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Revisiting the Derivation of an Equilibrium Vacancy Rate

Executive Summary. Three approaches are used to derive an equilibrium vacancy rate, defined as that rate in which there is no pressure on real rents. It is clear that equilibrium vacancy rates differ by market and to some extent by cycle. This should be true for various property types as well, but here we focus on office property. Office property tends to have higher equilibrium vacancy rates compared to other property types like retail, perhaps due to lumpy space markets with significant friction. Friction drives the vacant space required for normal turnover and occupant moves. Once the equilibrium vacancy rate is estimated, it provides a useful trigger for rental forecasts. Here we examine nine metro markets that span the United States from East to West.

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The primary measure of a real estate market's health is frequently expressed in one number: the vacancy rate. A high vacancy rate is bad, while a low vacancy rate is good if you are an owner/investor in real estate. High and low, however, are relative terms and must be put into context. The context for a market vacancy rate is the equilibrium vacancy rate.

An equilibrium vacancy rate is the rate that produces no upward or downward pressure on rents. Since disequilibrium is manifested by rising or falling rents, it stands to reason that equilibrium should be characterized by stable rents. Comparing a market's actual vacancy rate with its longer term equilibrium vacancy rate provides an indication of future rent movements.

A few questions arise related to the notion of an equilibrium vacancy rate. Is it different for different property types? Is it different in different markets? Does it change over time? In this paper, we present evidence that the equilibrium rate is different for different markets and may also differ if measured over different time periods. In this regard, we find that equilibrium vacancy rates in recent cycles are similar to those discussed in the literature by Born and Pyhrr (1994) or Mueller (1999) and others, even though the recent cycle trough (2009–2010)

was characterized as one with much less oversupply than in previous cycles.

The purpose of this paper is twofold: (1) to re-visit the concept of equilibrium vacancy; and, (2) to propose a method of equilibrium vacancy rate measurement.

Market Equilibrium as Defined in the Literature

Considering its importance to real estate market analysis, the concept of market equilibrium is given relatively little attention in the literature. Generally, market equilibrium is referenced as simply the point where demand and supply are equal. Often it is treated as if the meaning were self-evident. For example, Fanning (2005, p. 256) identifies step five of the Six-Step Process as "Analyze Market Equilibrium or Disequilibrium" without defining either term.

The *Dictionary of Real Estate Appraisal* (2010, p. 121) defines market equilibrium this way: "The theoretical balance where demand and supply for a property, good, or service are equal. Over the long run, most markets move toward equilibrium, but a balance is seldom achieved for any period of time."

The above definition seems to dismiss the relationship as merely "theoretical" and existing only when supply and demand are "equal." If the word "equal" is taken literally, an equilibrium condition could be defined as a market without a vacancy. But this conflicts with the concept of frictional vacancy where there is accommodation for the turnover of occupants and time required for search, contracting, tenant retrofits, and moving. That frictional vacancy is a necessary condition, the friction actually representing the lubricant necessary for the market to work, may first have been identified by Hauser and Jaffe (1947, p. 3) when they pointed out that the "continuous turnover in housing occupancy necessitates a minimum number of vacant units which may be described as frictionally vacant units." Hauser and Jaffe had built upon the work of Hoyt (1933), who identified time cycles in the Chicago market.

The association of idle assets in a market with an equilibrium condition was also identified by Friedman (1968, p. 8) while pointing out that there is some level of natural unemployment that is "consistent with equilibrium in the structure of real wage rates." This equilibrium relationship was extended to the real estate rental market in 1974, when Smith (1974, p. 481) concluded that there is some level of vacancy that is associated with market equilibrium, "at which rents are in equilibrium."

Rosen and Smith (1983) showed empirically what was meant by rents being in equilibrium; the vacancy rate at which rent changes equal zero. This has been expressed in various ways but with the same meaning: the rate of vacancy that provides landlords with no incentive to adjust rents (Jud and Frew, 1990; Mueller, 1999; and others); the vacancy rate where effective demand is equal to effective supply (Clapp, 1993); and a market is in equilibrium when there is no tendency toward changes in prices or quantities (McDonald and McMillen, 2011).

Stable real rental rates are therefore a necessary condition of market equilibrium. If there is market disequilibrium due to excess supply, there will be downward pressure on rental rates, which stimulates demand for vacant space. If the disequilibrium is due to excess demand, there will be upward pressure on rental rates until the demand is diminished (via higher rents or additional delivered space). Since stable rental rates are the only indispensable condition associated with market equilibrium, market equilibrium can be defined as the relationship between demand and supply that produces stable real rental rates. This is not a theoretical condition and is certainly not a condition that is seldom achieved.

The Equilibrium Vacancy Rate Hypothesis

Much of the research on market equilibrium has been performed with the expressed goal of proving

something that appraisers and analysts generally take for granted: rental rates respond to vacancy rates (the change in rent is the dependent variable). The goal of such research was often expressed as a study of the "price-adjustment mechanism" i.e., what causes average rental rates to vary over time and across space? The consensus conclusion is that the rate of change in rents is partly determined by the deviation of short-run vacancy rates from their long-run or "normal" level, and partly due to market-wide inflationary/deflationary pressures. As more research has been completed, the role of vacancy has been generally accepted as the dominant influence on real rent change.

