Workplace Trends in Office Space: Implications for Future Office Demand

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Abstract

Purpose - This study examines the trends in space per office worker and the influence of a number of factors on the ability to reduce space per worker. These trends are important in that they impact future office demand along with property values.

Methodology – Using both survey ane empirical data a simulation model is used to examine the impact on space per worker over the course of a typical lease. Factors considered include the length of lease, the worker growth rate of the firm, turnover and time to fill positions, the type of organizational management hierarchy, whether dedicated or non-dedicated space is utilized and firm policies towards working out of the traditional office.

Findings - Space per worker will continue to decline over time, yet collaborative work environments and the effects of traditional management and cultural momentum suggest that downsizing will take time. Counter to the initial hypothesis growing tenants do not over-consume space in the early years but rather tend to renegotiate leases when growth spurs the need for more space.

Practical Implications – Forecasters of office space demand must input an estimate of the growth in professional employment and then apply a space per worker assumption. This assumption in most markets will be declining, by as much as 30% over several years. Washington DC is already being affected by downsizing, yet most markets with reasonably good economic growth will be able to offset most of this transition to more intensively used space.

Originality/Value – This is the first paper to try and reconcile the views of commercial real estate owners and operators with those of corporate space planners, who both have opposite sides of the same lease. It is also the first to point out the explicit reasons why downsizing efforts are sometimes not as effective as expected.

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Keywords: Workplace trends, Space-per-worker, Office demand, Space planning, Shadow space, Worker churn, Space efficiency, Future office demand

I. Introduction and Background

Office space demand estimation is an important topic. In the US alone office inventory represents over 12 billion square feet (111 million square meters) of space and $1.6 trillion U.S. dollars in value. (Florance, et al 2010) Office space demand is driven by professional employment trends and is especially sensitive to space requirement assumptions. Other factors beyond the number of employees influence space demand including, but not limited to, workspace utilization levels, relative rent levels and cycles, tenant type, occupant employee turnover, firm growth rates and culture. In many office demand models we simply assume 150, 200 or 250 square feet of space per worker without any solid evidence for such an assumption other than sketchy data and conventional wisdom.

If you ask a corporate real estate manager or a human resources manager they may tell you the target for their firm is 100 square feet per worker (9.29 square meters) or even less. The US Government Services Administration (GSA) has been able to reduce space per worker at its Washington DC offices to less than 85 square feet per worker. We already witness much lower figures in Asia and the more expensive European markets than in the US. Firms that have embraced shared standardized space not dedicated by rank, and not dedicated to specific employees, using shared digital cloud style file storage systems are, in fact, able to get by with much less space per employee. However, these low targets per worker are only possible when the firm is able to match its leased space with a predictable number of employees spending a predictable amount of time in the office. Firms that are growing or shrinking or experiencing significant turnover struggle with matching fixed leased space with current needs. In fact, one reason US space per worker figures are so high is because so many firms don't last more than several years. They go out of business, split into multiple units, merge with other firms and this business survival turmoil adds greatly to the space per worker results as leases hold firms to space than no longer matches their needs. These points will be demonstrated using a simple simulation model.

The estimate of office-using employment growth rate is no more or less critical an assumption for office demand estimation than the space required per worker and at the same time, the disparity of assumptions we observe in the market is baffling. More refined office demand models will use space per worker by industry sector with a forecast of the growth by each sector for each geographic market. Often the planning decisions boil down to a reasonable guess on the space requirement per worker and how important it is for everyone to have space. Some firms will allow employees to work at home, libraries, coffee shops and locations known as "third work places" when they run into 100% utilization rates. Other firms will rent temporary space for overflow demand. These issues will be addressed in more depth later in the paper. One minor but significant reason we find a discrepancy in the amount of space assumed to be required per person is because of terminology, as generated and used differently in the worlds of space managers and asset managers, but this only explains about 16% of the difference. For example, IFMA, the International Facility Management Association focuses more on usable

space, and netting out encroachments, would calculate the average RBA, rentable building area, as 84 percent usable. Thus, what a developer may call 200 square feet per worker using RBA is only 168 square feet per worker of useable space to a facility manager.

Below is a discussion on US national office space per worker trends compared by various geographic and industry metrics as additional background.

Space Per Worker Trend Evidence

If we only look at the square feet per worker on **new** leases where the tenant moved in within the last 90 days, we see a US national average in late-2013 of 183 square feet. This figure is far below the historical US figures running well above 250 square feet per worker on average for the last few decades, according to CoStar data. (The CoStar Group includes data on all major markets in the US and uses a staff of some 1500 employees to verify and track data on many attributes of leases and buildings.) Newer modern buildings allow more efficient use of space, especially when built-to-suit for a particular tenant. As the lease ages, the amount of space leased and the number of workers in the space generally changes with the result that the space per worker climbs. As second generation tenants replace the first generation tenants, it is often more difficult to use the space as efficiently, and this is the case for most smaller firms who cannot, on their own, drive new supply in the market. Some firms grow and some shrink and some are able to negotiate expansions more easily than contractions, especially in soft markets.

As of late 2013, on leases close to expiration the average space per worker is often double the estimate for new leases, well in excess of 300 square feet per worker. Newer firms and start-ups squeeze more people into the same space while older firms can't downsize until leases expire. This might help to explain why the average square feet per worker shown in Figure 1 is so much higher than the figures suggested by corporate real estate executives or facilities managers. Figure 1 is based on RBA, rentable building area, and not the usable space that is used by the corporate real estate world. Still, when we do not discriminate by when the lease was signed, and simply look at how much space the average tenant occupies, the figures are quite large compared to stated goals.

In soft economies we would expect a fair amount of shadow space. Shadow space is leased but not occupied. Since labor costs matter much more than occupancy costs, by a factor of approximately 10 to 15, most tenants are able to honor their leases until the leases expire and pay for more space than they actually need. The extra space also provides a convenient option to expand and hire more workers without the need to move. So we should expect to observe significant extra space in weaker economies, when rents seem to be bargains, and we do. When space per worker trends are climbing it usually suggests that tenants have not had the chance to downsize yet and are awaiting either the expiration of the lease or simply riding out the weak economy with extra space.

Figure 2 is a sample of averages pulled from mid-2013 from a sample of various cities. Note that while we see more space per worker in the larger cities like New York and Boston, these markets also have more shadow space, as of the point of the survey, compared to smaller markets. One other bias in the square foot per worker data is that in the larger cities where we observe retail space on the ground floors, this space is classified by CoStar as "office" and not retail space, so that there is a slight upward bias in the measurement, especially in large dense cities. Certainly this is insignificant for the nation as a whole, but for cities like New York, San Francisco and Boston it may mean as much as a 5% upward bias helping to explain why in Figure 2 we see larger numbers than might be expected. Only Honolulu in this survey is close to 200 square feet per worker as of mid 2013, and Honolulu is an extremely supply-constrained market. We also know that in the very expensive markets of London and Hong Kong the average space per worker is on average much smaller than the figures shown here, so we should not presume that larger, more expensive cities always require more space per worker. Mark Hickey and Aaron Jodka, Senior Economists from PPR (Property Portfolio Research, a division of CoStar) suggest that "we observe more high-paid jobs in markets like New York and Boston compared to smaller cities and so the space allocated per person is larger while back-office people work in cheaper areas." Figure 3 provides a rough global comparison of space per worker; we note that the Japanese and Chinese occupy much smaller footprints per person on average, reflecting perhaps both costs and culture. Although this data is somewhat out of date, it still reflects stark differences in the space per worker which likely remain.

Certainly shadow space provides much of the explanation for the run-ups in 2008-10. If you assume a conservatively high figure of 250 square feet is required per worker, far higher than any industry model would suggest, you would still estimate that the average firm had one-fifth of its space as excess shadow space remaining as of late 2013.

