Search Frictions and Time to Lease Heterogeneity for Office Properties*

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Abstract

As the adage goes "leases are the engines of commercial real estate." Rental revenues generated from long-term leases are fundamental to value and a basic tenet of the cash flows generated by office property investment. This study provides a first view on the determinants of the time to lease. The results imply that factors that inhibit an owner's ability to lease property such as a longer lease term, properties that involve non-local owners, properties that are larger or are of a lower quality are associated with a longer time to lease. Thus, this study highlights the role of search and matching frictions on the time to lease.

Keywords: commercial office, investment returns, search frictions, time on market, vacancy.

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1 Introduction

Commercial office properties comprise a large portion of the nation's wealth (Slade, 2000), provide the working environment that allows businesses to operate efficiently (Clapp, 1993) and make up an important component of the urban landscape (Hough and Kratz, 1983). The most fundamental element of value to office properties is the cash flow generated by office rents. The long-term leases that govern these cash flows are, therefore, of primary importance. Commercial real estate vacancy spells and duration are key indicators of property efficiency, performance and stability. This relationship provides an opportunity for a detailed analysis examining the nuances of vacancy, extending the knowledge on the distinctions of natural and structural vacancy and shocks to equilibrium vacancy levels. An analysis of individual lease contracts allows for modeling elements of complexity and volatility that are, often unobservable, but ever present and consequential in commercial property markets. The objective of this article is to outline a conceptual framework of vacancy spells and duration in the commercial office market. The originality of the research rests in its utility as a ground-level examination of vacancy duration, or time to lease (TTL) for individual properties, as a function of lease characteristics, the nature of the structure and conditions of the market at the time the space is made available. Private and institutional investors, lenders, appraisers, urban planners and others have a vested interest in better understanding office property cash flow, and how the markets and idiosyncratic property characteristics influence the potential for securing tenants. The tandem shocks from the financial crisis, and COVID, have created a great deal of volatility, hampering the ability to accurately predict cash flows from rents. Couple this with the potential for a recession, or at least a correction, and there is value to enhancing the broader knowledge of modeling leasing activities.

There is an extensive literature examining equilibrium vacancy rates at the aggregate (Grenadier (1995), and Voith and Crone (1988) are notable examples). The studies focus on market level vacancy at the metropolitan level over time, due, in part, to the lack of large-scale, detailed data on leases. This study relies on a dataset of office lease contracts across the United States. The contract data runs from 2005 – 2020 encompassing, the financial crisis and the recovery. The lease data is married with information on the building housing the leased space. This provides valuable detail on the characteristics of the individual property. The study is not only unique in the detail of the data, additionally, the analysis drills down into the individual lease contracts to identify factors unique to the individual space and property under time varying market conditions. The prospect for gaining new knowledge on the factors that influence, or are linked to, the time to lease office space, (or the spell) leads to a better understanding of office cash flows.

We use a hazard model to gain insights on the factors that influence the time to lease. There is expansive literature exploring both time on market for the housing segment, and extensive work, more generally, on commercial office markets; however, this is the first such study that actually considers the determinants of TTL, or vacancy term, on such a granular level. The model comprises of lease-specific, counterparty and property details, and market conditions as factors. The empirical results highlight the role of search related frictions that inhibit an owner's ability to lease property and hence result in a prolonged time to lease. For instance, the results imply that leases that have a longer term, properties that involve non-local owners, properties that are larger or are of a lower quality are associated with a longer time to lease.

The next section synthesizes the literature on commercial leases that serves a guide in identifying important factors to consider in model design. The conceptual model provides the foundation for our empirical tests. The following section describes the data. The final two sections discuss the model results and how those results inform future inquisitions into the length of time office space is marketed for lease. Lastly, we present some concluding remarks.

2 Summary Literature on Office Markets

Although there is no prior research directly modeling the TTL for commercial office space, there is a well-developed literature on office markets, more generally. For the purposes of this analysis, research on office lease determinants can be practically allocated into property-specific and geospatial categories.[1] Property-specific research focuses on the price elasticity of rent as a

[1] A survey of the econometric and theoretical models of office markets is provided by McDonald (2002).

function of vacancy, temporal changes in the demand for space and the physical characteristics of the property. Hekman (1985), Shilling et al. (1987), Pollakowski et al. (1992), Hendershott (1996), Hendershott et al. (2002) all find an empirical connection between vacancy and rents in office markets. Frew and Jud (1988), Wheaton and Torto (1988) and Sivitanides (1997) also studied the impact of vacancy rates on office rents. Wheaton and Torto (1994) utilize office rent indices to document the persistence of a rent/vacancy relationship and Slade (2000) examines the variation in market participants' value of office space amenities during different periods in a market cycle.