In short, the equilibrium vacancy rate hypothesis is that there must be a market vacancy rate where demand and supply are effectively equalized. As a corollary, the movement of rents in a market is inversely related to the vacancy rate of that market and movement away from equilibrium can produce either upward or downward pressure on rental rates.

Building Upon the Prior Models of Rents as Impacted by Vacancy Rates

With few exceptions, the scholarly literature provides empirical support for the existence of an equilibrium vacancy rate. The research has relied on historical vacancy rates linked to published rental rates. There is no known way to forecast an equilibrium vacancy rate; it must be inferred or extracted from the historical record.

Rosen and Smith (1983) had a goal to uncover the components of the rent-adjustment mechanism for a particular property type (in their case, rental housing). Based on the hypothesis that excess supply or excess demand determines the rate of change of rent, Rosen and Smith expressed the rent adjustment mechanism as a function of operating expenses and vacancy:

$$R_n = f(E, V_e - V), \tag{1}$$

where R_n is the rate of change of nominal rent, E is the rate of change of total operating expenses (intended to reflect the nominal price influences on R_n), V is the actual vacancy rate, and V_e is the equilibrium rate (which they called the *natural rate*). Assuming a constant equilibrium vacancy rate over the study period, the regression equation becomes:

$$R_n = b_0 - b_1 V + b_2 E. \tag{2}$$

Given that b_1 and b_2 are positive numbers, the equilibrium vacancy rate is determined by solving for V when R_n is zero. Although the practical application is limited, it is important to realize that the formula expresses the expectation that rent change in a market is a function of the interaction of multiple nominal price influences, plus the relationship of equilibrium vacancy with actual vacancy.

Virtually all subsequent studies used a rent change equation similar to (2). Wheaton and Torto (1988), however, simplified the equation by using real rent (as opposed to nominal rent) as the dependent variable, thereby (theoretically) eliminating the need to specifically include operating costs (on the theory that real rent would capture the inflationary/deflationary changes in operating costs). The resultant regression equation from this approach is as follows:

$$R_r = b_0 - b_1 V, \tag{3}$$

where R_r is the change in real rent. If R_r is zero, then the equilibrium vacancy rate is expressed by the following formula:

$$V_n = b_0 \div b_1. \tag{4}$$

Over the years, there have been at least 15 published studies where the equilibrium vacancy rate was estimated for different property types in many different communities and for many different time periods. The results range from 4.4% to 22.3%. All relied on historical data that were often up to a decade old. As the understanding of the cause of equilibrium vacancy advanced, morphing from direct landlord control to a pure market response, the results presumably became more accurate and more

credible through a refinement of methodology. Although the studies may differ in methodology, they all report that variations from the equilibrium vacancy rate are a primary cause of rent change; the degree of influence is the big difference among studies.

In summary, the scholarly research began with the goal of determining what combination of independent variables account for most changes in rent. As research evolved, the focus became how best to determine the vacancy rate that results in no change in rent. The typical derivation of the equilibrium vacancy rate has been to employ regression analysis. The evolution of the methodology has settled on formula (3), relating the change in real rent to the level of vacancy.

Additional Literature Reflecting on Equilibrium Vacancy

The earliest, and one of the few, references to an equilibrium vacancy rate in the market analysis literature is found in Clapp (1987, p. 78). Referred to as "normal" vacancy, it was defined as the long run average vacancy rate in the local market, adjusted "to reflect recent information on interest rates and expected demand growth."

Downs (1993, p. 161) did considerable research concerning the vacancy that impacts the housing and office markets. He recognized that the construction of new space was linked to an "equilibrium vacancy rate," stating that an imbalance due to oversupply "will cause a cessation of new construction projects." Glenn Mueller extended and commercialized such analysis in his Cycle Monitor, his widely disseminated cycle reports by property type and market.[1]

Fanning, Grissom, and Pearson (1994) provide three case studies and each one references a 5% *frictional* rate based on "the industry rule-of thumb." This rate is "employed in estimating proposed construction (i.e., justifiable building space) and in analyzing market equilibrium" (p. 241). By implication, it can be concluded that the 5% frictional vacancy rate was equated to the equilibrium vacancy rate. Fanning (2005) mirrors Fanning, Grissom, and Pearson (1994) in implying that a 5% frictional vacancy rate equates to the equilibrium vacancy rate.

Geltner, Miller, Clayton, and Eichholtz (2007, pp. 105–106) identify vacancy as an "equilibrium indicator." While acknowledging that "it is normal for some vacancy to exist," they make it clear that this normal vacancy is not necessarily related to an equilibrium condition. The equilibrium condition, instead, is associated with what they called the natural vacancy rate, "the vacancy rate that tends to prevail on average over the long run in the market, and which indicates that the market is approximately in balance between supply and demand." They also propose that the "natural vacancy rate is not the same for all markets" and that "the actual vacancy rate will tend to cycle over time around the natural rate."

