

Estimating Office Space per Worker

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Abstract: In the world of the corporate real estate manager, space costs money and the less space we can fit our workforce into the lower our operational costs. So, the long-term observer of human resource and corporate real estate planners has perpetually heard discussions on how to do more with less space and bring down real estate occupancy costs. Office hoteling or sharing models, telecommuting part time, working in open standardized bull pens and smaller cubicles all support the aim of lowering occupancy costs and are reducing space per worker requirements. Keenly interested in these trends are the real estate developers, investors and analysts who forecast future office demand and in turn, estimate the space required per worker and utilize this along with office using employment estimates to determine future demand. If we utilized the stated goals of corporate real estate planners we might believe that total demand will be rapidly decreasing in the future. If we utilize the actual space per worker as observed in the market we might become overly ebullient and optimistic in our modeling. So, do we rely more on the rhetoric of planned shrinkages or the empirics of historical reality for our forecasts? That is the essence of this study - to reconcile these two diametrically opposed schools of thought and to explain why the truth lies somewhere in between. We will require more space than the optimum preference of the corporate real estate planner and less than the shadow space-laden inventory of the Great Recession.

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Estimating Office Space per Worker

I. Introduction

Office space demand estimation is an important topic representing over 12 billion square feet of space and \$1.6 trillion U.S. dollars in value in the United States alone, even during the lingering recessionary market of 2009.² As of 2012 the office stock may be worth closer to \$2 trillion.³ Office space demand is sensitive to space requirement assumptions, rent levels, tenant type and possibly culture. In many demand models we simply assume 200 or 250 square feet without any solid evidence for such an assumption other than 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 185, 150 or even as low as 100 square feet per person in the U.S. and even less in Asian or expensive European markets. However, they are generally speaking only of a target based on some high utilization⁴ target and stable employment, where nearly everyone the firm plans to hire over the next several years is already hired and present and no one is leaving so turnover is low. Until such time as they actually have hired all the potential new employees they may find that they are nowhere near the target figures resulting in excess capacity, lower utilization than expected and higher than targeted space per person goals. Of course, firms that are not growing or shrinking in size will also find they are drifting further and further from space per worker targets.

One example of a firm that has downsized its rental footprint and increased utilization rates is Accenture.⁵ In the year 2000 Accenture already permitted some remote work and had a 50% utilization rate, not unusual for the office market and allocated 250 square feet per work station and 118 square feet per employee. In 2011 Accenture had workstations based on 120 to 150 square feet per workstation and 65 square feet per employee and a utilization rate of 87%. During this time the occupancy cost went from 14% of general and administrative expense to 8% of general and administrative expense. In theory if a firm utilizes 50% of its space at any one time and if all spaces are substitutable and employment is stable, they could cut their space demand in half. Of course, this may create a stock out problem with insufficient space but in the case of Accenture they have shifted this overload demand to a variety of short term space providers, such as LiquidSpace.com, Regus, Servcorp, Bizspace, Premier Business Centers, Office Suites Plus, Corporate Office Centers or a variety of similar on demand short term office space providers. Such firms charge by the hour and provide private offices, workstations and huddle rooms and larger conference and presentation rooms. Of course, the library and

² See "Slicing, Dicing and Scoping the Size of the Commercial Real Estate Market," Florence, Miller, Peng and Spivey, *Journal of Real Estate Portfolio Management*, Vol. 16, No. 2, 2010.

³ Rough estimate by the author using the composite index of the Costar Commercial Repeat Sales Index, when value weighted.

⁴ Utilization rate here refers to the percentage of time that all work stations or desks or offices are actually occupied as a percent of total availability.

⁵ Source: Presentation by Dan Johnson of Accenture at the Corenet Global Summit, April 30, 2012 in San Diego.

Starbucks and others also provide alternatives to home based offices for those that need to escape working at home or need to meet up with others. Procter and Gamble has increased utilization rates and reduced space demand by standardizing cubicles so that nearly everyone in the firm has the same sized workstation and by providing huddle rooms for meetings and leasing less space than required for all employees. Whether many other firms will follow the lead of Accenture and Procter and Gamble and promote and support, or at least, tolerate remote workers and using shared flexible standardized office space remains to be seen. If they do, we will see a shift in the amount of space rented directly by users, a significant increase in the use of temporary office space providers and more people working at home, libraries, and coffee shops. This will in turn decrease the total amount of office space per employee as we move to higher utilization rates.