Clapp (1980) identifies property age as a physical characteristic, along with other locational variables, as significant factors that influence the level of office rents. Additional research verifies the significance of property age, including that of Bollinger et al. (1998), and Slade (2000). In the early-1980s, Brennan et al. (1984) identify building size and locational characteristics within the CBD as key factors, and then Chuangdumrongsomsuk and Fuerst (2017) develop a model of rent determinants between suburban and CBD space. Hough and Kratz (1983), Vandell and Lane (1989), Doiron et al. (1992) and Robinson et al. (2017) investigated the impact of structural features on rent, and Colwell and Ebrahim (1997) provided a framework for determining the optimal design of an office building. Sivitanidou (1995) and Hui and Liang (2016) show that spatial amenities influence office rents. Glascock et al. (1990) analyzed office rents across different classes of buildings, while Shilton and Zaccaria (1994) provide evidence that office values are a function of building size. There is also an expanding literature on the impacts of "green" design amenities on rents (see Wiley et al. (2010), Eichholtz et al. (2010) and Devine and Kok (2015) for examples).

Research addressing geospatial issues focuses on the broader office market, the role of location within a market and spillover impacts from proximate properties. Colwell and Sirmans (1978), Colwell and Ebrahim (1997), and Savini and Aalbers (2016) have examined the structure of urban land prices, illustrating how rents vary depending on a property's distance to the city center. Archer and Smith (1994), find that downtown office properties play a significant role in local economies and that the future of the central business district as a core node in urban space did not appear to be ending soon (as of the early 1990s). Along this same line, Shilton and Stanley (1999) found a high concentration of Fortune 500 firms in the largest metropolitan cities, although technological changes suggest that firms could reduce costs by migrating away from high-cost city centers. Bollinger et al. (1998) and Albouy and Lue (2015) investigated how locational differences in wage rates, transportation rates and the concentration of support services affect the spatial variation in office rents, concluding that these items do contribute to an estimate of rental rates. More recently, Goodman and Smith (2021) examined how spillover effects from health service quality influenced medical office rents. They observed a link between the reputation for quality of care of the nearest hospital and the rent premium that tenants were willing to pay to be near high quality hospitals. Our work intersects multiple threads of the literature on office-property research. We consider how property, geospatial spillovers as well as economic factors influence the liquidity of available space, or the TTL.

3 Conceptual Model

The search process in office markets is similar to the residential real estate market in one important dimension; tenants, like home buyers, evaluate the space in terms of the utility that it provides for them and to their firm. Amenities and disamenities, in addition to market conditions, are capitalized into the willingness to pay, and likewise, to affect the marketability of the space. To provide a conceptual framework for the empirical analysis we rely on a model used in studies of professional firm location. Early versions of these models (Clapp (1980), and Bollinger et al. (1998)) indicate that the ability to meet face to face with suppliers and customers is an important factor in the location decision. Our adaptation assumes that professional firms, search the metropolitan area for the location that maximizes profit, given the set of amenities available at that location including prominence, proximity to additional services that are demanded by their clients and the ability of clients and or staff to access the location. As such, the tenant search process is governed by the following production function:

$$Q = f(OS, K, N, A, S, NQ) \tag{1}$$

where, Q = productive output of tenant firm; OS = office space; K = derived utility from depreciable capital either acquired or contracted; N = measure of labor input efficiency; A = client or staff access to location; S = contractual services facilitated by proximity to the client or other complementary service provider; and NQ = quality, or fit, of the building and neighborhood. Access is included as an input to represent the fact that many tenants either provide, or depend on services in unique combinations depending on the course of business the firm is engaged. Consideration for the access to contractual services reflects the potential for economies of scale and agglomeration benefits.

Similarly, our focus on time to lease is based on the notion that tenant profitability in a particular location is enhanced when the location of the space, and the building can enhance productive capacity. This can occur in a myriad of ways including; access to a skilled workforce, proximity to clients, access to modern telecommunications capacity and proximity to complementary services to name a few. Of course, a location with a high degree of utility for one potential tenant is likely to have a similar level of utility for others; ergo the space will be in high demand.

Labor enters the production function of potential tenants measured in efficiency units. Efficiency units increase as the distance between the space and complementary services decreases such that

$$N = a\bar{x}L, \tag{2}$$

where a represents efficiency, L is labor hours and $\bar{x}$ is the average distance to supporting entities and or infrastructure. Formulating labor in this manner captures the knowledge and technology exchange that come from both formal and informal interactions between employees of the tenant firm and, other firms and their clients either proximate or accessible due to the location. The concept that physical location and proximity influences labor productivity has a strong presence in the literature both theoretically (Glaeser, 1994) and empirically (Ciccone and Hall, 1996).