Figure 1: U.S. Space per Worker Trends in Square Feet

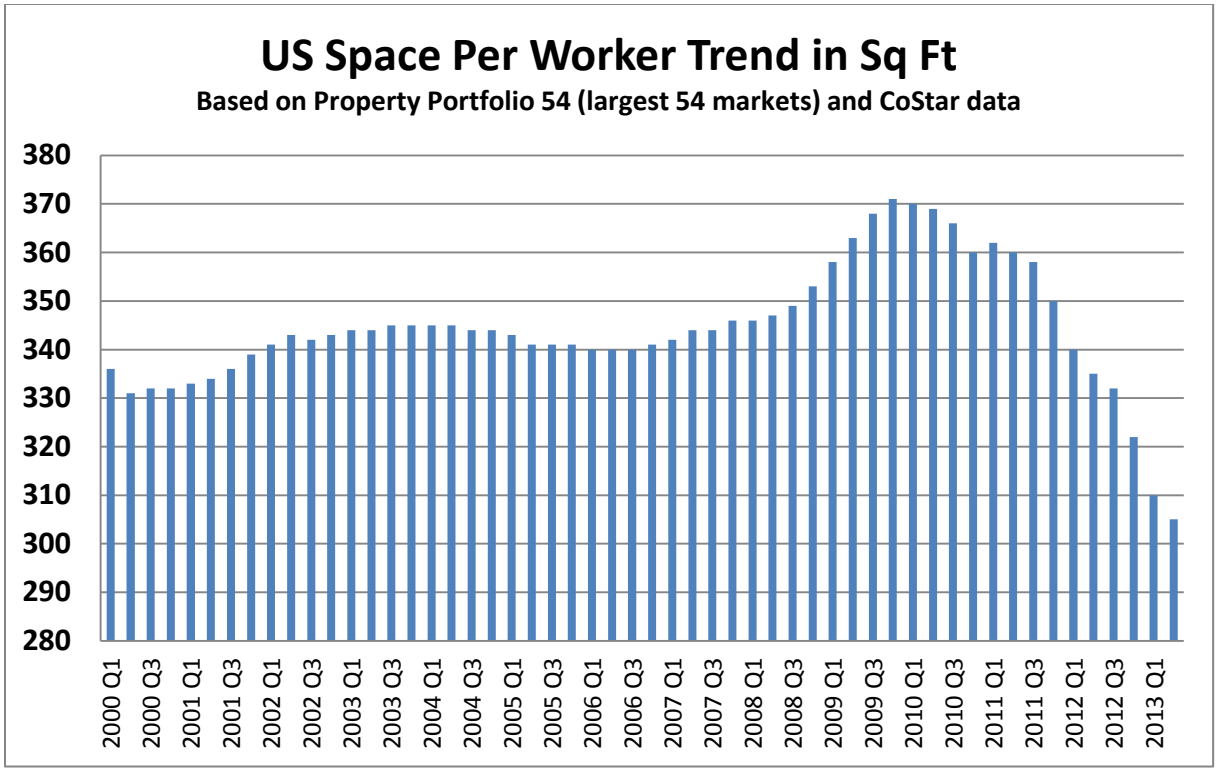


Figure 2: Square Feet per Worker By U.S. Market

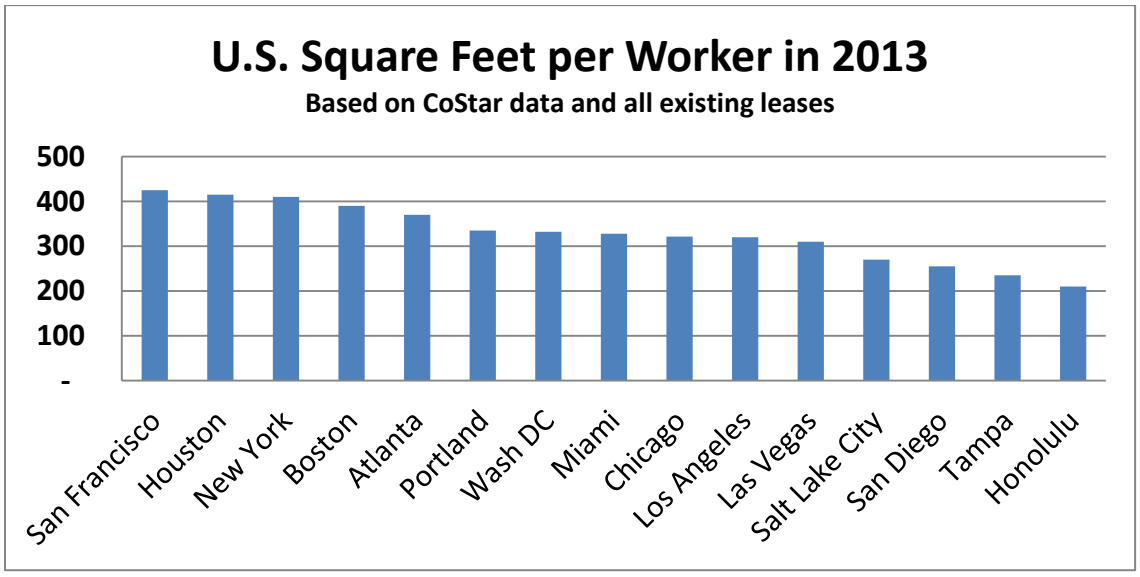
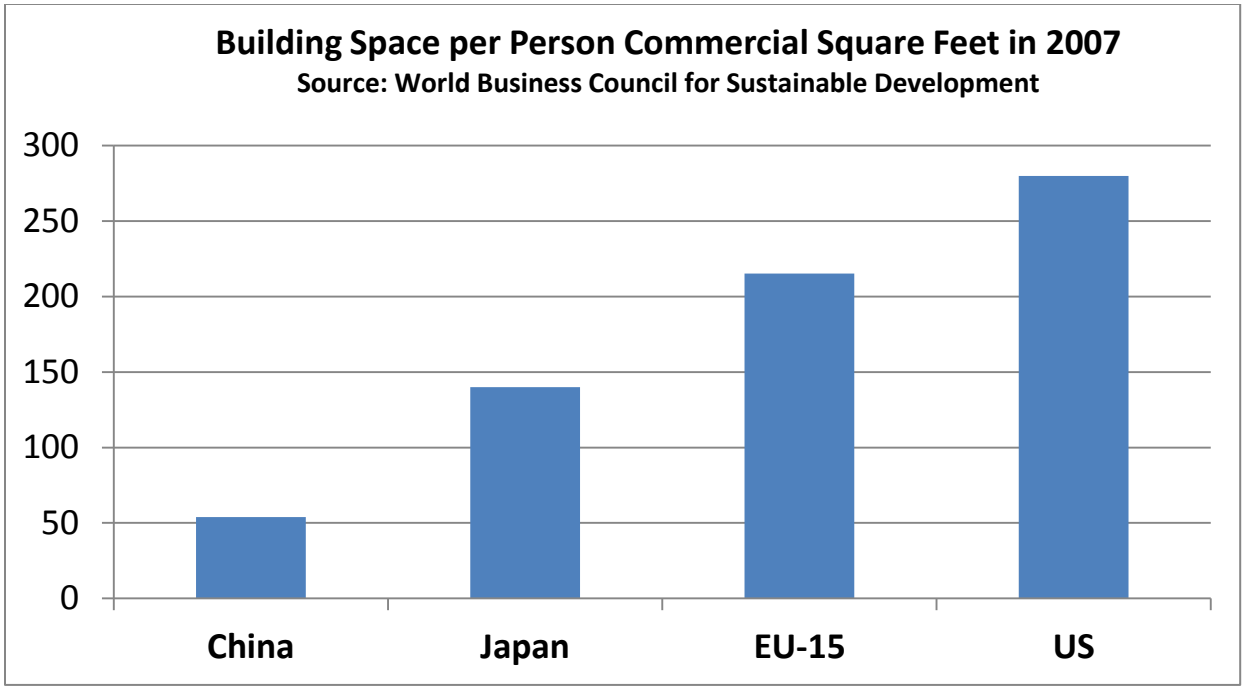


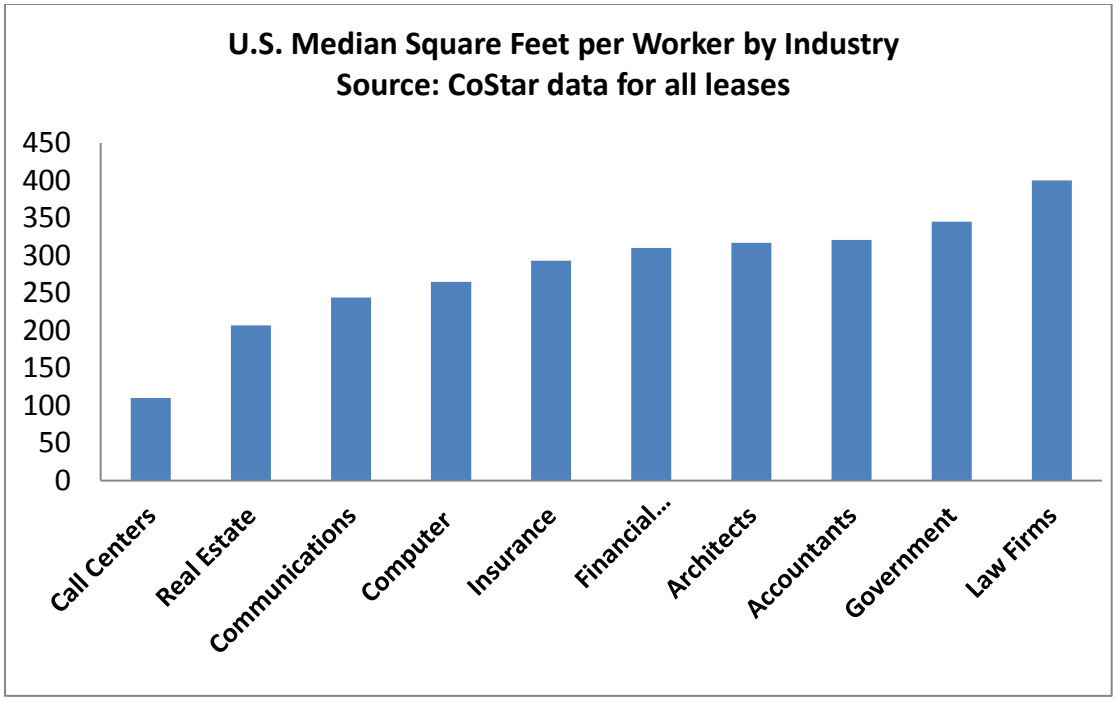
Figure 3: Building Space Consumption Varies around the World



Space Per Worker by Industry or Function

Figure 4 compares occupied space per worker by industry group. It is not surprising then that government space has historically been fairly generous to workers, but also includes some public access and service space that might help explain the well-above average space use per worker results. Law firms come in tops as high space demanders followed by accountants, architects and financial institutions, which often include generous open space at branches. The results in Figure 4 are not inclusive of all industries but merely serve to demonstrate that we will find systematic differences in space demands when we analyze each industry group. If a particular industry group, such as telemarketing which operates through call centers, is moving into an area and has stated that they need to hire 1,000 new workers it would have dramatically less impact on office market space demand than 1,000 architects or computer software designers. When possible, space per worker in demand estimate models should be adjusted for what is typical in the relevant industries present in local markets.