The estimate of office-using employment growth rate is no more or less critical an assumption than the space required per worker and at the same time, the disparity of forecast 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. One reason we find a huge 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, as described below.

Perspectives and Terms Vary by Trade Association

In 2007 IFMA, the International Facility Management Association, in conjunction with BOMA (Building Owners Management Association International) agreed upon terms that are different from those traditionally used in commercial real estate by brokers, developers and leasing agents within NAR (National Association of Realtors), NAIOP, (Commercial Real Estate Development Association) or CCIM (Chartered Commercial Investment Member). IFMA with BOMA came up with the following terms:

“Interior Gross,” which is basically the same as “Gross Area” in commercial real estate terms.

“Plannable Gross”: Perimeter encroachments are subtracted from gross area. For example, window seals are subtracted or posts and beams that protrude into the interior.

“Plannable”: Vertical penetrations like elevators and service areas are subtracted. This is fairly akin to what commercial real estate people call the RBA (Rentable Building Area) although the commercial real estate people may not subtract all space intrusions.

“Assignable”: This is the net usable space where all interior encroachments including demising walls and partitions are subtracted. The net useable space for commercial real estate would generally not subtract non-supporting interior dividing walls.

In a survey conducted near the end of 2009 and tabulated and published in 2010, IFMA received 424 completed responses detailing space use for different types of organizations. The sample was nationally stratified and included Canadian provinces as well as U.S. states. It was fairly proportional to population so the largest number of surveys came from California. The typical building was 31 to 50 years old but ranged from 1 to 200 years. Using the IFMA definitions of space, Plannable Gross or RBA was 93.8% of the Interior Gross. So as of 2009, landlords lost on average 6.2% of the building from rentable space, because of vertical penetrations and encroachments. When we go from RBA to “Plannable,” which we might also call “Usable Space,” tenants lose 16.2% off of the RBA based on the facilities managers’ calculations. When you go to “assignable” space adjusted for interior encroachments IFMA ends up at only 75.6% of the RBA. So on average tenants lose 16.2% of the RBA before they even divvy up the space according to IFMA estimates. This means that the tenant might consider themselves as having 250 square feet per worker (using the usable definition of IFMA) while a landlord might calculate this out at 298 square feet, as they are charging rent on the RBA space even though some of it is not usable. Right away we start to understand how the corporate facilities managers might have smaller figures per worker than real estate people who are relying on RBA definitions. Based on this one sample we see facilities managers as estimating significantly lower space per worker figures compared to asset managers within the real estate industry.

In section II below is a discussion on US national office space per worker trends compared by various geographic metrics. In section III this same discussion is continued in light of differences by industry group. Section IV reviews the prior literature upon which this research builds and section V presents a model within which we generate estimates of the amount of space per worker that will be observed on average, in light of stated efficiency targets. In section VI the conclusions and summary of findings are provided.

II. Space Per Worker Trends

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 national averages over time of 180 to 220 square feet.⁶ Newer modern buildings also allow more efficient use of space, especially when built to suit for a particular tenant who become first generation users. As the lease ages, the amount of space leased and the number of workers in the space often changes and so the space per worker often 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 2012, on leases close to expiration the average

⁶ Source: CoStar data in August of 2011. These numbers are reflective of a fairly tight economic environment where firms do not want too much excess space even though they feel that current rental rates are attractive.

space per worker is sometimes double the estimate for new leases.⁷ 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 Exhibit 1 is so much higher than the figures suggested by corporate real estate executives or facilities managers. We also must keep in mind that Exhibit 1 is based on RBA, rentable building area, and not the plannable or usable space that is used by the corporate real estate world. ***This difference in terminology alone explains as much as a 16% upward bias in the figures.*** Instead of 340 square feet, the corporate real estate person might calculate this as 283 square feet. Still, when we do not discriminate by lease origination date, that is, when the lease was signed, and simply look at how much space the average tenant occupies, the figures are quite large.

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 in the typical U.S. city, most tenants are able to honor their leases until the leases expire and pay for more space than they need. The extra space also provides an 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 over time 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. The more uncertain the future need for workers the more optional space a firm needs to control in order to be able to ramp up quickly, unless they are to rely totally on remote workers or temporary space providers. This point will be demonstrated later in the discussion.

Exhibit 2 is a sample of averages pulled from mid-2010 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.⁸ Only Honolulu in this survey is close to 200 square feet per worker as of 2010, and we know that 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.⁹ Exhibit 3 provides a rough global comparison of space

⁷ For leases with original terms of five years that are within the last year of their lease, we see figures that are double the estimate for new leases. This is certainly a reflection of a soft economy and lots of shadow space.