With equation (1) we can construct the cost and profit functions for office space as the following:

$$C = sOS(jNQ) + cK + eN + tuA + tvS \tag{3}$$

$$\pi = PQ - C \tag{4}$$

where, s represents the unit costs for office space, j is the anticipated premium for space with a high level of amenities or utility, and c the cost of capital services. P is the tenant profit for services provided e, the cost per unit of labor efficiency, t, travel costs, and u and v represent distance for customers and suppliers.

Assuming the demand for services and input prices vary spatially, there are unique demand equations for each of the variable inputs. The demand equation for space (OS), at location i is expressed as follows:

$$OS_i = f(s_i, j_i, c_i, e_i, t, u_i, v_i, w_i, x_i, R_i) \tag{5}$$

where w_i is the wage rate, x_i represents additional control variables in the demand for office space and R_i is expected revenue. It is hypothesized that the utility derived from a particular space enhances the earning potential of tenants and has the potential, all else equal, to enhance liquidity (i.e. reduce time to lease) for the space. This increased earning potential is capitalized into rents, which in the following models will be positioned as controls, and potential liquidity. We rely on the relationships from equations (1) through (5) to estimate models, explaining TTL, concentrating on the characteristics of the lease and the building while controlling for economic and market conditions at the time the space is offered.

4 Data and Variables

The principal data are drawn from commercial office lease contracts from CoStar, made available through an academic license agreement. CoStar is the largest and most detailed data source for commercial real estate transactions in the United States. According to the National Association of Real Estate Investment Trusts (NAREIT) eighty-three percent of commercial real estate transactions involve a CoStar subscriber, and 95 percent of the leading 1000 brokerage firms rely on CoStar data and support services. Among its many functions, CoStar serves as a commercial property listing service. As such, CoStar data provides superior detail when compared to alternative data providers by enhancing the data set with information outside the public domain such as marketing duration, sale conditions, detailed transaction information and proprietary measures (e.g., broker and seller/buyer). All properties in the CoStar database are assigned a unique "Property ID," that CoStar relies on to identify individual properties in the global database. This property ID is used to join the lease data with property transaction data from the global database of over 3.9 million transactions, and the enhanced property details contained in the recorded sales transactions.

The sample includes information on individual leases, spanning the period 2005 through 2020 across the United States. After eliminating observations for missing information such as the date the property was made available for lease, the number of days the property was vacant and available for lease, lack of transaction details, and the lease rate, the sample is reduced to roughly 58,000.[2]

Table 1 presents the names and summary statistics for the variables in the analysis. The dependent variable is based on a count of the number of days between the point in time when the space is listed for rent and the date the lease is signed *(time to lease or TTL)*. Each observation includes the date the property was made available for lease and the date a contract is executed with a tenant. The independent variables are divided into three groups

[2]There is potential for bias in the CoStar data with respect to the represented sample identified as office properties. For example, there are many configurations of occupancy that are included in the office category such as offices with warehouse space or living space in a mixed-use development. Where the information is available, leases that include space other than that originally constructed and reconfigured as professional office have been dropped.

– those specific to the lease, variables that distinguish the building, and control variables for the geography and market conditions at the time the space offering was initiated. *Building lease ratio* is the proportion of the building included in the observed lease contract. It serves as a pseudo proxy for relative importance of the lease, or tenant, to the fiscal health of the building, similar to the anchor versus ancillary tenant in retail facilities. A mean of 10 percent suggests the sample is comprised of many smaller scale leases. The *lease term* is the contracted length of the lease in months. The average is 3 years with the maximum around 8 years. It is anticipated that the longer-term leases will require more time to obtain a commitment. A countervailing view would see longer leases negotiated out of sight of the open market and the public listing for the space is just a matter of course. The data provides a coding for the service type, e.g gross, triple net and modified (derivations of net/modified). There is some potential for confounding results as the CoStar coding for modified, the dominant arrangement according to the data, includes many lease structures that appear to be just as reasonably represented as a derivation of net leases. These include different combinations of owner and tenant expense commitments. The variable *occupied* is a dichotomous variable coded 1 if the space is currently occupied at the time of listing. Intuitively, one might expect this to be positively related to time to lease (increase time) as the property manager has, rationally, chosen to advertise in advance of the current tenant vacating. At the same time there are a number of renewals in the data that may offset this expectation.