Figure 4: Space per Worker by Industry



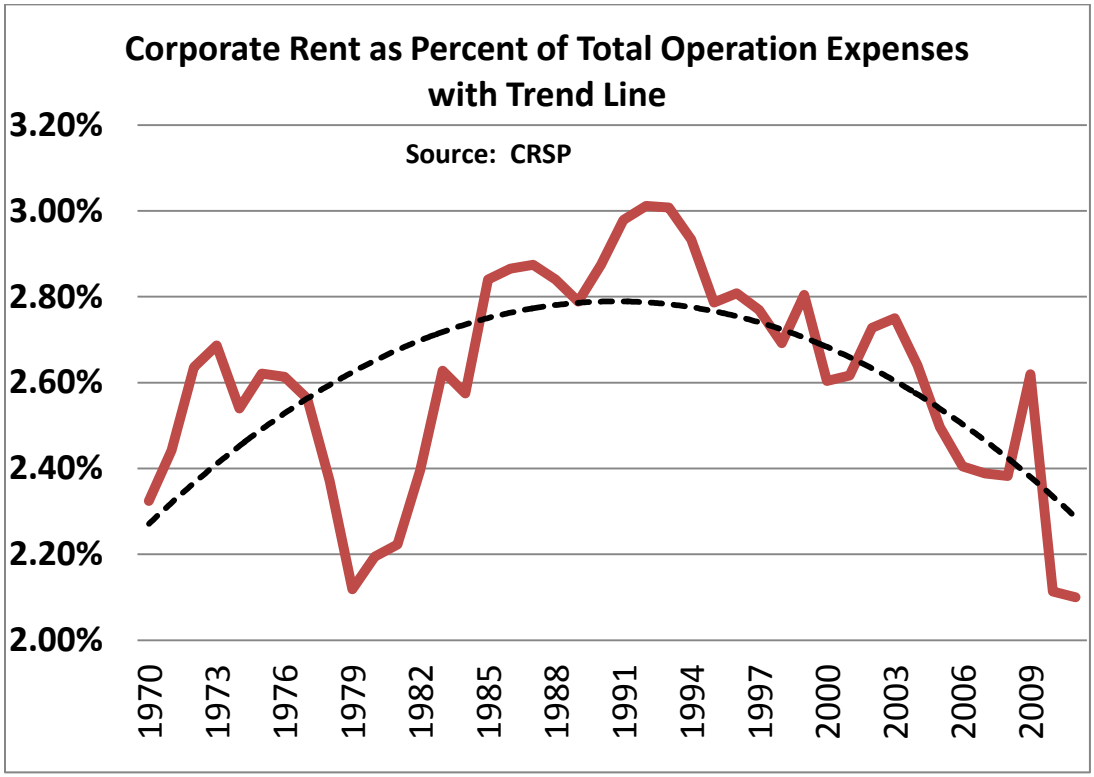
Space per worker has always been an important assumption in office forecast models, and it is worth mentioning a few of these studies that take space per worker as an input into office demand estimates. An excellent review of the literature of office demand was provided by Rabianski and Gibler (2007). They observe that models of office market demand analysis have become more complex and able to segment demand by industry and/or geographic area as better data has become available. Early studies (Jennings 1965, Detoy and Rabin 1972, Lex 1975, Martin and English 1985) attempted to understand how much office space was needed by using ratios of non-manufacturing employment to population or office space to employment. As better industry breakdown became available, we saw more segmentation into industry grouping (Kelly 1983, Schloss 1984, Clapp 1987, Birch 1988) or by headquarters or private vs. public space or the size of the firm (Carn, Rabianski, Racster and Seldin 1988, Dowall 1988). Throughout most of the literature we see heavy reliance on FIRE employment as a proxy for office employment. FIRE is the Bureau of Labor Statistics classification for the finance, insurance and real estate industries, which is utilized by Clapp (1993) and many others. Most of the early models estimating future office space demand relied on crude estimates of space required per worker based on surveys from BOMA (Building Owners and Managers Association International) or gross estimates of total space divided by employment (Clapp 1993). DiPasquale and Wheaton (1996) note that space per worker should vary by occupation and we see that in Figure 5 above they do. Space may vary over time as the occupation and technology changes, and that space per worker may vary by market and costs. All of these former speculations are correct, but the

question remains what factors drive space per worker other than design norms and culture? And why have so many reports and surveys come out in recent years suggesting dramatic down-sizing?

For example, in a 2010 report by Cushman & Wakefield aimed at corporate real estate executives, the firm suggests that space per worker can be reduced by 25%, not by reducing the actual office space per worker but by increasing the headcount per unit of space with more sharing of space. Based on this presumption, Cushman & Wakefield illustrates the benefits of moving from 200 square feet to 150 square feet per headcount. Naturally, such strategies, if widely implemented, could reduce the total demand for office space. In late 2013 CBRE moved into it's new LA office called CBRE 360 where 100% of the space is shared. That is, no one has dedicated private space. This is the single most effective way to downsize a firm's footprint.

Finally, by way of background it is useful to note that the occupancy cost as a percent of overall US public firm revenues had been increasing from 1970 through 1990 but then has been decreasing for the past two decades as shown in Figure 5 below. Real rents have also been declining over this same 1990 to 2011 period suggesting that one reason there has not been more pressure to use space more efficiently is that costs have been declining on a relative basis. The great recession most likely triggered renewed pressure for leaning-up all possible expenses.

Figure 5: Public Corporation Rent as a Percent of Operational Expenses Through 2011



In the next section a model will be developed to simulate the effects of various factors influencing the efficiency of office space use. One caveat that should be mentioned is that design is not explicitly part of the research process here and clearly this is a limitation of the research.

II. Method

Based on the CoStar existing industry data and author derived survey data describing factors which affected the space required per person, a model was developed. What is different about this model is that it is the first to consider explicitly factors which increase or decrease space per worker, aside from design, although space friction discussed below is a type of design constraint as is the standardization of space. The approach taken was to take a planned space per person as a base line and then to examine the effects of factors which contributed to achieving or not achieving the space per worker goal. Each of these modeled factors are described in turn, after which the model utilized is described:

Lease term: The initial theory is that the length of lease should affect the results on space per worker in that longer term leases should require excess space up front for a growing firm. The faster a firm expects to grow the more extra space they should lease at time zero. Shorter term leases and options were not considered here but are certainly a way to reduce the need to lease extra space for a growing firm and might explain why the results do not support the theory. In fact, what is most interesting empirically is that recent vintage leases reveal much lower space per worker than older leases near expiration, and yet for a growing firm one might expect just the opposite. Another consideration is that while many firms might expect to grow, many do not and mergers, dissolutions and downsizing all contribute to the empirical results suggesting firms have the most efficient space intensity near the start of a lease in contrast to the initial theory suggested here.

Sharing of space or non-dedicated space: Also known as office hoteling, this is the single most dominant factor in the simulation model supporting dramatic downsizing results. Simply implementing a policy of sharing space will significantly reduce space per worker, especially if the firm assumes that a certain portion of the work force will be out of the office at any point in time, or allows third work places (e.g. home, coffee shops, and libraries). Such a policy requires some standardized work stations and cloud based storage, and without these a firm faces great resistance to office sharing.

Employee turnover or churn: Based on survey data d, described later, 80% of all firms reported that turnover per year ranged from 10% to 30% per year. The greater the turnover in the firm the more vacant seats one would expect, depending in part of the time required to fill a position.

Time to fill vacant positions: Most firms reported from 1 month to 6 months to fill vacant positions. The longer it takes a firm on average to find new talent the greater will be their space per worker result.

Growth rate of the firm in employees: Most firms expect to grow. On average they do not. In fact, most small firms go out of business in less than 10 years. Business week surveys suggest that only 40% of all start-up firms will last 5 years. So while the economy may be growing on average, it is the result of minority of successful firms. The growth rate of the firm is varied from negative to positive based on a range of expectations in the model below. Obviously declines in firm size result in much higher space per worker figures.

Uncertainty behind the growth rate of the firm: Firms that grow in spurts have more trouble matching up space needs with people working in the firm. This point seems obvious.

Management hierarchy and the number of specialized office space types: Firms that have a management hierarchy where different levels of management require different types of non-substitutable space create what is here called ***space friction***. The greater the number of types of office space the greater the space friction whereby space cannot be used as intensively. The opposite of space friction would be 100% standardized space, fully useable by anyone in the firm.

