1/v_i) - av_i - bW_i v_i + u_i, \quad (16)$$

where  $W_i$  is a variable designed to roughly match the growth in the percentage of households using the Web. The value of this variable is set equal to zero until 1994, which corresponds to the introduction of the Netscape browser, a watershed

event in terms of website development and popularization of the Web. (Prior to 1994, there were very few websites.) As with many new product introductions, initially there was a very high rate of growth, as measured both in terms of the number of websites and in the number of users. As use of the Web has matured, the rate of growth has slowed. As of 2005, the last year in our data set, the percentage of U.S. households using the Web was approximately 68.1% (Internet World Stats, 2007). To create our “web variable,” the pattern of usage growth of the Web is approximated with the function:

$$W = 1 - \frac{1}{e^{.05t}}, \tag{17}$$

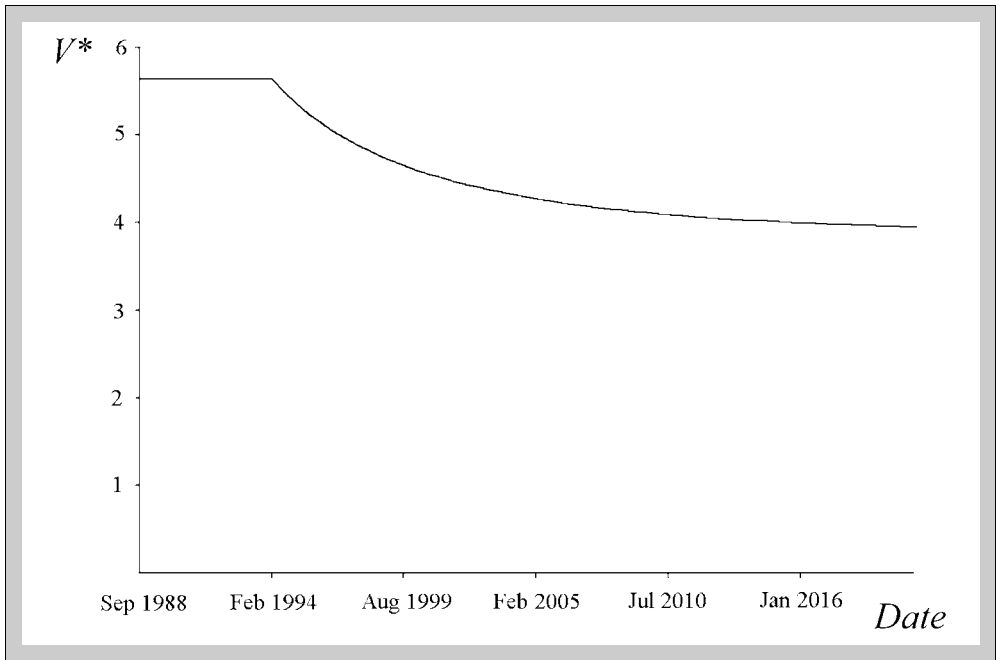
where  $t$  is a time trend starting at 1 with the September 1994 time period in our data.<sup>2</sup> The value of  $W$  is 0.0488 in September 1994, and rises to 0.6834 by September 2005. Note that as  $t$  goes to infinity,  $W$  goes to one. The estimated rent change equation yields estimates of the natural vacancy rate  $v^*$  equal to  $(am/a)^{-5}$  when  $W_i = 0$  and  $[(am/(a + bW_i))]^{-5}$  for  $W_i > 0$ .

As may be seen in Exhibit 5, the coefficient on the web variable has the expected sign, and is significant at the 1% level. For the period prior to September 1994, when the value of the web variable is equal to zero, the estimated natural vacancy rate is 5.64%. Starting in Fall 1994, the estimated natural vacancy rate declines, as shown in Exhibit 6. By September 2005, the last apartment survey in our data, the estimated natural vacancy rate has fallen to 4.25%. Based on the functional form of our web variable, which assumes a continuing (but slowing) rate of increase in Web usage, our estimated model predicts a continuing decline in the natural vacancy rate beyond the period of our data. By September 2020, the model predicts that the natural vacancy rate will have fallen to 3.95%. Based on our

**Exhibit 5** | Regression Results with Web Variable

	Coeff.	t-Stat.
$1/v_{t-1}$	4.231	9.140*
$v_{t-1}$	-0.133	-9.551*
$W_i v_i$	-0.148	-4.064*
Adj. R <sup>2</sup>	0.217	

Notes: This table reports the results of a regression to estimate the effect of the introduction and growth of the Web, as measured by the variable  $W_i v_i$ , on the natural vacancy rate. The dependent variable is the percentage change in real rent ( $r$ ).  $n = 495$ .  
\*Significant at the 1% level.