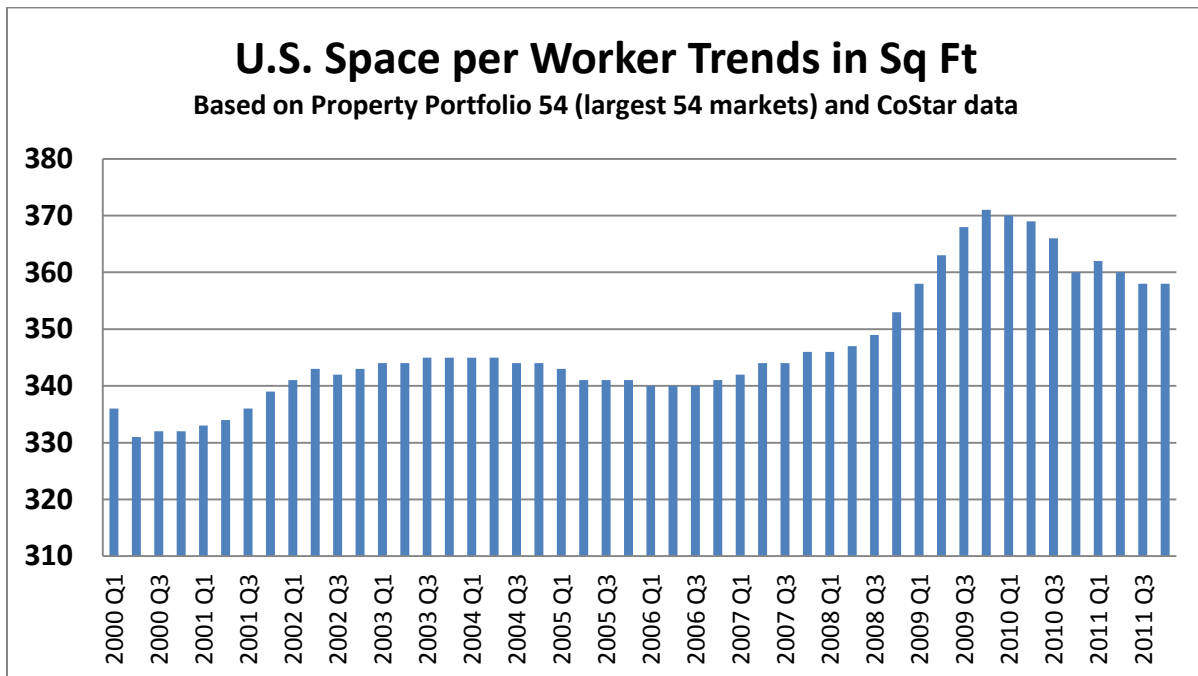
⁸ One other bias in the square foot per worker data is that in the larger cities where we observe retail space on the ground floors, this space is classified by CoStar as "office" and not retail space, so that there is a slight upward bias in the measurement. Certainly this is insignificant for the nation as a whole, but for large cities like New York, San Francisco and Boston it may mean as much as a 5% upward bias helping to explain why in Exhibit 2 we see larger numbers than might be expected in the larger cities.

⁹ 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.

per worker and we note that the Japanese and Chinese occupy much smaller footprints per person on average, reflecting perhaps both costs and culture.¹⁰

Certainly shadow space provides much of the explanation for the run-ups in 2008-10. If we take the lower 340 average square feet figure in the last decade as more realistic of what a firm prefers, we would estimate that, on average, firms had about 9% excess space in 2010, some much more and some much less. If you assume a lower figure, based on the more recent leases, but are still conservative at 250 square feet, you would estimate that the average firm has one-third of its space as excess shadow space as of 2010. Certainly this has and will continue to decline over time, but figures as conservative and elusive as 200 square feet per worker remain more aspirational than anything else.

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



¹⁰ Lydia Jacobs Horton of P&G suggests that it is much easier to format an office for less space per worker in China or Japan since they have not become accustomed to the vast large private offices of so many older American workers.