The cycle concept may first have been associated with an equilibrium condition by Born and Pyhrr (1994). They defined market equilibrium as "that point in time when aggregate demand and supply forces are in balance...at the peak of the real estate cycle" (p. 465). They reinforced the Rosen and Smith (1983) observation that "the peak can be proxied by market occupancy rates" (p. 465). That is, the peak of the real estate cycle, as represented by occupancy, is the point where supply growth finally catches up to demand growth.[2]

Mueller (1995) refined the real estate market cycles theory by dividing it into a physical cycle (supply, demand, and occupancy of physical space) and a financial cycle (capital flows into real estate). Mueller (1999) further refined the theory by identifying four phases of the physical market: recovery, expansion, hyper-supply, and recession. These four phases are defined by relative occupancy as the market cycles in a nonsymmetrical manner around the long-term average occupancy (LTAO). As a consequence of the cycle, nominal rental growth rates vary according to the cycle phase, with the LTAO coinciding with a growth rate that approximates inflation. Mueller,

however, continued the recognition that the peak of the cycle represented equilibrium, while at the same time crediting the LTAO as the point where the growth rates of *real* rent reverses course.

In summary, there is general agreement on the need of vacant space for a commercial real estate market to operate efficiently. Beyond that, there appears to be little agreement on whether additional space is needed to produce an equilibrium condition.

Derivation of an Equilibrium Vacancy Rate

On a practical level, appraisers and market analysts should have the ability to extract an equilibrium vacancy rate from their local market for any property type. The proper use of inferential statistics will then permit extrapolation for predictive purposes. The question to be answered is how can this be done in a reliable manner with readily available information sources? Researchers have emphasized two main methods: (1) regression analysis using rent as a dependent variable; and (2) simply using the average vacancy rate over an extended time period. We employ both of these methods, and test a third intuitive approach: graphic interpretation of the movement of vacancy rates and rental rates.

We have chosen nine markets to study: three cities on the West Coast, three cities on the East Coast, and three cities in the central part of the United States. In all cases, the equilibrium vacancy rate of the city's Class A office space is the focus of analysis.

We use Costar data in our study.[3] Although none of the earlier research indicated a proper study period, we have tried to normalize the period covered over the cities tested, going back to no earlier than 1996 (depending on the availability of information) and going forward through the fourth quarter 2013. We note that the behavior of each market must include both periods of rent change and/or periods of rent stability. If there is no evident period of stability, then there must be periods of both upward and downward movement in rents. A time frame that does not produce a balanced sample of market behavior will produce misleading results. A summary of input data is presented in Exhibit 1.

Additional notes on the data:

- CoStar reports that the relevant definitions, including vacancy rate and direct average rent, have not changed over the study periods.
- Direct average rent is the asking "face" rent for all vacant space in the office buildings offered by the property landlord (sublets excluded). Not all buildings were reporting direct rents for every quarter.
- Occupied space that is offered for lease is excluded from vacancy consideration.

Ideally, net effective market rent would be tracked instead of asking face rents. However, reliable quantification of effective market rents over time is impractical. Asking face rents are used as a proxy in this research, but done so with the caution. Geltner, Miller, Clayton, and Eichholtz (2007, p. 106) identified the weakness of this approach. *Asking rents*, which may typically be reported in surveys of landlords, may differ from the *effective rents* actually being charged new tenants. The concept of effective rent includes the monetary effect of concessions and rent abatements that landlords may sometimes offer tenants to persuade them to sign a lease.

A market just turning downward from an equilibrium condition would likely first invoke concessions before actually having asking face rents decline; similarly, a recovering market just turning upward would likely shed the concessions before increasing asking face rents. Ultimately, if a condition persists, downward pressure will prevail in forcing face rents down and upward pressure will prevail in forcing face rents up, evidencing a movement around equilibrium. All previous research has also been hampered by these possibly off-setting limitations.

We use the input data to derive an equilibrium vacancy rate for Class A office space in the nine chosen