**Exhibit 6** | The Effect of the Web on the Natural Vacancy Rate

Note: The figure shows the natural vacancy rate as predicted by a model that includes a variable for the introduction and growth of the Web.

results, most of the impact of the Web has already occurred. We estimate that additional market penetration will only lower the natural vacancy rate by another quarter percentage point.

In modeling the effect of the Web on the natural vacancy rate, an alternative specification would be to model the Web as a discrete event. To test this alternative, we estimated the model with  $W_t$  defined as a dummy variable equal to 1 for time periods starting September 1994. This alternative approach yielded a regression with a lower R-squared and a higher standard error than the regression shown in Exhibit 5, leading us to conclude that there is additional explanatory power gained with the more sophisticated approach of modeling the rate of Web penetration over time.

### Natural Vacancy Rates by Submarket

In our model, natural vacancy rates are determined by the efficiency of the matching process between apartment seekers and unfilled apartments. Differences in the efficiency of this process for different rental housing submarkets can thus lead to differences in natural vacancy rates. In thinking about factors that might

drive these differences, it is useful to draw from the Belsky and Goodman (1996) and Gabriel and Nothaft (2001) approach of distinguishing between the incidence or frequency of apartment vacancies and the duration of vacancies. In this approach, primary determinants of the incidence of vacancies are mobility of the renter population and the rate of new construction. The duration of vacancies on the other hand is determined by the cost and quality of information, as discussed above, and also by the size and heterogeneity of the market, in terms of the diversity of apartment types available and the dispersion of rents. Duration of vacancies is possibly influenced by the level of housing market discrimination as well.

In the case of rental housing submarkets defined on the basis of apartment type, natural vacancy rates may differ depending on the mobility characteristics of demographic groups most likely to demand a particular apartment type. For example, one-bedroom apartments may appeal primarily to students and young workers, as opposed to families. If students and young workers are also more mobile than families, the frequency of vacancies and thus the natural rate may be higher for one-bedroom than for two-bedroom units. On the other hand, there may be more diversity in apartment characteristics for two-bedroom units than for one-bedroom units (in terms of square footage, layout of rooms, etc.), causing the duration of vacancies and thus the natural rate to be higher for two-bedroom units. Depending on the strength of the several factors influencing incidence and duration in a particular market, natural vacancy rates for one- and two-bedroom units might differ.

To test whether the natural vacancy rate varies by apartment type in the Seattle market, we estimate:

$$r_i = am(1/v_i) - av_i - bW_i v_i - cD_i v_i + u_i, \quad (18)$$

where  $D_i$  is a dummy variable for two-bedroom apartments (one bath or two bath). For time periods prior to September 1994,  $W_i = 0$ , and thus the equation yields an estimate of  $v^*$  equal to  $(am/a)^{.5}$  when  $D_i = 0$  and  $[(am/(a + c))]^{.5}$  when  $D_i = 1$ . For time periods starting in September 1994, the estimated  $v^*$  is equal to  $[(am/(a + bW_i))]^{.5}$  when  $D_i = 0$  and  $[(am/(a + bW_i + c))]^{.5}$  when  $D_i = 1$ . As may be seen in Exhibit 7, the coefficient on the dummy variable for two-bedroom apartments is not significant, leading us to reject the hypothesis that the natural vacancy rate for two-bedroom apartments differs from the natural vacancy rate for one-bedroom apartments. Results suggest that for this market either factors such as diversity of apartments and mobility of the renter population do not differ for one and two-bedroom apartments, or the influences of these factors are offsetting in terms of their effects on the natural vacancy rate.<sup>3</sup>

Submarkets can also be defined on the basis of geographic subarea. In thinking about how natural vacancy rates might vary by subarea, it is again useful to

**Exhibit 7** | Regression Results with Apartment Types

	Coeff.	t-Stat.
$1/v_{t-1}$	4.344	9.164*
$v_{t-1}$	-0.154	-6.481*
$W_i v_i$	-0.147	-4.039*
Two bedroom $\times v_{t-1}$	0.025	1.102
Adj. R <sup>2</sup>	0.217	