As previously noted, the variables representing building characteristics are obtained from joining sales transaction data with the lease data. The variable *Base Leased Space SF* averages approximately 3,500 and represents the leased space excluding the common area. CoStar applies a quality ranking to properties, referred to as a Star rating. The rating system involves a nationally standardized approach, complementing property classifications (e.g., A, B, C) that are commonly reported by listing brokers and rely on locally relative comparisons. The ranking is supported by in-depth investigations of properties, site visits, subjective ratings, quantitative analysis, and interviews of local market experts. 97 percent of the observations in this sample fall near the moderate ranking (+/- 3). Also included are variables representing the *size* of the building and land, the building class (A, B or C) and age. The median building size is roughly

59,000 square feet. The land area ranges from approximately 3,500 to 284,000 square feet. 55 percent of the buildings are classified as class B. The average age of the structures is 43 years, ranging from roughly 12 to 127. There is a categorical variable representing the location of the property owner, coded 1 if the owner address is in the same CBSA as the property. It is anticipated that local ownership will allow for enhanced ability to negotiate a greater or lesser set of incentives with the tenant. It is further anticipated that local owners are expected to have access to a larger pool of potential tenants thereby reducing the search. The dichotomous variable *CBD* is coded 1 if the property is positioned within the central business district of the metropolitan area and 0 otherwise. This variable is derived from the CoStar indicator for location within the metropolitan area, (urban, CBD, suburban). As might be expected, the distinctions between the three designations are not black and white; most certainly in the urban code where there are uncertainties exactly where the CBD ends, or the suburban area begins. The estimated *vacancy* rate by quarter is employed as a proxy for the conditions in the local market at the time the space is made available for lease.

5 Empirical Analysis and Results

5.1 Empirical Model

The distribution of the time to lease variable is heavily right skewed with many observations clustered at, or near, zero. A linear regression is likely to yield negative values for certain independent variables, but the time to lease can only take on values from 0 to ∞. We employ a proportional hazard model to facilitate an appropriate analysis. The proportional hazard model, originally introduced by Cox (1972), provides a particularly useful approach to analyze the duration of office space listing. Cox's regression is a semiparametric approach to survival analysis. The proportional hazard model is the most general of the regression models because no assumptions concerning the nature or shape of the underlying survival distribution are required. The model assumes that the underlying hazard rate (rather than survival time) is a function of the independent variables (covariates). The method does not require that a probability distribution be formally specified; however, in contrast to nonparametric methods, Cox's regression does use regression parameters in the same way as generalized linear models.

Following the literature, we specify the proportional hazard of ownership termination as:

$$h_i(x,t) = h_{0i}(t)exp^{X\beta}, \tag{6}$$

where $h_i(x,t)$ is the hazard function at time t for a lease offering with covariates x. $h_{0i}(t)$ is an unspecified baseline hazard — that proportion of the lease offerings that would be contracted even under completely stationary, homogeneous conditions. $exp^{X\beta}$ is the exponential function that specifies how the exogenous variables $(x_1, x_2, ...x_n)$ influence the $h_i(x,t)$. When analyzing ownership termination, $h_i(x,t)$ represent the likelihood of turnover at time t, given the exogenous factors $x_1, x_2, ...x_n$. The essential assumption of this specification is proportionality; that is, if $x_1, x_2, ...x_n$ make a lease contract more likely at one point in time over the listing period, they have an equiproportional effect at all points in time. It is also implicit in equation (6) that the effect of $x_1, x_2, ...x_n$ on termination is time-separable. Past attributes of the environment and expected future values are assumed not to have any effect on current termination rates.

Cox regression obtains maximum-likelihood estimates of the β parameters without, as noted above, the necessity of specifying the baseline hazard function, $h_{0i}(t)$. The proportional hazard model evaluates the probability of lease contract, conditional on listing of the space to that point in time. Therefore, the model not only evaluates the determinants of leasing at the time of offer, but also analyzes the response of the market over the entire event history of the listing.

One implementation condition of the Cox model is continuous observation of the events over the observation period. This condition is typically not met by economic data, which are most often gathered periodically in discrete time intervals. Thus, an augmentation of the model, similar to that employed by Deng et al. (2003), is required. The lease observations utilized in this analysis include the day the space is offered for lease and the contract date, thus; the data accommodates the requirement for continuity.