Exhibit 1 | Summary of Inputs

	Chicago	San Diego	Atlanta	Denver	Dallas	Charlotte	Boston	San Francisco	Seattle
	2Q:1996–4Q:2013	**2Q:1999–4Q:2013**	**1Q:1996–4Q:2013**	**4Q:1999–4Q:2013**	**1Q:1996–4Q:2013**	**1Q:2000–4Q:2013**	**1Q:1998–4Q:2013**	**1Q:1997–4Q:2013**	**1Q:2000–4Q:2013**
Initial Building #	353	109	211	65	135	95	117	113	56
Initial Total RBA	123,322,288	16,216,162	61,132,099	24,702,245	55,300,845	19,314,372	43,626,342	45,653,605	21,126,000
Initial Vacancy Rate	8.8%	7.8%	10.0%	7.1%	21.7%	4.8%	4.0%	3.3%	1.5%
Beginning Direct Aver. Rent/SF	$18.43	$25.49	$20.17	$23.67	$18.51	$21.34	$35.63	$24.92	$33.87
Ending Building #	558	254	499	99	179	186	147	142	119
Ending Total RBA	168,731,456	31,999,928	118,423,491	30,328,682	13,765,609	33,412,091	4,670,754	54,129,915	34,596,087
Ending Vacancy Rate	15.8%	10.7%	14.5%	12.5%	22.1%	11.6%	9.2%	7.8%	12.3%
Ending Direct Aver. Rent/SF	$25.92	$32.76	$22.36	$26.76	$23.04	$23.62	$46.27	$54.06	$34.08
Median Vacancy	15.8%	14.9%	15.6%	14.0%	20.2%	10.9%	9.3%	9.3%	9.1%
Graphic Interpretation	±15%	±17%	±15%	±13%	±18%	±10%	±8%	±10%	±8%
Regression									
Equilibrium Vacancy	15.9%	15.6%	15.8%	14.9%	21.8%	12.1%	9.1%	11.6%	10.7%
R^2	0.223	0.6127	0.1733	0.1804	0.0512	0.0531	0.1349	0.0679	0.038

markets by the three methods: regression analysis, long range average, and graphic interpretation.

Derivation 1: Regression of Rent and Vacancy Rate

In hopes of diminishing the effect of inflationary/deflationary pressure of operating expenses on market rent, real rents have been chosen for use as our first dependent variable in the regression model. This approach postulates that real, as opposed to nominal rent change, is a pure function of the deviation of the actual vacancy rate from the equilibrium vacancy rate. Nominal rents have been deflated by the Consumer Price Index (CPI) for each city.[4]

We use the Wheaton and Torto (1988) equation to test the relationship of real rents (dependent variable) with the market vacancy rate (independent variable), shown below:

$$R_r = b_0 - b_1 V, \tag{3}$$

where R_r is the change in real rents and V is the corresponding vacancy rate.

The equilibrium vacancy rate is the quotient of the estimated constant term (intercept) in the regression equation divided by the estimated independent variable coefficient:

$$V_e = b_0 \div b_1. \tag{4}$$

The regression of the quarterly observations of average real rent and the corresponding reported vacancy rate for each city produced the results in Exhibit 2.

For all cities, the intercept and variable coefficients are significant at the 5% level. The coefficients of determination (R^2) range from an unreliable 0.0147 (Seattle) to a fairly reliable 0.4435 (San Diego). In response to reviewer comments, several additional models were tested that included leads and some non-linear forms of independent variables. A sample of these results is shown in the Appendix for these nine plus two more markets. The Dallas and Boston markets perform better and are statistically significant with vacancy leads of one and two quarters, respectively. In summary, the results in Exhibit 2 show that some market rents respond more simultaneously to vacancy levels and trends while others respond on a lagged basis, that is, the vacancy rate leads the changes in rent levels. Some markets respond in linear fashion while a few respond on a non-linear basis (San Francisco, San Diego, and Chicago). We know that supply responses vary by market; some are more constrained than others or require longer time periods to get approvals and permits, so it should not be surprising to see different results. The conclusion is that each market should be studied independently and that generalizations from national aggregation levels should be avoided.

In theory, using real rent would ideally eliminate the influence of inflation/deflation on the movement of rental rates. This is predicated on the assumption that rental rates are noticeably affected by changes in the CPI. Since it is actually nominal rents that respond to contemporaneous changes in vacancy rates, we tested this relationship as well. We use a variation of the Wheaton and Torto (1988) equation to test the relationship of nominal rents (dependent variable) with the market vacancy rate (independent variable), shown below:

$$R_n = b_0 - b_1 V, \tag{5}$$

where R_n is the change in nominal rents and V is the corresponding vacancy rate. Exhibit 3 shows the results with nominal rents.

Again, for all cities, the intercept and variable coefficients are significant at the 5% level. The coefficients of determination (R^2) are consistently higher, as are the *t*-statistics, for both the intercept and the variable. It might be the case that the CPI is a poor measure of inflation and simply adds noise to the results.

Under both the real and nominal relationships, we tested lagged vacancy rates to determine if the market registered a delayed response to a vacancy rate.

Exhibit 2 | Real Rents

	Chicago	San Diego	Atlanta	Denver	Dallas	Charlotte	Boston	San Francisco	Seattle
	2:Q1996–4Q:2013	2Q:1999–4Q:2013	1Q:1996–4Q:2013	4Q:1999–4Q:2013	1Q:1996–4Q:2013	1Q:2000–4Q:2013	1Q:1998–4Q:2013	1Q:1997–4Q:2013	1Q:2000–4Q:2013
Regression Results									
Equilibrium Vacancy	14.5%	13.7%	12.5%	13.6%	18.7%	6.0%	8.2%	10.7%	4.8%
R^2	0.1994	0.4435	0.0754	0.1207	0.0261	0.0151	0.1294	0.0526	0.0147
Intercept Coeff.	0.0432	0.0416	0.0154	0.0477	0.0243	0.0043	0.0540	0.0449	0.0042
Variable Coeff.	−0.2970	−0.3038	−0.1225	−0.3494	−0.1297	−0.0723	−0.6561	−0.4214	−0.0885
Intercept *t*-Stat.	4.050	6.069	1.953	2.613	1.260	0.485	2.841	2.103	0.377
Variable *t*-Stat.	−4.115	−6.621	−2.371	−0.272	−1.360	−0.910	−3.042	−1.899	−0.888