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

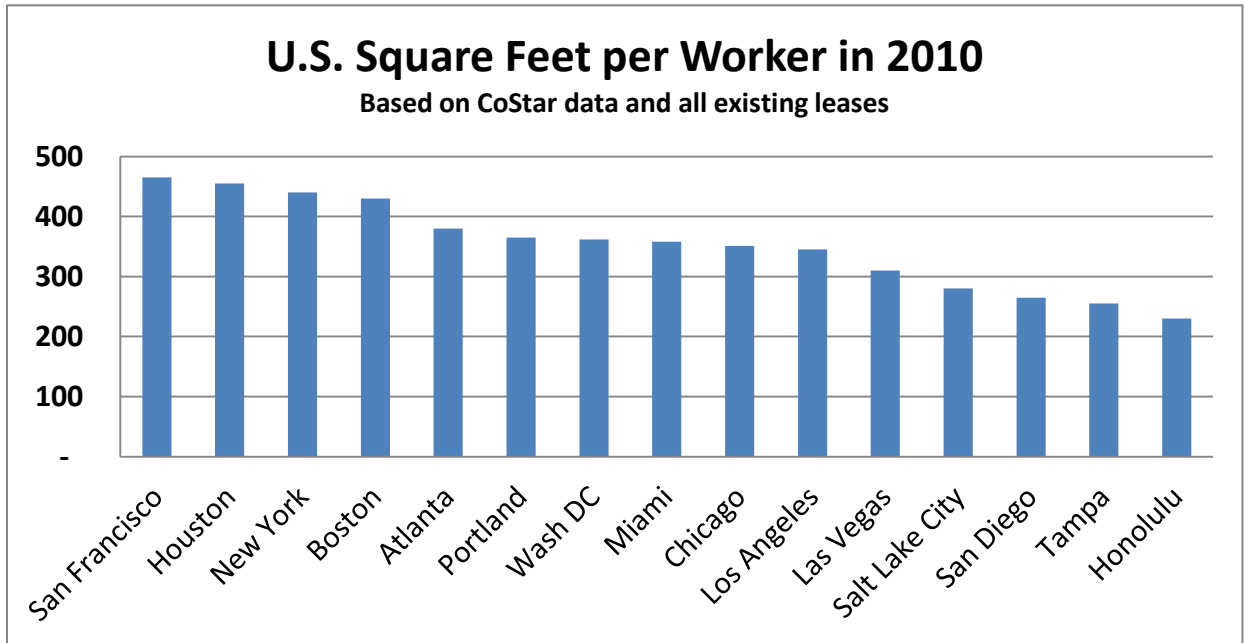
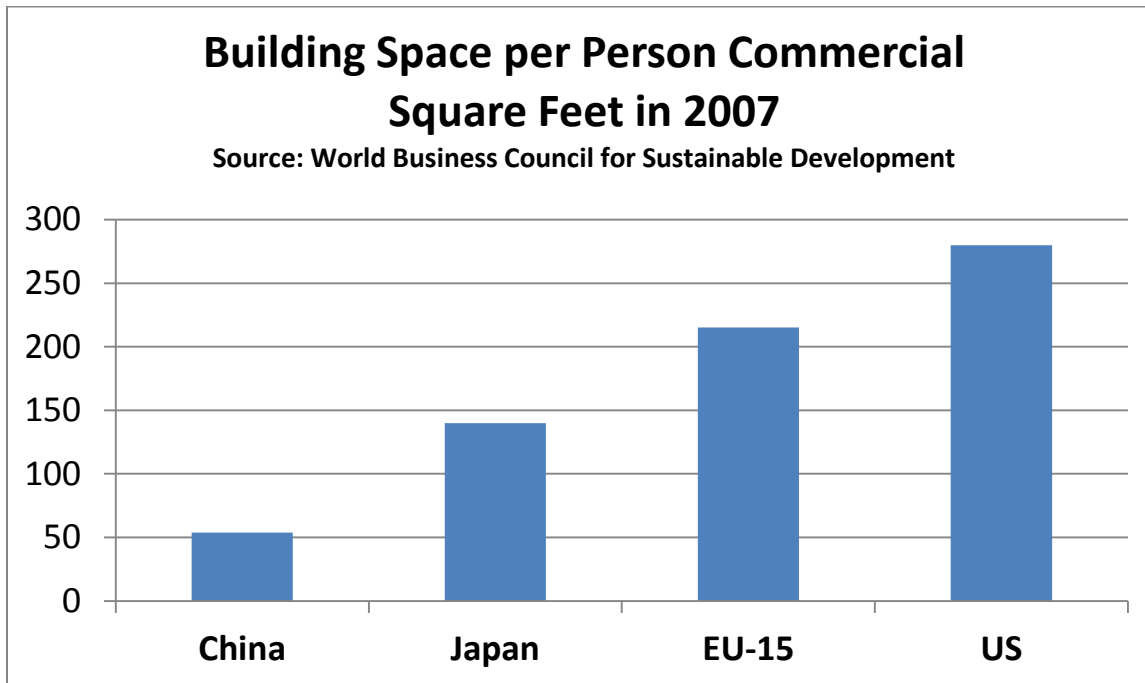