Notes: This table shows the results of a regression to test whether the natural vacancy rate varies between one and two-bedroom apartments. The dependent variable is the percentage change in real rent ( $r$ ).  $n = 495$ .  
\*Significant at the 1% level.

consider factors believed to influence the incidence and duration of vacancies. Several of the factors mentioned above—mobility of the renter population, the percentage of new construction, and the degree of diversity of available apartment types—can vary across geographic subareas of a larger market. Based on its location, for example, one subarea may have the potential for scenic views, creating more diversity in terms of the existence and quality of views. This would imply a longer search in this subarea than in subareas with no view potential, and thus a higher duration of vacancies and a higher natural vacancy rate. On the other hand, the subarea with scenic views could attract an older, more affluent and therefore less mobile renter population, which would imply a lower incidence of vacancies and a lower natural vacancy rate than in other subareas. For a particular city, whether natural vacancy rates vary across geographic subareas will depend on the combined effects of the various factors influencing incidence and duration of vacancies.

To test for differences in the natural vacancy rate across geographic subareas in Seattle and surrounding King County, our estimated rent change equation includes variables that interact lagged vacancy rates with dummy variables for four of five geographic subareas. We estimate the equation:

$$r_i = am(1/v_i) - av_i - bW_i v_i - c_1 \text{North}_i v_i - c_2 \text{East}_i v_i - c_3 \text{Central}_i v_i - c_4 \text{Southeast}_i v_i + u_i, \quad (19)$$

with the remaining subarea “South” represented by the coefficient on  $v_i$ . For time periods prior to September 1994 when  $W_i = 0$ , this specification yields an estimate of the natural vacancy rate  $v^*$  equal to  $(am/a)^5$  for the subarea “South,” equal to



$(am/(a + c_1))^{.5}$  for the subarea “North,” equal to  $(am/(a + c_2))^{.5}$  for the subarea “East,” etc. For time periods beginning September 1994 when  $W_i = 1$ , the estimated natural vacancy rate  $v^*$  is equal to  $[(am/(a + bW_i))^{.5}$  for the subarea “South,” equal to  $(am/(a + bW_i + c_1))^{.5}$  for the subarea “North,” equal to  $(am/(a + bW_i + c_2))^{.5}$  for the subarea “East,” etc.

Regression results and estimated natural vacancy rates are shown in Exhibits 8A and 8B. The estimated coefficients are significant at the 1% level for the North

**Exhibit 8A** | Regression Results with Geographic Subareas

	Coeff.	t-Stat.
$1/v_{t-1}$	4.281	9.048*
$v_{t-1}$	-0.087	-3.608*
$W_i v_i$	-0.150	-4.043*
North $\times v_{t-1}$	-0.085	-2.735*
East $\times v_{t-1}$	-0.062	-1.884***
Central $\times v_{t-1}$	-0.058	-2.110**
Southeast $\times v_{t-1}$	-0.034	-1.164
Adj. R <sup>2</sup>	0.225	

Notes: This table shows the results of a regression to determine whether the natural vacancy rate varies between geographic subareas. The dependent variable is the percentage change in real rent ( $r$ ).  $n = 495$ .

\* Significant at the 1% level.  
 \*\* Significant at the 5% level.  
 \*\*\* Significant at the 10% level.

**Exhibit 8B** | Estimated Natural Vacancy Rates by Geographic Subarea, for September 2005

Subarea	Percent
South King County	4.75
North King County	3.95
East King County	4.13
Central King County	4.16
Southeast King County <sup>a</sup>	4.38

Note:  
<sup>a</sup>The difference between this area and South King County is not statistically significant.

subarea, significant at the 5% level for the Central subarea, significant at the 10% level for the East subarea, and not significant for the Southeast subarea. Exhibit 8B reports estimated natural vacancy rates for the most recent time period in the sample. (For this time period, the estimated market-wide natural vacancy rate was 4.25%.) As compared with South King County, estimated natural vacancy rates are thus significantly lower for North, Central, and East King County. The relatively low natural vacancy rate for the northern area of King County is perhaps not surprising, given that this area includes the university district surrounding the University of Washington. Given the importance of proximity to the university, students may view the degree of apartment diversity in the university district to be relatively low. Relative to the average tenant, therefore, students may be more likely to take the first apartment offered, causing a relatively low natural vacancy. In terms of tenant mobility, a university district is likely to be associated with relatively high tenant mobility; however, this may be more than offset by factors such as standard contract periods associated with the school year, and the existence of superior housing placement services. Future research is needed to investigate the reasons for the estimated variation in natural vacancy rates for this particular market.