Exhibit 3 | Nominal Rents

	Chicago	San Diego	Atlanta	Denver	Dallas	Charlotte	Boston	San Francisco	Seattle
	2Q:1996–4Q:2013	2Q:1999–4Q:2013	1Q:1996–4Q:2013	4Q:1999–4Q:2013	1Q:1996–4Q:2013	1Q:2000–4Q:2013	1Q:1998–4Q:2013	1Q:1997–4Q:2013	1Q:2000–4Q:2013
Regression Results									
Equilibrium Vacancy	15.9%	15.6%	15.8%	14.9%	21.8%	12.1%	9.1%	11.6%	10.7%
R^2	0.2230	0.6127	0.1733	0.1804	0.0512	0.0154	0.1349	0.0679	0.0382
Intercept Coeff.	0.0508	0.0574	0.0257	0.0477	0.0396	0.0175	0.0599	0.0568	0.0152
Variable Coeff.	−0.3193	−0.3688	−0.1633	−0.3494	−0.1821	−0.1440	−0.6587	−0.4870	−0.1422
Intercept *t*-Stat.	4.754	9.725	3.935	3.607	2.076	1.868	3.184	2.630	1.377
Variable *t*-Stat.	−4.418	−9.327	−3.803	−3.447	−1.929	−1.725	−3.085	−2.177	−1.447

This is based on the possibility that variations in vacancy rates may affect average rents with a lag. There is no standard lag period, but most studies have used six months, possibly because that was the periodic spacing of their data. We employed one- and two-quarter lags using formulas (3) and (5) modified, as shown below:

$$R_{r/n} = b_0 - b_1 V_{t-1}, \quad (6)$$

where V_{t-1} is the actual vacancy rate delayed by one period.

Using formula (6), we regressed the real and nominal rent for each city and determined that there were no significant changes in the results (equilibrium rent similar with no noticeable improvement in R^2s). We conclude that the results of regressing nominal rent with contemporaneous vacancy are at least as good as regressing real rent with contemporaneous vacancy, but we used real rent changes in the additional tests shown in the Appendix. Using changes in real rents results in lower R^2s.

Derivation 2: Long Run Average Vacancy Rates

In the long run average vacancy rate approach, we de-link the rental rate from the vacancy rate, and focus only on the vacancy rate. In order for this approach to produce credible results, the data set must demonstrate sufficient fluctuation [i.e., it must have time periods of down markets (increasing vacancy rates and declining rental rates) as well as up markets (decreasing vacancy rates and increasing rental rates)]. We calculated both the mean and the median over the study period for each city. The results are shown in Exhibit 4. The consistent similarity of

Exhibit 4 | Long Run Average Vacancy Rates

	Chicago	San Diego	Atlanta	Denver	Dallas	Charlotte	Boston	San Francisco	Seattle
	2Q:1996–4Q:2013	2Q:1999–4Q:2013	1Q:1996–4Q:2013	4Q:1999–4Q:2013	1Q:1996–4Q:2013	1Q:2000–4Q:2013	1Q:1998–4Q:2013	1Q:1997–4Q:2013	1Q:2000–4Q:2013
Average Vacancy	14.1%	14.2%	14.7%	13.8%	20.1%	10.8%	8.2%	8.8%	10.1%
Median Vacancy	15.8%	14.9%	15.6%	14.0%	20.2%	10.9%	9.3%	9.3%	9.1%

the median to the mean is interpreted as indicating that the samples approximate a symmetric distribution and that the data meet the fluctuation criteria.

Clapp (1987, p. 78) recommended that the average vacancy rate be "a reasonable starting point for estimating the normal [equilibrium] vacancy rate." He recommended adjusting the average to reflect recent information on interest rates and expected demand growth. This implies that the rate is not constant over time and that its applicability to the future could be affected by a change in market conditions not adequately represented in the data set. This might be the case if the survey period is as short as five or ten years (the time frame referenced by Clapp). In the present case, however, the extended time frame for each city included a wide range of demand influencing factors, including a range of interest rates and growth, and perhaps are representative of the modern market.

Derivation 3: Graphic Interpretation

In the graphic interpretation, the independent variable for each city is the observed quarters. There are two dependent variables: the average full service *real* rent per square foot and the actual *occupancy* rate. We used the occupancy rate in order to show the positive correlation between rent and occupancy. Representations of the results are shown in Exhibits 5A (Atlanta) and 5B (San Diego):

In the Atlanta market, we observe a range of occupancy rates that appear to trigger a response in real rents.[5] The rent response to occupancy may not be immediate and it may not be exact, but it appears to fall in the range of 85% to 92% occupancy. This indicates an equilibrium vacancy rate of about 16% for the Atlanta Class A office market. A similar interpretation of the San Diego market can be made, but with the range being from 84% to 90%, with equilibrium vacancy rate being about 14% for the San Diego Class A office market. This practical visual approach is probably a good starting point prior to any empirical analysis.