Another well-recognized problem in estimating hazard functions is right censoring, which occurs if the duration continues past the time window for the observed data. A second concern present in duration data is the possibility of left censoring, which occurs when the lease offering is initiated prior to the time window of the sample. Concerns regarding left censoring of sample data have been well documented in the labor economics literature. In both instances the threat are not present in the data for this analysis as the sample is restricted to space listings that that are eventually contracted.

5.2 Empirical Results

Table 2 presents the estimated results of the hazard model. Column (1) presents the results where lease specific factors are included as explanatory variables. Lease month-year and city fixed effects are included as controls.[3] In the hazard model specification, a negative coefficient implies a lower hazard and hence a longer time on market for the completion of a lease contract. The coefficient for *Building Lease Ratio* is positive and statistically significant and implies that higher building lease ratios are associated with a shorter time on market. The coefficient of *Lease term* is negative and statistically significant implying that leases with a longer term are associated with a longer time on market. An interpretation may be that search related frictions result in a longer time to identify matches that accept a longer lease term. The coefficients for *Triple Net Lease* and *Gross Lease* are negative and statistically significant. The simple interpretation of the coefficients is that leases that have a triple net or gross rent structure are associated with a shorter time to lease completion. Of course, that is confounding and is not particularly informative. Gross/triple net leases account for only 8 and 17 percent, respectively, of the sample. Thus, there is significant loss in information in the inability to tease out the various structures of net and modified leases.

Column (2) presents the hazard model results where a binary variable that indicates if the the owner is "local", i.e. is in the state of the property's location, is included as an explanatory variable. The coefficient for *Local Owner* is positive and statistically significant suggesting that local presence is negatively associated with time on market. Intuitively, this may imply that

[3] Lease month-year refers to the date on which the space was offered for lease.

a local presence mitigates frictions that translate into quicker lease contract completions. The coefficient for *Occupied* is positive and statistically significant. Properties that have a current lease holder occupying the property have a shorter time to lease completion. This may be counter-intuitive as occupancy presents frictions in the search process. Although it could be similar to a reference mentioned earlier. Property managers typically approach tenants in advance, and proximate to the end of the lease term, to determine the likelihood of intent to vacate or renew. This information allows for managers to start marketing early without actually listing the property publicly.

Column (3) is restricted to property specific variables. The coefficients suggest that larger properties (leased space and land area) are associated with a lower hazard for lease contract completion and hence a longer time on the market. The coefficient of the squared terms are positive and suggest that the degree of variable influence effect is declining as size increases. Likewise, older properties are associated with a lower hazard; however, this effect is less pronounced as the age increases. Properties that are rated higher in terms of star rating or building condition are associated with a longer time on the market. Lastly, Column (4) includes all the explanatory variables from Columns (1) to (3) simultaneously and we see similar results as before with the exception of the coefficient for *Occupied*. In the specification with an array of control variables, the coefficient of *Occupied* is negative and statistically significant.[4]

The empirical results can be interpreted in the context of search related frictions. Search frictions in the commercial market may inhibit an owner's ability to lease property and hence

[4]To examine the robustness of the findings, Table A.1 in the Appendix presents the hazard model estimates across temporal subsets of the data. In this case we separate the data at a height of the financial crisis and just before the commercial real estate market recovery begins. Column (1) presents the results based on data from the 2005 to 2010 period, whereas Column (2) presents the results based on data from the 2011 to 2020 period. There is a material loss in significance in the variables with this division, which limits the confidence in making direct coefficient comparisons. Instead, the comparison will focus on the sign and significance where appropriate. For example, the variable *Gross Lease* is significant at the 99 percentile for both segments. However, it is positive in the subset of lease listings prior to 2011, and negative after 2010. All prior models where the *Gross Lease* is positive it has a negative sign suggesting a reduction in the hazard (longer time to lease). Interestingly, the *Age* and Age^2 variable are significant with signs as expected, but that significance is not present in the post 2010 model. In a similar vein the only class and star variable that is significant is the *class C* designation for the post 2010 subset. That result is consistent with the global dataset and given all the significant variables are the same sign in the post 2010 segment the smaller sub-sample of observations pre-2011 is either plagued with a small sample size, or there were a host of unobserved factors impacting the leasing hazard. Next, Table A.2 in the appendix presents the estimates of the hazard model that includes price per square foot as a control variable to account for concerns relating to heterogeneity in property quality. The overall inference remains unchanged.

result in a prolonged time to lease. The median time to lease as indicated in Table 1 is 1.25 years, thus potentially signifying a search and matching process that comprises of significant frictions. The hazard model results can be interpreted to highlight the role of such frictions. For instance, leases that have a longer term are associated with a longer time to lease. There may be greater transaction costs in finding tenants that select into contracts requiring a longer financial commitment. Next, an owner's local presence is associated with a shorter time to lease. One interpretation may be that local owners have an informational advantage that facilitates the search process and translates to a shorter time to lease. Larger properties are associated with a longer time to lease. This may be due to a smaller demand set of tenants that have liquidity to rent large properties. The results imply that lower class properties are associated with a longer time to lease. Search frictions may be greater for properties that are of a lower quality.