Modeling Process

These variables are used in the following model to describe key elements in the decision as to how much space to lease and over time the resulting space per worker.

x_i = office space type, 1, 2, 3, 4, etc. where each type represents a non-interchangeable type of space with any other. Space types typically are of different sizes with larger sizes allocated to more senior staff and management.

s = shared office space percentage for each office space type x_i from 0 to 1.0 for 100%.

n = lease term in months or the specific month.

gw = goal space per worker in terms of average square feet based on total firm space divided by the average number of workers allocated office space. The total space of the firm is based on rented building area, RBA, including all space required for the firm such as common areas, conference rooms, and hallways and storage areas.

ge = goal space per employee based on the total number of employees of the firm assigned to a particular regional or office. This is merely a derivation of gw dependent on t, described below.

t = percentage of total worker time expected to be spent intentionally working at home, airports, libraries, coffee shops, or other locations.

p = percentage of time that workers spend with clients or outside the office, in work-related functions, while they are based in the traditional office space. p may overlap with t above, but is defined here as a percent of (1-t) time based within the regular office space.

gr = growth rate in the firm in terms of employees per year stated on a percentage basis in negative or positive terms.

c = churn rate based on the percent of employees that turnover each year from 0 to 1.0 for 100%.

cm = average time in months required to fill a vacated position.

U = utilization rate defined as the percent of total time desks are occupied using a one shift day of 8 to 10 hours. There is no weighting by square feet, so each desk is counted as one. This calculation is an output that is based on the simulation results. Where U exceeds 1.0 there would a need to double up, use conference rooms for temp space, secure or rent temporary space outside the regular office. This variable is an output that is put into an optimization framework using a stock out model approach, as described in the next section.

The goal space, gw, is based upon the following process: If the firm is growing, then required space per worker it is solved at the end of the lease term and back calculated to find the amount of space occupied in each period from the start of the lease. We assume here that there is only one type of space, although this single standardized space assumption will be relaxed below to allow for multiple unique non-substitutable spaces. The process of accommodating expected growth in worker counts is merely a geometric progression, where:

gw = ge/t(p) and then we solve for each period of the lease back to zero based upon the following pattern derived from the compounded growth rate:

$$(1) \qquad OSPW = ge/t(p)/(1+gr)^{n}$$

The importance of solving for the space required in any period is that while the goal space may be 100 square feet per worker, a firm signing a 5 year lease will need to over consume space in the beginning in order to accommodate employee growth. Temporary overflow space providers are not modeled here, although clearly such providers could feed into a decision as to how conservatively to model space needs. Examples are HQ, Instant Office, Regus and others that provide monthly rentals of fully furnished spaces while firms like Liquid Space provide small conference rooms by the hour. The costs for a typical Instant workstation may run $800 to $900 per month for 120 square feet plus access to conference space and common areas, converting to about double the rate for long-term leased traditional space in bulk. For the instant space provided by firms like Liquid Space we see rates in the $60 to $90 US dollar range per hour for a conference room in a major city that would hold 4 to 6 people. While firms rarely sign long-term leases while in downsizing mode, downsizing simply happens unexpectedly, and this also results in extra space consumption. Such uncertainty is modeled through the range of growth

rate assumptions, from negative to positive, using the 80% confidence range of typical growth rates for a sample of CBRE tenant firms and Corenet Global members surveyed.

Now let's factor into the model time spent outside of the office, which is only relevant if $s > 0$, and we need to do this for each office type x_i so that we repeat and sum the model based on allocating all space to one of the potential office space types.

(2) $OSPWx_i = s(ge/t(p)/(1-gr^{)n})$ This sharing of space has the effect of reducing the total space required as a function of the degree of sharing and p, the time spent working outside the office, while assigned to space inside.

Next let's factor in the churn rate, c, and time to fill the vacated slots, cm.

(3) $OSPWxi = s(ge/t(p)/(1-gr)^n)/(cm/12c)$ This has the effect of adding some friction to the efficient use of space by acknowledging that some of the time space will be empty waiting for new hires.

Next, let's factor in various types of space in the simulation by using a ratio of space for each office type; thus, for type x_1 we may have 1.5 times the average space per worker and for x_4 we may have .5 times the average space per worker. The average weighted space will be the same as for the goals, but we must recognize that churn in space x_1 in this case will create a larger impact on the overall unplanned space per worker compared to the x_4 worker type space. We do not show this in equations since it is merely a repeat of (3) above for each x space type where the result is summed. Note that the more office type spaces that cannot be substituted, the more friction in the system.

The last step in the model is to decide how certain one need be that there is enough office space. We can view this decision much like a stock out problem in operations management. Imagine inventory as space available to house workers and imagine that we are unsure about how many workers we will need to house over the next several years. The longer the term of our analysis the more difficult the problem becomes, and in turn optimal space decisions are harder for longer-term leases or when owned space is involved. Still this operations management perspective is a useful framework for modeling space demand, consistent with an optimization based on marginal utility analysis in economics.

From an inventory management perspective, we have two kinds of costs: overage costs, $C_{o,}$ when we have too much inventory (space) and underage costs, C_u, when we have insufficient inventory. We need to select the right level of inventory or office space per worker, OSPW, that balances these two costs. If these two costs were equal then we would end up seeking the amount of OSPW that has a 50% probability, P, of being too much or too little space. In this case, we seek to find OSPW that satisfies the following condition:

$P(OSPW) = C_u/(C_u+C_o)$ such that $P(OSPW)<X = .5$ where X is the actual space required.

The ratio which provides an optimum could be based on the marginal costs of adding temporary space, where available, such as that provided by instant office space providers. Using a sample of temporary office providers and annualizing the cost, which obviously will vary by market, we end up with typical rents at least four times that of traditional space. This is akin to comparing a hotel room rent with an apartment and so such differentials are not unexpected. This is similar to using the differential between the costs of having too much space to the cost of having sufficient space. The cost of having too much space is less than the cost of not having enough, so if the cost of too much space is one-fifth that of too little space, we end up with the same exact ratio, as when the cost of marginal space is five times as expensive, seeking the following solution:

$P_x<OSPW = 4/(4+1) = 4/5 = 80\%$

implying that we wish to have 80% confidence that we will have sufficient space. P_x is the probability the demand for space is less than x, the actual needed. If the cost of temporary space is higher, say nine times that of regular space, then we will want to be approximately 90% confident we have sufficient space at any point in time. General estimates for temporary office space suggest the cost is about 8 to 10 times the typical cost for longer-term leased space, based on anecdotal evidence collected by the author at the CORENET Global conference in 2012.

The approach used in operations management is no different from that used in microeconomics. We set the marginal benefits equal to the marginal costs as the minimal sufficient condition for an investment decision. The last unit of space added, $OSPW^*$, is that which sets the expected cost of too much space, C_o, equal to the expected cost of too little space, C_u, recognizing that these costs may not be equal per unit of space.

The concept of optimizing office inventory or seeking to avoid stock outs of sufficient space is identical and parallel to the utilization, U, goal of firms, where they seek a minimum or average utilization rate. Utilization rates are based upon the occupancy rate for all available desks over the course of working days, measured periodically. Traditional firms have rather modest utilization rates, typically 50% to 60%, according to Corenet Global research. But firms that allow sharing of desk spaces, known as non-dedicated office space, and some telecommuting may experience utilization rates of 80% or higher. Firms like Accenture and Procter & Gamble intentionally run at 80% and even 90% or higher utilization rates.

The impact of space friction: The above model becomes more complicated when the internal spaces (inventory) are not substitutable. We might think of office cubicles as fairly homogeneous and substitutable and in those firms with fairly generic and flexible space, there is less friction in adjusting to the needs of workers with different levels of specialization and authority. In firms with more structured authority or specialization and less flexible space, there will be higher transaction costs to adjust space resulting in space inventory supply friction. In

this case, the optimal space model becomes a summation of several sub-space optimization models, each with its own inventory of space and its own demand.

Firms like Procter & Gamble have moved to more standardized space, which allows for greater ease of space optimization strategies. Other firms with formal hierarchies of managers, each with different space requirements, will end up with much more required space per person simply because of the lack of substitutability. Think of a firm with one CEO, one COO, 10 senior VPs and 30 VPs, 50 sales staff and then 300 other staff workers of various kinds, each with their own space requirements. A senior VP leaves the firm and rather than move a regular VP into the office, it sits empty rather than risk the charge of favoritism being applied to the facilities manager that allocates space. These frictions increase the need to secure more space per worker for the entire firm as the probability increases that space will remain unoccupied for uncertain periods. So one might conclude that the less substitutable the space, the higher will be the summed average space per worker in a firm, all other things equal.

III. Data and Sample Descriptive Statistics

Three sources of data were used in this study. CoStar data, already mentioned, is used for background and starting parameters. CoStar data includes a US national sample of millions of office leases. Surveys were administered by the author to two different occupant groups. One is CoreNet Global members, consisting of manly owner occupants with a bias towards large public firms. The second, aimed at including smaller and privately owned companies were tenants of buildings managed by CBRE. These samples are described below in Table 1.