Summary of Derivation Results

The results of our analysis are summarized in Exhibit 6. The equilibrium rate indicators for each city are fairly similar for many markets but demonstrate enough variation that once again, it appears localized analysis is essential. On an individual city basis, each of our three tests confirms and reinforces the others. The mean vacancy rate for each city is very close to the regression results, both using nominal rent and real rent. However, the correlation is greatest with the nominal rental rate.[6] Graphic analysis generally supports the mean vacancy rate as a reliable indicator of a market's equilibrium vacancy rate, while providing visual confirmation. Geltner, Miller, Clayton, and Eichholtz (2007, p. 106) concluded that the regression process may not produce reliable results unless net effective rent is used, stating that "real [net effective] rents reflect the actual physical balance between supply and demand in the space market." By using the mean vacancy rate, this deficiency is eliminated.

Additional issues with the regression approach are its linear nature and the potential for serial correlation. Serial correlation occurs in time series studies when the errors associated with a given time period carry over into future time periods. This is most likely present in this test (as well as in all the previous scholarly work). The issue with regression is

Exhibit 5A | Atlanta Class A Offices

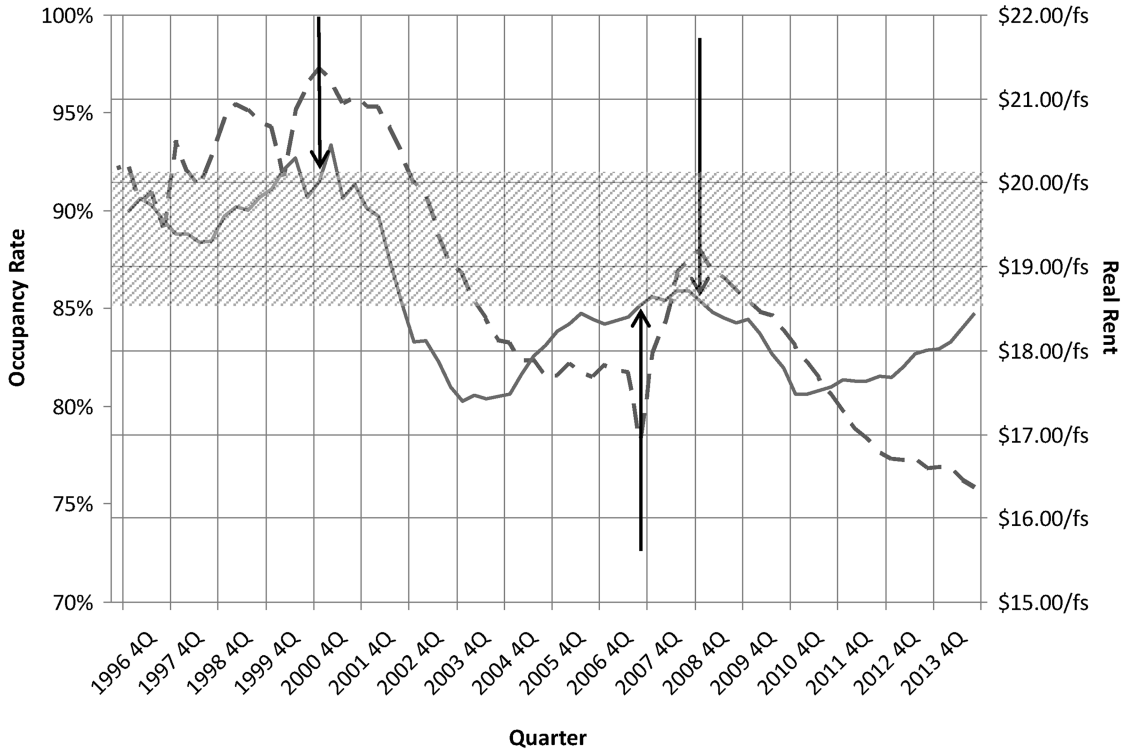

Exhibit 5B | San Diego Class A Offices

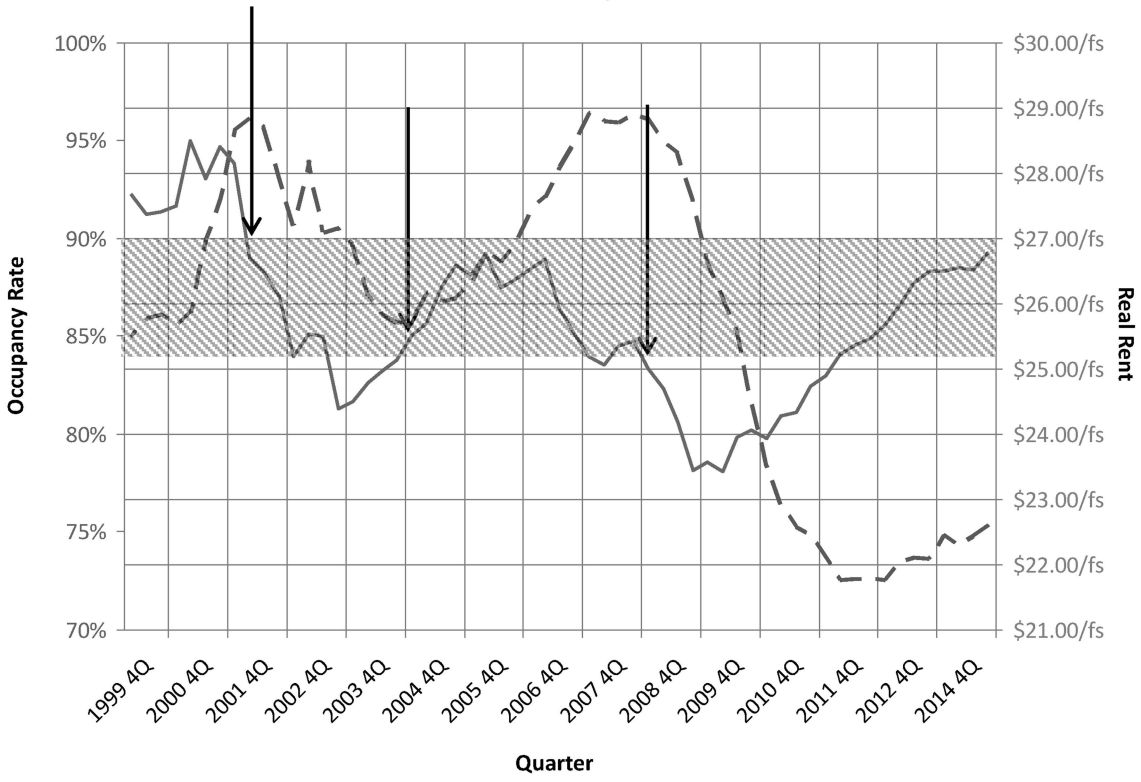

Exhibit 6 | Summary of Results

	Chicago	San Diego	Atlanta	Denver	Dallas	Charlotte	Boston	San Francisco	Seattle
	2Q:1996–4Q:2013	2Q:1999–4Q:2013	1Q:1996–4Q:2013	4Q:1999–4Q:2013	1Q:1996–4Q:2013	1Q:2000–4Q:2013	1Q:1998–4Q:2013	1Q:1997–4Q:2013	1Q:2000–4Q:2013
Average Vacancy	14.1%	14.2%	14.7%	13.8%	20.1%	10.8%	8.2%	8.8%	10.1%
Median Vacancy	15.8%	14.9%	15.6%	14.0%	20.2%	10.9%	9.3%	9.3%	9.1%
Graphic Interpretation-Real Rents	±15%	±8.6%	±14%	±13%	±18%	±10%	±8%	±10%	±8%