6 Effect of Market Conditions

In Table 3 we examine the effects of market conditions on the time on market. Column (1) presents the hazard model estimates for the market vacancy rate at the time of the lease along with interactions with the lease term, as explanatory variables. The coefficient for *Vacancy Rate* is negative and statistically significant. This makes sense, and implies that higher market vacancy rates are associated with a lower hazard and a longer time on market. The coefficient for the interaction between *Vacancy Rate* and *Lease term* is positive and statistically significant, suggesting that the negative effect of market vacancy rates is less pronounced for leases that have a longer term. It may be the case that longer lease terms help mitigate search frictions in down markets. This relationship could also be driven by potential tenants negotiating to lock in long term contracts in down markets.

Column (2) presents the hazard model estimates that includes an interaction between the market vacancy rate at the time of the lease and *Local Owner*. The coefficient for the stand alone variable *Vacancy Rate* is still negative and significant, but is materially smaller. However, the coefficient for the interaction between *Vacancy Rate* and *Local Owner* is negative and statistically significant potentially implying that local owners are more willing to wait for a match for a longer time in down markets. The balance of coefficients on the independent variables are consistent with column (1). It is important to note that the inclusion of *Vacancy Rate* in our models renders the ratings and class ranks insignificant, save for the class C variable. This result suggests that a high vacancy rate creates an environment where securing tenants is challenging regardless of the quality of the property. Except, in the case of the lowest quality properties in the market (class C) and the tenant search challenge is enhanced.

7 Conclusion

This study provides a first view on the determinants of the time to lease for commercial property. The modeling in this analysis considers how elements of the lease, the characteristics of the property and conditions in the market influence the time it takes to secure the lease contract. The results imply that leases that have a longer term, properties that involve non-local owners, properties that are larger or are of a lower quality are associated with a longer time to lease. These factors can be viewed in the context of search related frictions that inhibit an owner's ability to lease property. Hence, this study highlights the role of search and matching frictions on the time to lease in the commercial real estate market.

Tenants choose locations based on the amenity set available in that particular location and how well it complements their business model. Those amenities/disamenities that serve their business interest are capitalized into the space in determining a willingness to pay. The results from the models contained in this article are generally consistent with office market priors. Larger spaces that are in of lower quality tend to take longer to secure a tenant. Age too, increases the time on market as well as the presence of an existing tenant. The modeling did uncover inconsistencies that represent opportunities for future exploration.

One of the most important of these lays in the reality that there is likely significantly more information contained in metropolitan level variations than can be represented in a fixed effect control. Modeling the data on a multilevel structure will allow for variations in both the intercept and the sloped across metropolitan areas. Additional controls for local market conditions will also enhance the results. These include rental rates in the "neighborhood" of the observation as well as absorption and construction activity in the larger markets. Although preliminary, the analysis contained in this article is an important first step in creating models of leasing activity that can be applied to a number of property types and in a more localized manner within and across markets.

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Table 1: Summary Statistics

	N	Mean	P1	P50	P99	SD
Time to Lease	57,816	696.96	0.00	456.00	3,013.00	705.51
Building Lease Ratio	57,816	0.10	0.00	0.03	1.00	0.23
Lease Term (months)	57,816	35.46	6.00	36.00	96.00	20.31
Gross Lease	57,816	0.08	0.00	0.00	1.00	0.27
Triple Net Lease	57,816	0.17	0.00	0.00	1.00	0.37
Local Owner	57,816	0.42	0.00	0.00	1.00	0.49
Occupied	57,816	0.36	0.00	0.00	1.00	0.48
Base Leased Space SF	57,816	3,473.81	150.00	1,894.00	25,637.00	6,574.28
Land Area SF	57,816	135340.72	3,484.00	77,536.00	779723.00	283864.89
Size	57,816	135202.34	1,682.00	58,693.50	1.23e+06	221984.34
Age	57,816	43.06	12.00	38.00	127.00	24.96
Class A	57,816	0.30	0.00	0.00	1.00	0.46
Class B	57,816	0.55	0.00	1.00	1.00	0.50
Class C	57,816	0.15	0.00	0.00	1.00	0.36
1 Star	57,816	0.01	0.00	0.00	0.00	0.07
2 Star	57,816	0.27	0.00	0.00	1.00	0.44
3 Star	57,816	0.44	0.00	0.00	1.00	0.50
4 Star	57,816	0.26	0.00	0.00	1.00	0.44
5 Star	57,816	0.02	0.00	0.00	1.00	0.14
CBD	57,816	0.17	0.00	0.00	1.00	0.38
Vacancy Rate	50,160	0.12	0.05	0.12	0.20	0.03

This table presents summary statistics for the variables including mean standard deviation and relative percentiles.