Table 1: Corenet Global and CBRE Survey Median 2012 Results

Attribute	**Corenet**	**CBRE Tenants**
Sample size of respondents	78	212
First Generation Space	50%	26%
Second Generation Space Refurbished	50%	74%
Non-dedicated Shared Space as % of All	15%	5%
Allow Telecommuting By Workers (yes)	71%	55%
Use Temporary Office Space Providers (yes)	21%	3%
Time required to fill a position (Ave Months)	3.8	1.8
Typical lease in years	5.0	5.0
Lease expansion options (yes)	57%	58%
Different types of office space configurations	2.9	3.3
Private space as percent of all space	20%	36%
Years in Business	30.6	22.0

Average Number of employees	29,623	204
Employee Turnover per year (stated)	12.0%	8.4%
Expected Growth Rate of the Firm in Employees	4.2%	18%
Publicly Owned	75%	36%
Non-Profit Firm	7%	0

Three important comparisons are provided below in Figures 6 and 7 on the targeted space per worker versus the actual, and the targeted utilization rates versus the actual. In Table 1 above we see the much faster growth rate expectations of the smaller firms and the slightly lower turnover rates. These are consistent with prior expectations and verify a range of turnover assumptions in the models tested. In Figures 6 and 7 below, we observe the time required to fill a position is also much longer for the larger public firms. Target utilization rates are above actual, as one might expect, and the space per worker figures are higher than desired.

Figure 6: RBA Space Per Worker and Target Space Per Worker in Square Feet

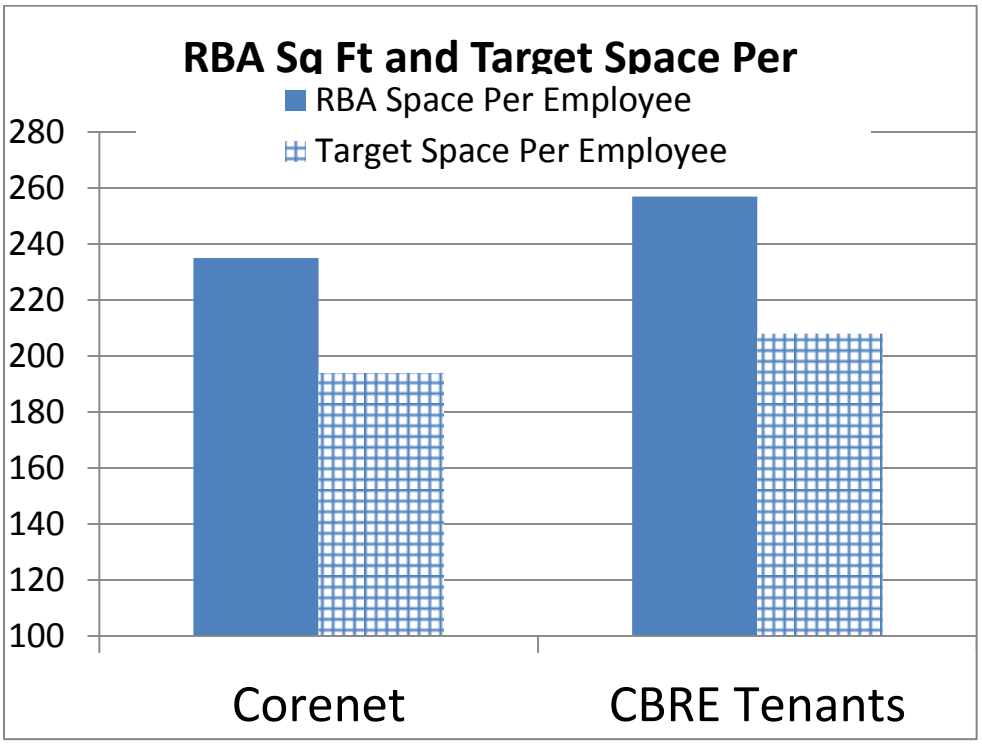
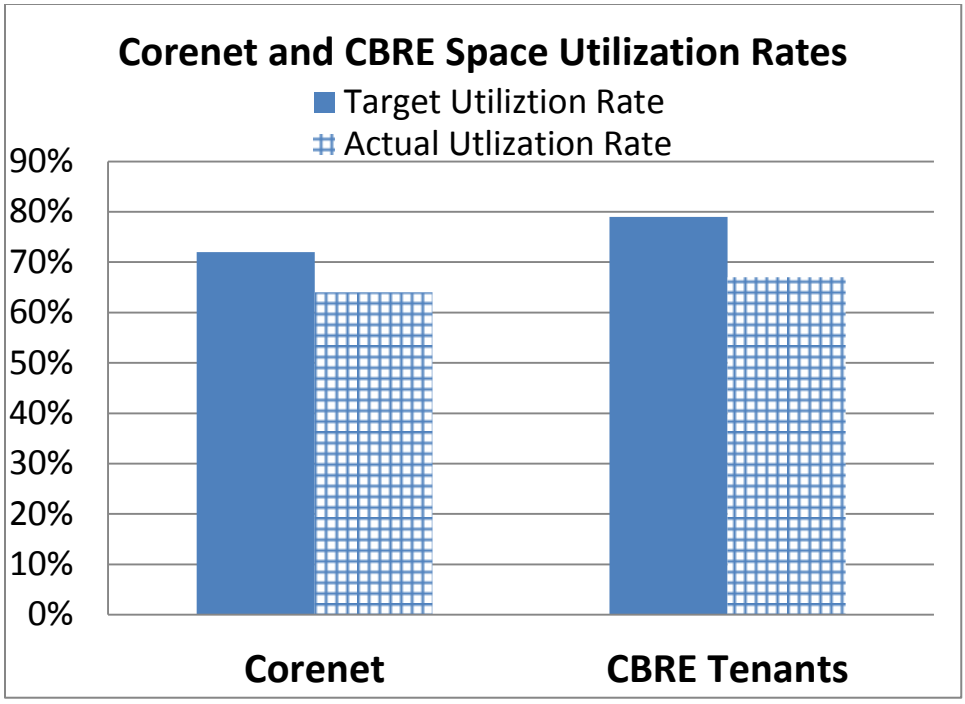


Figure 7: Utilization Rates



Within the surveys respondents were asked about strategies to reduce space per worker. Typical answers were:

- ✓ Allowing the worker to work anywhere, when not in team meetings
- ✓ Reducing the percent of dedicated private space
- ✓ Standardizing space and using more open designs
- ✓ Requiring that files are stored on a centralized "cloud" server
- ✓ Using temporary office space providers when overflow demand for space exceeds capacity

IV. Results of the Simulation Model

Several models were tested, some where all space is non-dedicated and some where there are only standardized spaces. There are too many variations to describe here and one might suggest that many of the results are obvious. Nevertheless it is useful to quantify the impact of lease term, space friction, employee churn and so forth on the ability of the firm to use space efficiently. The real contribution of this study is to demonstrate explicitly the impact of reality based assumptions on space per worker results.

The key variables for the model, are shown in Table 2 below, where all workers are treated the same (no difference in space per worker) are as follows, with the low, base and high figures provided:

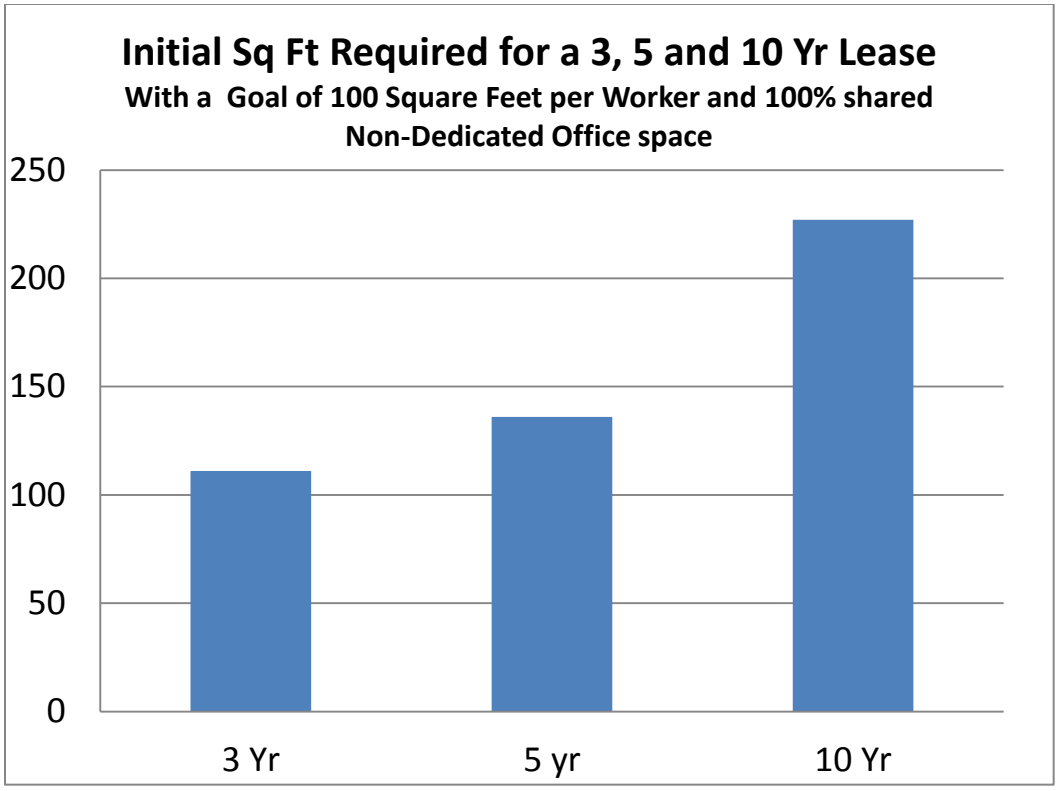
Table 2: Key Model Inputs

Variable Inputs	Low	Base	High
Initial number of workers		119	
Average planned space per worker	65	150	200
Annual turnover rate in employees	5%	20%	33%
Time in months required to fill a position	1	3	5
Growth rate in the firm with respect to number of total employees	0	5%	18%
Length of initial lease	3	5	10

.