Exhibit 3: Building Space Consumption Varies Around the World

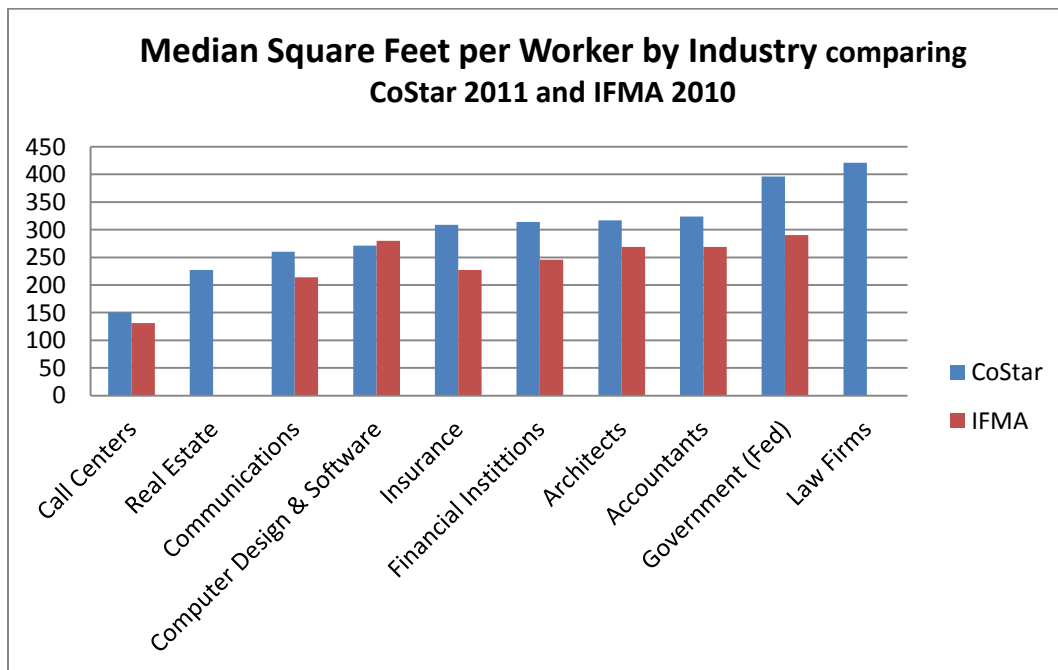


III. Space Per Worker by Industry or Function

Aside from call centers that cram a lot of workers into small cubicles where they answer telephones, we see fairly large figures for the typical space required by industry, relative to the goals stated by corporate real estate executives. At the same time call centers are now being

shifted to home-based workers, at least in the U.S., where computer networks manage phone call systems and workers answer phones when they are available, saving transport costs, overhead and allowing a more flexible work schedule so this group of intense space users may be less relevant in the future statistics. Knowing that 2011 was a year with significant shadow space, we would still expect to see some variation by industry. It is not surprising then that government space is both 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 Exhibit 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. We compare CoStar and IFMA data in this chart, which demonstrates perhaps some systematic differences in measurement definitions as well as different samples and slightly different time periods. 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. We see this approach used in the more sophisticated models of office demand, discusses next.

Exhibit 4: Space per Worker By Industry



IV. Prior Office Space Literature

Relying extensively on an excellent review of the literature by Rabianski and Gibler (2007) which covers the literature going back to 1965, we 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. Rabianski and Gibler, build upon the review work of McDonald (2002) and divide the body of literature into those models which are econometric in nature and those which are judgmental in nature. In the former case we have demand and supply models that attempt to capture the stock and flows of the office market, such as additions, deterioration or demolitions. In the latter case, we seek to understand the dynamics and how office demand is changing over time and what drives these changes, such as technology or the changing nature of where and how people work.

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, and this is utilized by Clapp (1989 and 1993) and many others. More ambitious modeling attempts using stock-flow models that included both demand and supply variables have been provided by Rabianski (1994 and 2004) and a continuation of work on industry segmentation as new industry classification approaches became available including both the older SIC (Standard Industrial Classification) and newer NAICS (North American Industry Classification System) first adopted in 1997. For example, Fanning (2005) uses NAICS and most studies in the future will likely rely on these more modern descriptions of industry grouping.