Regression Results-Nominal									
Equilibrium Vacancy	15.9%	15.6%	15.8%	14.9%	21.8%	12.1%	9.1%	11.6%	10.7%
R^2	0.2230	0.6127	0.1733	0.1804	0.0512	0.0154	0.1349	0.0679	0.0382
Regression Results-Real									
Equilibrium Vacancy	14.5%	13.7%	12.5%	13.6%	18.7%	6.0%	8.2%	10.7%	4.8%
R^2	0.1994	0.4435	0.0754	0.1207	0.0261	0.0151	0.1294	0.0526	0.0147

that it forces a linear relationship where we know a cyclical condition exists. We consider non-linear tests in the Appendix and in a few cities the results improved. We also considered fixed time effects, which capture the serial time correlation, and in most markets the models with fixed time effects worked best.

A major value of calculating the long run mean vacancy rate is that it implicitly recognizes the cyclical nature of any real estate market and is consistent with the rental growth theory (Mueller, 1999). In this theory, the long run average occupancy rate is the point of inflection, where the growth rate of real rents changes course. In the process of changing course, the rents inhabit (however briefly) an area of stability. Since our definition of equilibrium is based not on growth rates but just a change in direction of rents, by definition, this temporary stability signifies market equilibrium.

We conclude that the long run average (or *natural*) vacancy rate can be a reliable indicator of the equilibrium rate for any given market, as long as adequate fluctuation over an extended period has been experienced by the market.

Mueller (1999) observed that the market cycle was not symmetrical and that the response of rents was different if the market was above or below the long-term average vacancy. This suggests that while the historic mean vacancy rate can be calculated, forecasting rents requires an adjustment for current supply and demand characteristics. For example, if the mean is calculated at a time of peak occupancy (or vacancy), this would skew the average upward (or downward) and result in an equilibrium vacancy rate that maybe artificially high (or low).