Table 2: Modeling Lease Hazard

	(1)	(2)	(3)	(4)
Building Lease Ratio	0.2472***			-0.0935***
	(0.0209)			(0.0328)
Lease Term (months)	-0.0066***			-0.0040***
	(0.0002)			(0.0002)
Gross Lease	-0.1073***			-0.0813***
	(0.0238)			(0.0241)
Triple Net Lease	-0.0818***			-0.0675***
	(0.0136)			(0.0137)
Local Owner		0.1974***		0.0667***
		(0.0102)		(0.0112)
Occupied		0.0348***		-0.0554***
		(0.0102)		(0.0109)
ln(Base Leased Space SF)			-0.5530***	-0.5219***
			(0.0444)	(0.0447)
ln(Base Leased Space SF)^2			0.0288***	0.0286***
			(0.0028)	(0.0029)
ln(Land Area SF)			-0.1851***	-0.1877***
			(0.0551)	(0.0554)
ln(Land Area SF)^2			0.0061**	0.0064**
			(0.0025)	(0.0025)
ln(Size)			-0.4168***	-0.5312***
			(0.0454)	(0.0538)
ln(Size)^2			0.0145***	0.0197***
			(0.0021)	(0.0024)
Age			-0.0006	-0.0015**
			(0.0007)	(0.0007)
Age × Age			0.0000	0.0000**
			(0.0000)	(0.0000)
2 Star			-0.0729	-0.0803
			(0.0668)	(0.0673)
3 Star			-0.1120*	-0.1241*
			(0.0679)	(0.0684)
4 Star			-0.0485	-0.0600
			(0.0698)	(0.0703)
5 Star			-0.0255	-0.0384
			(0.0800)	(0.0802)
B			-0.0076	-0.0165
			(0.0156)	(0.0157)
C			-0.0499**	-0.0716***
			(0.0226)	(0.0227)
Lease Month-Year f.e.	Yes	Yes	Yes	Yes
City f.e.	Yes	Yes	Yes	Yes
Log pseudolikelihood	-5.74e+05	-5.74e+05	-5.73e+05	-5.73e+05
N	57,816.00	57,816.00	57,816.00	57,816.00

This table presents the hazard model estimates. Standard errors are indicated in parentheses. ***, ** and * indicate significance at the 1, 5 and 10 % level respectively.

Table 3: Modeling Lease Hazard - Effect of Market Conditions

	(1)	(2)
Building Lease Ratio	-0.0885**	-0.0824**
	(0.0351)	(0.0356)
Lease Term (months)	-0.0208***	-0.0035***
	(0.0011)	(0.0003)
Vacancy Rate	-6.2893***	-0.6728**
	(0.4543)	(0.3413)
Lease Term (months) × Vacancy Rate	0.1416***	
	(0.0087)	
Gross Lease	-0.0736***	-0.0689**
	(0.0284)	(0.0282)
Triple Net Lease	-0.0698***	-0.0711***
	(0.0144)	(0.0145)
Local Owner	0.0551***	0.3569***
	(0.0120)	(0.0470)
Local Owner × Vacancy Rate		-2.4682***
		(0.3661)
Occupied	-0.0592***	-0.0608***
	(0.0117)	(0.0117)
ln(Base Leased Space SF)	-0.5352***	-0.5464***
	(0.0490)	(0.0487)
ln(Base Leased Space SF)^2	0.0297***	0.0304***
	(0.0032)	(0.0031)
ln(Land Area SF)	-0.2024***	-0.2353***
	(0.0609)	(0.0610)
ln(Land Area SF)^2	0.0070***	0.0084***
	(0.0027)	(0.0027)
ln(Size)	-0.5388***	-0.5163***
	(0.0601)	(0.0609)
ln(Size)^2	0.0196***	0.0186***
	(0.0027)	(0.0027)
Age	-0.0015**	-0.0017**
	(0.0008)	(0.0008)
Age × Age	0.0000**	0.0000**
	(0.0000)	(0.0000)
2 Star	-0.0313	-0.0397
	(0.0765)	(0.0764)
3 Star	-0.0697	-0.0770
	(0.0777)	(0.0776)
4 Star	-0.0121	-0.0167
	(0.0799)	(0.0797)
5 Star	0.0400	0.0364
	(0.0893)	(0.0894)
B	-0.0157	-0.0143
	(0.0168)	(0.0169)
C	-0.0515**	-0.0502**
	(0.0241)	(0.0242)
Lease Month-Year f.e.	Yes	Yes
City f.e.	Yes	Yes
Log pseudolikelihood	-4.90e+05	-4.90e+05
N	50,160.00	50,160.00