The longer the term of the lease, the initial theory here is that more space that must be leased now relative to the average number of employees using that space over the term of the lease. In Figure 7 we use 100% non-dedicated office space and assume that 50% of the employees are randomly out of the office at any one time on average. The other assumptions are as listed above with an average employee growth rate of 5%. The goal of the tenant is to get down to 100 square feet per worker, noting that many of the employees are out of the office at any one time. The results are based upon the assumption that the faster the firm is growing the more space you need to lease up front in order to accommodate the extra employees. However, we also note that uncertainty over growth rates and the ability to renew existing space and option addition space with expansion clauses suggests great benefits to shorter leases, such as five years, even for growing firms. That explains why expansion clauses are so common among many office leases and why five year leases are far more common than ten year leases. Empirically this result and theory turned out to be incorrect. Longer term leases do not result in more space per worker up front. When corporate real estate experts were asked about the result, the consensus view was that it is easier to renegotiate a lease when expanding versus contradicting and so there was no need to lease so much extra space up front.

Figure 7: Theoretical Impact of Lease Term on Space Required at the Time of the Initial Lease



Again, this theory on lease term and growth rates turned out to be incorrect and yielded the only results in the model that were inconsistent with empirical evidence. In response to this incorrect model specification, the author contacted several firms to ask whether they planned for expansion space at the time of initital leasing. While anecdotal in nature, the typical response was that expanding was not difficult. Landlords will renegotiate larger spaces and new terms for such firms, while downsizing firms met with more resistance.

In Figures 8, 9 and 10 below are the summary of model simulations. The distribution shown are from 10,000 simulation runs using the model inputs. The certainty level shown is the probability that there is sufficient space for all employees and the space required to hit that goal. The graph distribution shade changes where the probability level shown is met. For example, in Figure 8 where the 90.093 is shown, this is a percentage probability that the actual space per worker result will be 215.6 feet or less. The distribution curve shown reveals the actual possible combinations of space per worker over the range of variable inputs tested. The distributions appear to be fairly normal with just the slightest touch of skewness.

Figures 8 and 9 below suggest that faster growth rates (up to 20% employee growth per year) should also drive a firm to require more space per worker up front, but again this is not supported by empirical evidence. Firms that expect to grow do not lease much extra space, so the results in Figures 7 and 8 below do not provide any guidance on the behavior of space decisions. If one

assumes that any long term lease can be renegotiated at any time for an expanding firm, the results would instead suggest much less space per worker required at the start of the lease. The remainder of the variables tested did perform as expected and provide some insights into the challenges behind downsizing goals.

Figure 8: Space Required Per Worker as a Function of Growth Rates (First-Year Results)

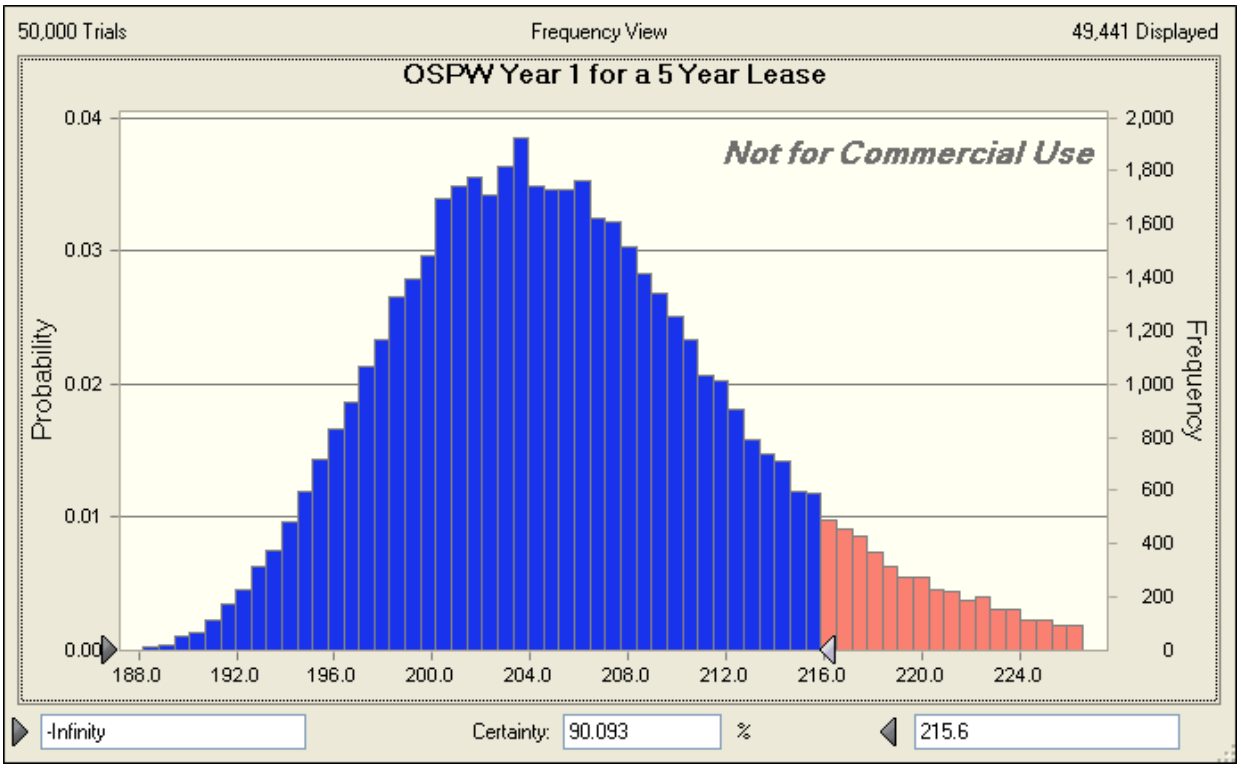
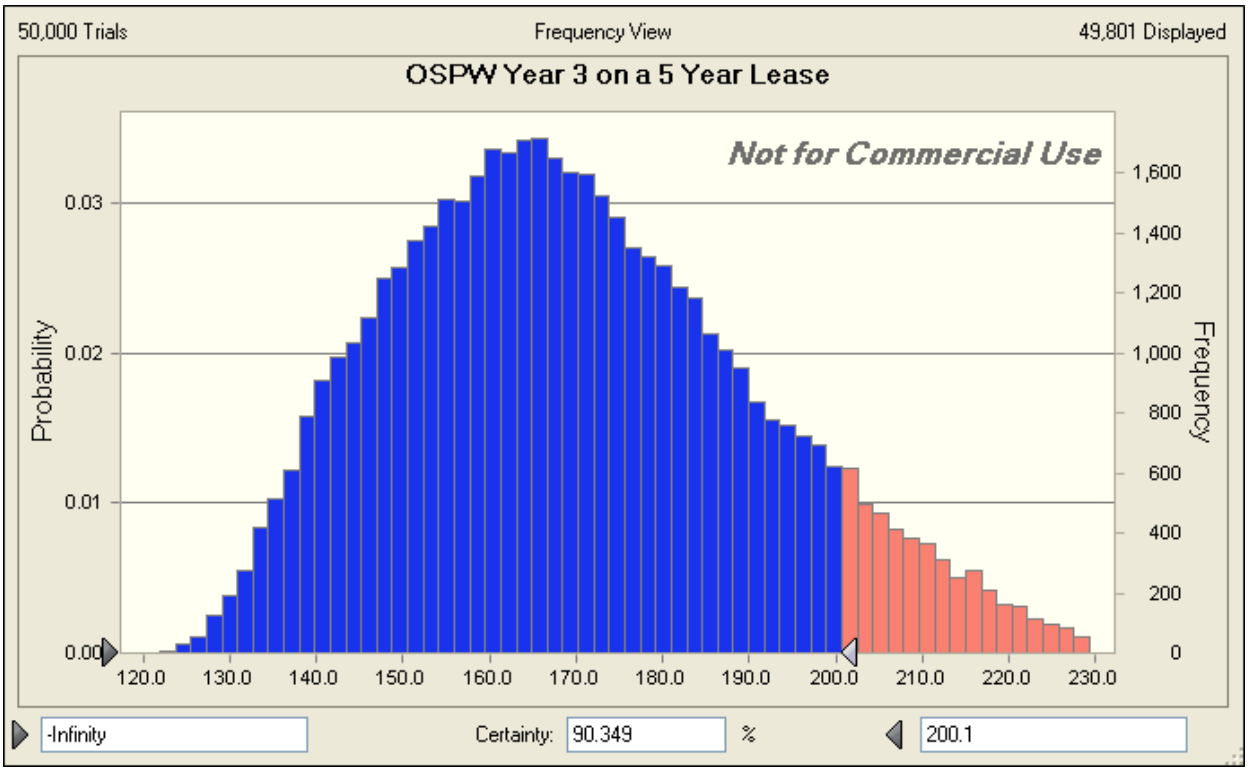


Figure 9: Space Required Per Worker as a Function of Growth Rates (Third-Year Results)



Churn rates and employee turnover are investigated next. Starting back at the base case but increasing the churn rate of the employee turnover results in slightly less efficient space use. While there is some impact on space efficiency, it is modest as long as the time to fill positions is quick with low volatility. So, churn alone does not have much impact. On the other hand when the time required to fill a position increases, one sees a corresponding and somewhat linear increase in the amount of space required, so that if the average churn is 10% with one month to fill a position on average and this is changed to three months, there will be an increase the vacant space and resulting space per worker by approximately 2% per year.