Conclusion

The research reviewed in this paper is convincing that vacancy influences rental rates. Market observation, however, indicates that rental rates also influence vacancy. At a fundamental level, both rents and vacancy are responsive to economic demand for space. Demand absorbs vacant space to the point that rents are driven up, which stimulates new construction, which may drive average rents up (due to premium charged for new space) or down (due to an oversupply). This type of interrelationship can produce a small R^2, but one that is nonetheless significant (at the 5% level). While we know that the vacancy rate plays a significant role in rent changes, this role may become more prominent as the vacancy rate distances itself from the equilibrium level. The research could be skewed in this direction since the further away from equilibrium the vacancy rate gets, the less likely concessions are to mask minor changes in face rent.

Given that vacancy can and does significantly influence rent changes, and that stable rents are a characteristic of market equilibrium, it follows that there must be some level of vacancy—the equilibrium vacancy rate—that produces stable rents. Vacancy in excess of this rate will produce downward pressure on rents; vacancy of less than this rate will produce upward pressure on rents.

Our research utilized three methods of extracting an equilibrium vacancy rate on a representative sample of nine Class A office markets. We also tested some non-linear regression models on 11 markets. We conclude that an equilibrium rate is reliably and easily extracted from a market by simply determining the market's mean vacancy rate over an extended period of time. Although we agree that inflationary/deflationary pressure on rents can cause market-wide movement, this issue and others are avoided by relying on the mean vacancy rate for an indication of the market's equilibrium rate. Doing so, however, must recognize that the equilibrium rate is dynamic and asymmetrical. It is dynamic in that it is a moving target, shifting with each new vacancy rate. It is asymmetrical in that, even though it is an extension of the theory of real estate cycles, rents would be expected to respond differently to changes in vacancy depending on the relative relationship to the equilibrium rate.

The equilibrium vacancy rate hypothesis is not in conflict with the presence of frictional vacancy. Accepting frictional vacancy as a necessary component only changes the numbers, not the relationship. For example, if frictional vacancy is assumed to be 5%, then demand equaling supply becomes 95% occupancy. Because search, contracting, and moving costs cause some vacancy in every market, a portion of the vacancy of the equilibrium condition is most certainly associated with friction.

Knowledge of equilibrium vacancy is a valuable component of market analysis and valuation. Forecasting when a change in vacancy will actually produce a change in rent is critical to any cash flow prediction. We have demonstrated that just because the vacancy rate is moving does not mean rental rates will move. Instead, movement in rents is altered when the vacancy rate crosses the critically important equilibrium rate, and that this rate may in fact be a range.

Appendix
Sample Models

Metro	R^2	Chg in Vac −2 Qtrs Lead	Chg in Vac −1 Qtr Lead	Log Current Vac %	Total Current Vac %	Total Current Vac %^{2}	Constant (SEE)	Time Fixed Effects
Seattle	0.751	−0.173** (0.083)					0.0985 (0.0735)	Yes
San Francisco	0.193				−1.396*** (0.435)	0.0774*** (0.027)	5.326*** (1.468)	Yes
San Diego	0.573			−0.877*** (0.230)			2.256*** (0.544)	Yes
Portland	0.075				−0.0502** (0.025)		16.90 (30.95)	No
Denver	0.661	−0.0841* (0.067)					0.258** (0.113)	Yes
Dallas	0.544		−0.169*** (0.043)	−2.396 (1.528)			7.459 (4.757)	Yes
Washington DC	0.049				−0.440** (0.219)		2.388** (1.168)	No
Chicago	0.216			−0.887*** (0.257)			−14.88 (27.79)	No
Charlotte	0.301	−0.0668 (0.046)					0.0219 (0.066)	Yes
Boston	0.358	−0.274*** (0.086)					2.238*** (0.778)	No
Atlanta	0.218				−0.0355*** (0.012)		−0.0153* (0.049)	Yes

Notes: The table shows sample models of 30 variations tested for each metro based on the significance of independent variables and overall F-test of the model. The dependent variable is the change in real rent.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Endnotes

1. See Dividend Capital Research at http://www.dividendcapital.com/why-real-estate/market-cycle-reports/documents/Cycle_Monitor_12Q1_FINAL.pdf.
2. The trough of the cycle is not similarly credited with being a point where aggregate supply and demand forces are in balance "because the trough point is a time of oversupply ending and low demand growth turning positive" (Mueller, 1999).
3. The authors wish to express appreciation to CoStar for providing invaluable assistance in this research.
4. Charlotte is deflated at the regional level.
5. We also tested nominal rents and found a slightly tighter range but with similar, albeit not identical, results. For instance, using nominal rents for the Atlanta market produced a range of 86% to 88%, with the equilibrium rate about 88%; the San Diego market also produced a range of 83% to 88%, with an equilibrium rate of about 85%. Interestingly, in all cases the highest point of the range was experienced early in the study period, when inflation rates were generally higher.
6. The correlation coefficient for the nominal rent paired with the mean vacancy rate is 0.9994, while the coefficient for the real rent paired with the mean vacancy rate is 0.8072.

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