This table presents the hazard model estimates. Standard errors are indicated in parentheses. ***, ** and * indicate significance at the 1, 5 and 10 % level respectively.

Table A.1: Modeling Lease Hazard - Across Time Periods

	(1) 2010 and earlier	(2) After 2010
Building Lease Ratio	-0.0681	-0.0981***
	(0.0713)	(0.0381)
Lease Term (months)	-0.0055***	-0.0040***
	(0.0006)	(0.0003)
Gross Lease	0.2130***	-0.1117***
	(0.0752)	(0.0258)
Triple Net Lease	-0.0880*	-0.0685***
	(0.0482)	(0.0147)
Local Owner	0.0329	0.0751***
	(0.0368)	(0.0121)
Occupied	-0.0824**	-0.0566***
	(0.0395)	(0.0115)
ln(Base Leased Space SF)	-0.4542***	-0.5282***
	(0.1264)	(0.0497)
ln(Base Leased Space SF)^2	0.0252***	0.0288***
	(0.0080)	(0.0032)
ln(Land Area SF)	-0.3385*	-0.1656***
	(0.1822)	(0.0596)
ln(Land Area SF)^2	0.0133	0.0053**
	(0.0083)	(0.0027)
ln(Size)	-0.3983***	-0.5528***
	(0.1451)	(0.0601)
ln(Size)^2	0.0141**	0.0206***
	(0.0067)	(0.0027)
Age	-0.0072***	-0.0009
	(0.0022)	(0.0008)
Age $\times$ Age	0.0000***	0.0000*
	(0.0000)	(0.0000)
2 Star	-0.0473	-0.0892
	(0.1751)	(0.0752)
3 Star	-0.1216	-0.1234
	(0.1781)	(0.0763)
4 Star	-0.1414	-0.0549
	(0.1835)	(0.0783)
5 Star	0.0625	-0.0517
	(0.2152)	(0.0890)
B	0.0061	-0.0245
	(0.0541)	(0.0167)
C	0.0154	-0.0863***
	(0.0814)	(0.0242)
Lease Month-Year f.e.	Yes	Yes
City f.e.	Yes	Yes
Log pseudolikelihood	-52524.74	-4.99e+05
N	6,801.00	51,015.00

This table presents the hazard model estimates. Standard errors are indicated in parentheses. ***, ** and * indicate significance at the 1, 5 and 10 % level respectively.

Table A.2: Modeling Lease Hazard - Controlling for Price Per SF

	(1)
Building Lease Ratio	-0.0947***
	(0.0328)
Lease Term (months)	-0.0040***
	(0.0002)
Gross Lease	-0.0813***
	(0.0241)
Triple Net Lease	-0.0675***
	(0.0137)
Local Owner	0.0668***
	(0.0112)
Occupied	-0.0554***
	(0.0109)
ln(Base Leased Space SF)	-0.5220***
	(0.0447)
ln(Base Leased Space SF)^2	0.0286***
	(0.0029)
ln(Land Area SF)	-0.1882***
	(0.0554)
ln(Land Area SF)^2	0.0064***
	(0.0025)
ln(Size)	-0.5321***
	(0.0539)
ln(Size)^2	0.0198***
	(0.0024)
Age	-0.0015**
	(0.0007)
Age $\times$ Age	0.0000**
	(0.0000)
2 Star	-0.0804
	(0.0673)
3 Star	-0.1244*
	(0.0684)
4 Star	-0.0607
	(0.0704)
5 Star	-0.0409
	(0.0804)
B	-0.0162
	(0.0157)
C	-0.0712***
	(0.0228)
Price Per SF	0.0000
	(0.0000)
Lease Month-Year f.e.	Yes
City f.e.	Yes
Log pseudolikelihood	-5.73e+05
N	57,815.00

This table presents the hazard model estimates. Standard errors are indicated in parentheses. ***, ** and * indicate significance at the 1, 5 and 10 % level respectively.