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## Conclusion

Our analysis of vacancy rates for rental housing in the Seattle area provides additional empirical support for the natural rate hypothesis. The approach used here improves on the specification of the natural vacancy rate by incorporating into the model the efficiency of the matching process between apartment seekers and landlords. This approach yields estimates of the natural vacancy rate that are similar to the conventional approach, but that are somewhat lower. In both cases, the estimated natural vacancy rate for the 1989–2005 time period is close to 5%, the percentage of vacancies traditionally considered by local observers to reflect a “balanced market.”

Results provide preliminary evidence that the Web has caused the natural vacancy rate for apartments to fall. When we include a variable to test for the effect of the introduction and growth of the Web, we find a decline in the natural vacancy rate that is correlated with the timing of the development of the Web. For the period prior to the introduction of the Web, the estimated natural vacancy rate is 5.64%. By September 2005, the last apartment survey in our data set, the estimated rate falls to 4.25%. This result is consistent with the hypothesis that the Web has increased the efficiency of the apartment search process, whereby vacant apartments are matched with households seeking apartments. It is possible, however, that the estimated reduction in the natural rate over this period is attributable at least in part to non-Web related factors such as an increase in “offline” apartment matching services. Further research is needed to determine this. In addition, it is important to note that the result is specific to the Seattle

apartment market, and not necessarily generalizable to rental housing markets in other cities. Given the large presence of the computer software industry in Seattle, and the possibility that Seattle has a relatively “tech savvy” population, it may be the case that the Web had an earlier and/or larger effect on the apartment search process in this market than in other markets. Future research could address this issue by testing the Web hypothesis for other markets.

Our data allow us to test for differences in the natural vacancy rate across potential submarkets. While theory suggests that natural vacancy rates may vary by apartment type and geographic subarea, little research has addressed this question. We find that for the Seattle area, there is no significant difference in natural vacancy rates for one- and two-bedroom apartments. However, we find that the natural rate for apartments varies somewhat by geographic subarea. These results are also of course specific to the Seattle market, and may not be found for other markets, depending on the degree to which factors such as mobility of the renter population and diversity of the housing stock vary across geographic subareas of a particular city or metropolitan area.

Estimates of natural vacancy rates at the submarket level, as well as over time, provide information that is potentially useful for investors, lenders, and other real estate professionals. If the current vacancy rate is below the natural rate, rents would be expected to rise in the future, and vice versa. Moreover, improvements in the apartment search process that reduce the natural rate over time would increase the amount of rent that can be collected from a given property in the long run, *ceteris paribus*, thus increasing the value of that property.

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## Endnotes

- <sup>1</sup> Using  $1/v_{t-1}$ ,  $v_{t-1}$ , and the new variable  $1/v_{t-1}^2$  as the independent variables, we estimated the following coefficients (with *t*-statistics in parentheses): 5.041 (4.0),  $-0.1676$  ( $-9.4$ ), and  $-3.184$  ( $-1.04$ ). We were unable to obtain a statistically significant coefficient for any “asymmetry” parameter, and thus used the simple rectangular hyperbola suggested by Hansen (1970).
- <sup>2</sup> An alternative to our time path variable describing Web penetration would be to use a set of annual dummies, providing a more flexible functional form. However there are a number of potential stochastic shocks that affect a market in a given year. An annual dummy cannot distinguish between the effects of such shocks and the effect in that year of an increasing trend towards Web penetration. The use of an Web trend variable allows us to test for existence of such a trend without it being lost in the noise of individual annual shocks.
- <sup>3</sup> It should be noted that results here do not contradict the Wolverton, Hardin, and Cheng (1999) finding of separate submarkets by apartment type for the Seattle market, based on estimation of implicit prices of apartment characteristics. Even with differing supply and demand conditions, and resulting differences in implicit prices, natural vacancy rates may still be the same.