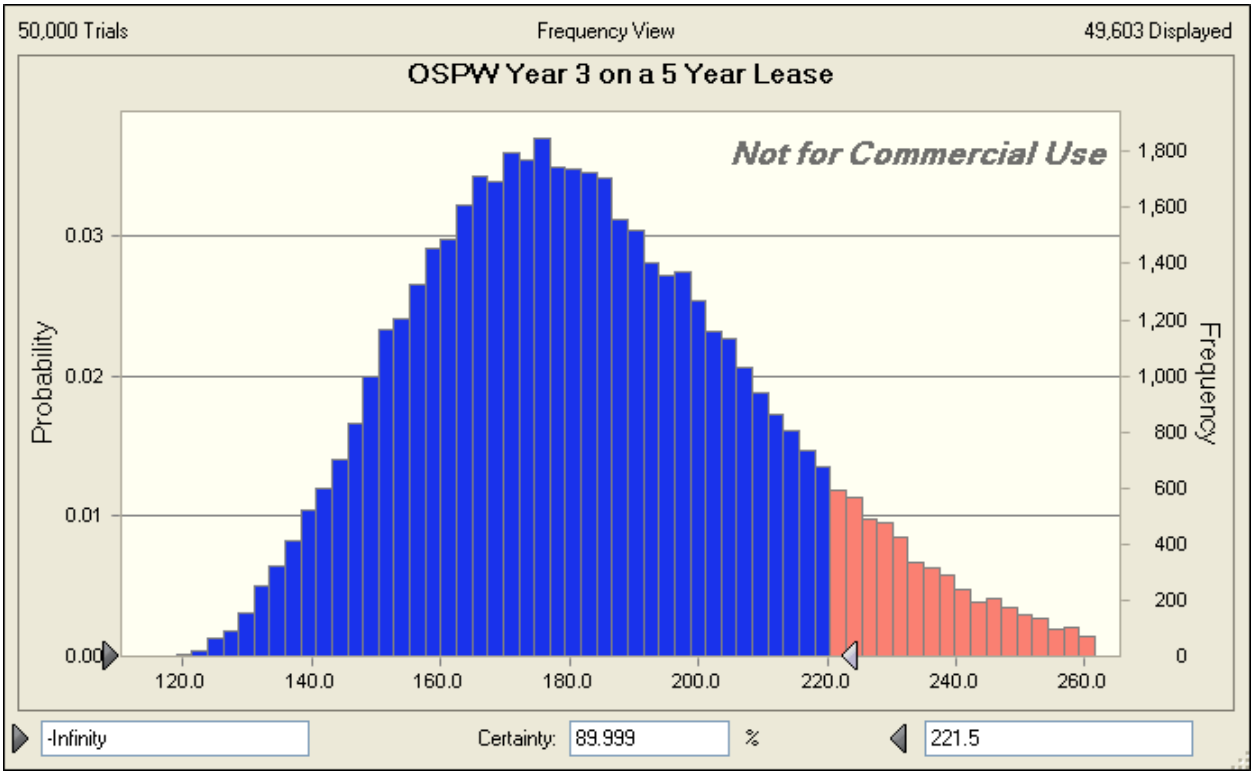
Unique office spaces and what is called here space friction has far more impact than churn rates. When a firm has 100% standardized non-dedicated space, in theory anyone can use any office, but when the number of unique offices is increased and these are non-substitutable, the demand for office space accelerates especially when all space is dedicated to specific individuals. Below four types of space are introduced that are not substitutable. The result is a significant increase in space per worker versus the case of homogeneous space, all of which may be substituted. The following unique space assumptions are tested:

Space Type	Percent of Total	Avg. Sq. Ft Each (including common areas)
1	80%	117
2	10%	150

3	7.5%	300
4	2.5%	450

The results are shown in Figure 10 below with 100% sharing among Space Type 1 but no sharing within space types 2, 3 and 4. The average space allocation is 142 for each worker, but with turnover and growth and space frictions, one observes significantly higher figures. In year one the space required per worker is 220 on average and 251 at the 90% confidence level. Year three is shown below, suggesting 181 square feet on average and 221 at the 90% confidence level.

Figure 10: Space Required Per Worker with Dedicated Space for Senior Management and Non-Dedicated Space for Staff with an Overall Goal of 142 Square Feet Per Worker.



Simulation Model Findings

1) While firms may target 200, 150 or figures as modest as 100 square feet per worker, only a firm with an extremely stable worker base, little turnover, modest growth and fairly standardized non-dedicated space could possibly achieve these targets on average over the course of an entire lease. Longer lease terms make it harder to hit space targets.
2) Positive firm growth rates and longer lease terms in theory should result in more space per worker at the start of a lease, but these findings are not empirically supported. Apparently firm expansion and lease renegotiation is not as difficult as expected. On the other hand, firms that have downsized results in significant excess space per worker. Obviously, shrinking firms will far exceed space per worker targets, which explains much of the shadow space observed in the market during and shortly after recessions.
3) The greater the churn rate of workers, the more space required per worker, but only modestly. Time required to fill a position has more impact on space per worker results.
4) The greater the number of non-standardized spaces that are not substitutable between ranks within the firm the lower will be utilization rates and the greater will be the space per worker. In firms with totally dedicated space and several layers of unique spaces, the average consumption of space per worker will be as much as twice or more that of a firm that shares standardized non-dedicated space. The implication is that branch operations with more standardized space will be able to use space more efficiently than headquarters and those with more managerial delineation within office space allocations.

Implications of downsizing on the office market

Based on input from Corenet Global members and CBRE tenants, the larger tenants are the ones working harder to use space more efficiently, especially those with footprints over 75,000 square feet. This group tends to encourage digital storage on centralized cloud-based servers and use more non-dedicated standardized space for all but the most senior of managers. This group represents 1.8% of all tenants in the United States by count and 27.9% of all office space. Those using more than 50,000 square feet represent 36% of the total office stock. If using some of the space sharing strategies described above, we assume 36% of the firms can reduce their primary leased office footprint by 50%, moving from 250 to 125 square feet, this would be the equivalent of 540 million square feet out of some 12 billion office square feet as of 2010. Historically this is equivalent to 3.6 years of average United States deliveries of net new space to the market, which has averaged close to 150 million square feet per year since 1983.

Decreases in total office consumption based mostly on higher utilization rates take time, and it is likely that these moves towards more efficient use of space will require many years of transition. At the same time that the market is seeing some downsizing, there is also a new kind of space being required, one that lets in more natural light with better natural ventilation, with better temperature control and provides for more collaborative and more productive workspace. With this perspective in mind, some of the existing office space may be considered obsolete and

require retrofitting. The innovations of cloud-based computing, shared storage, video conferencing and high-speed internet has freed up locational constraints allowing many professionals to work anywhere they wish, mostly coming to the office for collaborative work and meetings, and some firms are taking advantage of this flexibility. If all the 12 billion plus square feet of existing United States stock were instantly updated to accommodate the new style of work and the higher-quality features of more sustainable real estate, the market would not need any more space for a few years. But such a transition to better space takes time and the growing markets and downsizing markets need not match up.

One major problem for landlords faced with high space utilization tenants is the need for much greater parking per 1,000 square foot of leased space. While traditional models of parking supply suggest 3 to 4 cars per 1,000 square feet, this figure will likely need to be doubled when space per worker is down to 150 square feet or less.

V. Conclusions

The largest firms and the GSA represented entities have embarked on a path towards more efficient use of space seeking much higher utilization rates. This is possible with extensive use of standardized non-dedicated space and a policy that allows great flexibility in terms of where employees work. Slightly more than a third of the US market is represented by larger firms that are attempting to downsize footprints over the next several years. Others will follow over time. Still the culture of private space remains entrenched in the US and it is not clear how long the transition to smaller footprints will take. Only a smaller percentage in space per worker will drive some markets into negative absorption in the years to come. Portfolios with a heavy percentage of large public firms or GSA managed entities are most at risk from downsizing. Markets like Washington DC with the large presence of GSA managed entities are more likely to see negative absorption from these trends sooner than markets dominated by smaller non-GSA firms.

Few firms will ever be able to hit their target allocations of space per worker. Simulation models tested here suggest a variety of challenges are posed by turnover rates, time to fill positions and managerial space friction. Firms retaining a multi-level hierarchy of management, with private dedicated office space configuration as a signal of rank, will find it harder to use space efficiently just as second-generation tenants do not fit as efficiently into any given space as first-generation tenants.

The need for collaboration and innovation works against the trend of working at home or even in private offices. Overall, we should expect a greater spread of square feet per worker figures over the next several years, as some firms reduce footprints significantly while others maintain current practices with private dedicated space.

References

Birch, D.L. *America's Office Needs: 1985-1995*. Chicago, IL. Arthur Anderson & Co. 1986

CoreNet Global and several research reports at http://www.corenetglobal.org/

International Facility Management Association and several research reports available at http://www.ifma.org/

Carn, N., J. Rabianski, R. Racster, and M. Selden, *Real Estate Market Analysis*. Englewood Cliffs, N.J.: Prentice-Hall, 1988.