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## References

- Belsky, E. and J.L. Goodman. Explaining the Vacancy Rate-Rent Paradox of the 1980s. *Journal of Real Estate Research*, 1996, 11:3, 309–23.
- Blank, D.M. and L. Winnick. The Structure of the Housing Market. *Quarterly Journal of Economics*, 1953, 67, 191–208.
- Ellis, D.G. and G.K. Brown. Nominal and Real Vacancy Rates in Office Market Analysis. *Real Estate Review*, 1989, 19, 67–71.
- Eubank, A.A., Jr. and C.F. Sirmans. The Price Adjustment Mechanism for Rental Housing in the United States. *Quarterly Journal of Economics*, 1979, 93, 163–83.
- Gabriel, S.A. and F.E. Nothaft. Rental Housing Markets, the Incidence and Duration of Vacancy, and the Natural Vacancy Rate. *Journal of Urban Economics*, 2001, 49, 121–49.
- Gabriel, S. and F. Nothaft. Rental Housing Markets and the Natural Vacancy Rate. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 419–29.
- Frew, J. and G.D. Jud. The Vacancy Rate and Rent Levels in the Commercial Office Market. *Journal of Real Estate Research*, 1988, 3:1, 1–8.
- Hansen, B. Excess Demand, Unemployment, Vacancies, and Wages. *Quarterly Journal of Economics*, 1970, February, 1–23.
- Haurin, D.R. The Duration of Marketing Time of Residential Housing. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16, 396–410.
- Hendershott, P. Rental Adjustment and the Valuation of Real Estate in Overbuilt Markets: Evidence from the Sydney Office Market. *Journal of Urban Economics*, 1996, 39, 51–67.
- Hendershott, P.H. and D.R. Haurin. Adjustments in the Real Estate Market. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 343–54.
- Hendershott, P.H., B.D. MacGregor, and R. Tse. Estimation of the Rental Adjustment Process. *Real Estate Economics*, 2002, 30, 165–83.
- Internet World Stats. <http://www.internetworldstats.com/am/us.htm>. Accessed February 2007.
- Jud, G.D., J.D. Benjamin, and G.S. Sirmans. What Do We Know about Apartments and Their Markets? *Journal of Real Estate Research*, 1996, 11:3, 243–57.
- Jud, D. and J. Frew. Atypicality and the Natural Vacancy Rate Hypothesis. *Journal of the American Real Estate and Urban Economics Association*, 1990, 18:3, 294–301.
- Reece, B.F. The Price-Adjustment Process for Rental Housing: Some Further Evidence. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 411–18.
- Rhodes, E. Apartment Hunt Will Be Tougher For Renters. *Seattle Times*, October 15, 2006, E1.
- Rosen, K. and L. Smith. The Price-Adjustment Process for Rental Housing and the Natural Vacancy Rate. *American Economic Review*, 1983, 73, 779–85.
- Shilling, J.D., C.F. Sirmans, and J.B. Corgel. Price Adjustment Process for Rental Office Space. *Journal of Urban Economics*, 1987, 17, 208–29.
- Sirmans, G.S. and J.D. Benjamin. Determinants of Market Rent. *Journal of Real Estate Research*, 1991, 6:3, 357–80.
- Sivitanide, P. The Rent Adjustment Process and the Structural Vacancy Rate in the Commercial Real Estate Market. *Journal of Real Estate Research*, 1997, 13, 195–209.

Smith, L.B. A Note on the Price Adjustment Mechanism for Rental Housing. *American Economic Review*, 1974, 63:3, 478–81.

Tse, R.Y.C. and B.D. McGregor. Housing Vacancy and Rental Adjustment: Evidence from Hong Kong. *Urban Studies*, 1999, 36:10, 1769–82.

Voith, R. and T. Crone. National Vacancy Rates and the Persistence of Shocks in U.S. Office Markets. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 437–58.

Wheaton, W.C. and R.G. Torto. Vacancy Rates and the Future of Office Rents. *Journal of the American Real Estate and Urban Economics Association*, 1988, 16:4, 430–36.

Wolverton, M., W.G. Hardin III, and P. Cheng. Disaggregation of Local Apartment Markets by Unit Type. *Journal of Real Estate Finance and Economics*, 1999, 19:3, 243–57.

Zhou, J. Estimating Natural Vacancy Rates with Unknown Break Points for the Chicago Rental Housing Market. *Journal of Housing Research*, 2008, 17:1, 61–74.

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