Clapp, J.M., *Dynamics of Office Markets*. AREUEA Monograph Series No. 1. Washington, D.C.: Urban Institute Press, 1993.

Clapp, J. M., *Dynamics of Office Markets: Empirical Findings and Research Issues* (AREUEA Monograph Series No. 1.) Washington, D.C.: Urban Institute Press, 1993.

Clapp, J.M. *Handbook for Real Estate Market Analysis*. Englewood Cliffs, N.J.: Prentice Hall, 1987.

Clements-Croome, D., Kaluarachchi, Y. (2000) An Assessment of the Influence of the In-door Environment on the Productivity of Occupants in Offices Design, Construction and Operation of Healthy Buildings ,pp.67-81.

Colliers International, "Workplace Report 2012" New Zealand, by Alan McMahon, 2012.

CoreNet Global, "Reducing the Portfolio and Maximizing the Use of Existing Space" June, 2009 Research Bulletin, 14.

Cushman & Wakefield "Occupancy Optimization Considerations for Professional Service Firms" by Matt Jackson and Nnenna Alintah, 2010, **Business Consulting Report**.

Del Casino, J.J., "A Risk Simulation Approach to Long-Range Office Demand Forecasting." *Real Estate Review*, 1985, 15:2, 82:87.

Detoy, C.J. and S.J. Rabin, "Office Space: Calculating the Demand", *Urban Land*, 1972, June 4-13.

DiPasquarle, D. and W. Wheaton, *Urban Economics and Real Estate Markets*, Chapter 12, Prentice Hall, 1996.

Dowall, D.E. "Office Market Research: The Case for Segmentation," *Journal of Real Estate Development*, 1988, 4:1, 34:43.

The Gensler Design + Performance Index, The U.S. Workplace Survey (2013)

Gibson, V. “Flexible Working Needs Flexible Space?” *Journal of Property Investment & Finance*, 2003, 21:1, 12:22.

GSA Office of Government-wide Policy “Workspace Utilization and Allocation Benchmark” July, 2011 See http://www.gsa.gov/graphics/ogp/Workspace_Utilization_Banchmark_July_2012.pdf

Grissom, T.V. and J.L. Kuhle, “The Space Segmentation Technique (ST3): A New Approach to Market Analysis,” *Real Estate Issues*, 1983, 8:2, 21:29.

Hakfoort, J. and R. Lie, “Office Space Per Worker: Evidence from Four European Markets,” *The Journal of Real Estate Research*, 1996, Vol. 11, 2, 183:196.

Howarth, R. and E. Malisia, “Office Market Analysis: Improving Best Practice Techniques” *The Journal of Real Estate Research*, 1998, Vol. 16, No. 1. 15:34.

Hysom, J. “Office Market Analysis: A Solution to Overbuilding?” *Commercial Investment Real Journal*, 1988, 7:3, 9:13.

Jackson, M. and N. Alintah, “Occupancy Optimization Considerations for Professional Service Firms,” Cushman & Wakefield Research Report, 2010.

Jennings, C. “Predicting Demand for Office Space.” *Appraisal Journal*, 1965, July, 377:82.

Jones, C. “An Economic Basis for the Analysis and Prediction of Local Office Property Markets.” *Journal of Property Valuation and Investment*, 1995, 13:2, 16:30.

Kelly, H. “Forecasting Office Space Demand in Urban Areas” *Real Estate Review, 1983, 13:3, 83-95.*

Kimball, J.R. and B.S. Bloomberg, “Office Space Demand Analysis.” *Appraisal Journal*, 1987, 55:4, 567:77.

Laing, Andrew, David Craig, and Alex White “High-Performance Office Space” Harvard Business Review, Reprint F1109Z, September, 2011.

Lex, R.A. “Marketing Studies for Office Buildings,” *Real Estate Review*, 1975, 5:2, 101:03.

Liang, Y. and J.H. Kim, “Demand for Office Space.” *Real Estate Finance*, 1998, 15:2, 37:44.

Maisel, S. J. “*Demand for Office Space,”* Working Paper 89-161, Berkeley, Calif.: Center for Real Estate and Urban Economics, 1989.

Martin, W.B. and W.D. English, “Forecasting Demand for Multitenant Office Space” *Commercial Investment Journal*, 1985, 4:1, 7-9.

McDonald, J.F. "A Survey of Econometric Models of Office Markets." *Journal of Real Estate Literature*, 2002, 10:2, 223:42.

Miller, N. and D. Pogue, "Green Buildings and Productivity," *Journal of Sustainable Real Estate*, Vol. 1, No. 1, Fall 2009.

Miller, N. D. pogue, J. Saville, and C. Tu."The Operations and Management of Green Buildings in the United States", Journal of Sustainable Real Estate, Vol. 2, No. 1, 2010, 5:66.

Rabianski, J. "Office Market Demand Analysis." *Real Estate Review*, 2004, 33:2, 16:33.

Rabianski, J. "Linking Particular Office Marketability to the Market." *Real Estate Review*, 1994, 24:3, 83:86.

Rabianski, J. and K. Gibler, "Office Market Demand Analysis and Estimation Techniques: A literature review, Synthesis and Commentary," The *Journal of Real Estate Literature*, Vol. 15, No, 1, 2007.

Ragas, W.R., R.L. Ryan and T.V. Grissom, "Forecasting Office Space Demand and Office Space Report 4." Chicago, Ill.: American Institute of Real Estate Appraisers, 1989, 29:42.

Ragas, W.R., R.L. Ryan and T.V. Grissom, "Forecasting Office Space Demand and Office Space per Worker Estimates" *SIOREF Perspective*, 1992, March/April, 2-8.

Shilton, L. "The Eight Myths of Office Demand Forecasting." *Real Estate Finance Journal*, 1994, Winter, 67:72.

Schloss, N. "Technical Note: Use of Employment Data to Estimate Office Demand," *Monthly Labor Review*, 1984, 107:12, 40:44.

Silver, E.A., D.F. Pyke and R. Peterson "Chapter 10: Style Goods and Perishable Items," in *Inventory Management and Production Planning and Scheduling*, John Wiley & Sons, Third Edition, 1998.

Sundstrom, E., Town, J.P., Rice, R.W., Osborn, D.P. and Brill, M. (1994), Office noise, satisfaction, and performance, Environment and Behavior, 26(2), pp. 195-222.

Wheaton, W.C., "The Cyclic Behavior of the National Office Market," *AREUEA Journal*, 1987, 15:4, 281:99.

White, J.R. "*The Office Building*," Chapter 9, 1993, Counselors of Real Estate Publishers.

Appendix:

Survey Questions Sent to CBRE Tenants and to Cornet Global Members

1. Are you the first generation user of the space used for your current office? Yes__ No__
2. If a second or later generation user, did you refurbish the space interior? Yes__ No__
3. Average estimate of space in square feet per total employee count (includes all Rentable Building Area and all employees, even those permitted to work in non-traditional office settings) _____
4. Target space in square feet per employee if you have one: _____
5. Average space in square feet per worker (based on average utilization and those expected to work at the office some of the time) _____
6. Target utilization rate for all work stations in the office (percent that they are expected to be utilized per normal working day): ____
7. Average actual utilization rate if known (percent of normal working day work stations are used):____
8. Do you have only one work shift per day? Yes ___ No ___
9. Do you allow or encourage office sharing of spaces versus exclusive space allocation? Yes __ No__
10. What percent of the offices are non-dedicated spaces, used by more than one worker? ___%
11. Do you allow telecommuting from home or other meeting places? Yes__ No__
12. Do you utilize temporary office space providers for overflow space demand or conference space demand? Yes ___ No ___
13. Turnover of employees each year on average in percent of the total? ___%
14. Annual growth rate of your firm expected over the next 5 years to10 years in terms of the number of employees? _____%
15. How long does it take on average to fill a position once vacated? ____Months
16. How long are your typical leases in years? ____Years

- Typically Net leases ____ or Full Service___

17. Do you have options for expansion space built into your typical lease? Yes ___ No___

18. How many different types of non-substitutable office spaces do you have that are distinct in size and or indicate rank within the firm? ____ types of unique office spaces

19. What percent of all your office spaces are private and exclusive spaces dedicated to middle or senior management? ____%

20. Your industry type (NAIC categories are below) ___ (use list below)
    11 Agriculture, Forestry, Fishing and Hunting
    21 Mining, Quarrying, and Oil and Gas Extraction
    22 Utilities
    23 Construction
    31-33 Manufacturing
    42 Wholesale Trade
    44-45 Retail Trade
    48-49 Transportation and Warehousing
    51 Information
    52 Finance and Insurance
    53 Real Estate and Rental and Leasing
    54 Professional, Scientific, and Technical Services
    55 Management of Companies and Enterprises
    56 Administrative and Support and Waste Management and Remediation Services
    61 Educational Services
    62 Health Care and Social Assistance
    71 Arts, Entertainment, and Recreation
    72 Accommodation and Food Services
    81 Other Services (except Public Administration)
    92 Public Administration/Government
    Other _____

21. Number of total employees? _____
22. Years in business__? ___
23. Publicly owned firm__? Yes___ No___
24. Non-profit organization__? Yes ___ No___
25. Do you have strategies to reduce space use? If so, please describe?_____
    _____
    ___

26. Other comments on space planning and trends on office space per worker?

_____

_____