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, that the space may vary over time as the occupation and technology changes, and that space per worker may vary by market and costs. When viewed as a factor of production we may also see that the space demand per worker varies with changes in productivity, economic cycles where we see excess or tight supplies of space, and the real or expected costs of space. DiPasquale and Wheaton show that space demand is considerably higher per worker in relatively inexpensive markets compared with more expensive markets.¹¹

¹¹ DiPasquale and Wheaton, *Urban Economics and Real Estate Markets*, 1996, pp. 296-297.

The typical office demand model today will be based on the growth or decline in the particular mix of various industries over the next several years in a particular metropolitan area. A few such models will differentiate the space required per worker in different industries or by the type of use (headquarters vs. branch). The sensitivity of future office demand to the estimated space required per worker cannot be overstated.

Several studies have examined the trends in the space required per worker including Grissom and Kuhle (1983), Birch (1988), Dowall (1988), Crone (1989), Powers and Hunter (1989), Ragas, Ryan and Grissom (1992), Shilton (1994), Hakfoort and Lie (1996) and Liang and Kim (1998). En masse these studies have established how the space per worker has changed over time, differs by occupation, and market conditions, type and size of organization and as technology evolves. John White's 1993 commentary on space per worker reflects acknowledgement that technology, planning and design could affect trends in the space required per worker. White writes: "In the 1960s and 1970s, the introduction of air conditioning into office buildings caused an expansion of the total space demanded per worker because air conditioning equipment took up a great deal of room...at the same time...the use of office partitions and space planning reduced the amount of space allotted per worker."

Hakfoort and Lie had several hypotheses supported in their 1996 study including the following:

1. Office space per worker differs by industry sector and occupation.
2. Office space per worker is higher in smaller and older buildings. (Less efficiency is possible in smaller and older buildings.)
3. Office space per worker tends to be smaller in more expensive (rent) cities.

Office space per worker depends on the layout of the internal space. (Better space planning reduces space per worker.) We can summarize the evolution of the models as follows:

O = total office space demand in square feet

α = space per worker in square feet

β = share of total employment that is white collar

E = total employment growth over period t

e = professional employment growth over period t

i = industry i

m = metropolitan market

h = headquarters

cbd = central business district share

s = suburban share

$$O = \alpha \beta (E_m)$$

$$O = \alpha(e_m)$$

$$O = \alpha \sum (e_{mi})$$

$$O = e \{ \sum \alpha h_{m,i,cbd} + \sum \alpha (1-h)_{m,i,cbd} + \sum \alpha h_{m,i,s} + \sum \alpha (1-h)_{m,i,s} \}$$

While sequentially we have moved from models that used population or total employment estimates to models that differentiated professional employment to models that differentiated professional employment by metro, industry segment, central business district or suburban locations and headquarters or not, one critical assumption remains constant; the α , space per worker.

Space planners and in particular the corporate real estate managers from CoreNet Global and the facilities managers from IFMA (International Facilities Managers Association) continually strive for greater space use efficiency including office hoteling or sharing plans and more standardized and substitutable space. The goals of several reports from these two key trade associations are often 165 to 185 square feet per worker, and if you presume an increased trend toward telecommuting and office sharing, the existing office stock seems grossly superfluous. 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.¹² 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 - would quickly reduce the total demand for office space.¹³

As we read the goals of space planners and then compare the realities of space per worker trends and the space per worker on new leases we find they are totally incongruous. Bible and Whaley (1983) hinted at one reason for such differences in that occupied net space and actual leased space may differ and today we must presume a great deal of space is leased that is not actually required. As leases expire we should expect that new leases for many downsized firms will be in smaller spaces and lower space per worker figures. However, these economic cycles are not new, so unless the real costs of space have significantly declined, we should expect that space utilization and efficiency will trend down. We also note that if you start with assignable space per worker (their actual cubicle or office space) we see that from 1994 - 2010 the allocated space per person has declined slightly, from 115 to 95 for senior professionals and 90 to 75 for professional technical staff, excluding the conference space, team space and common areas that may have increased slightly over this same time period.¹⁴

To examine if the real costs of occupancy have trended down and if this could explain greater demand for total space or less pressures for the efficient use of space, we pulled a sample of CRSP (Center for Research in Security Prices) data from public companies and produced the following two Exhibits 5 and 6. What we observe in Exhibit 5 is that rent relative to operational

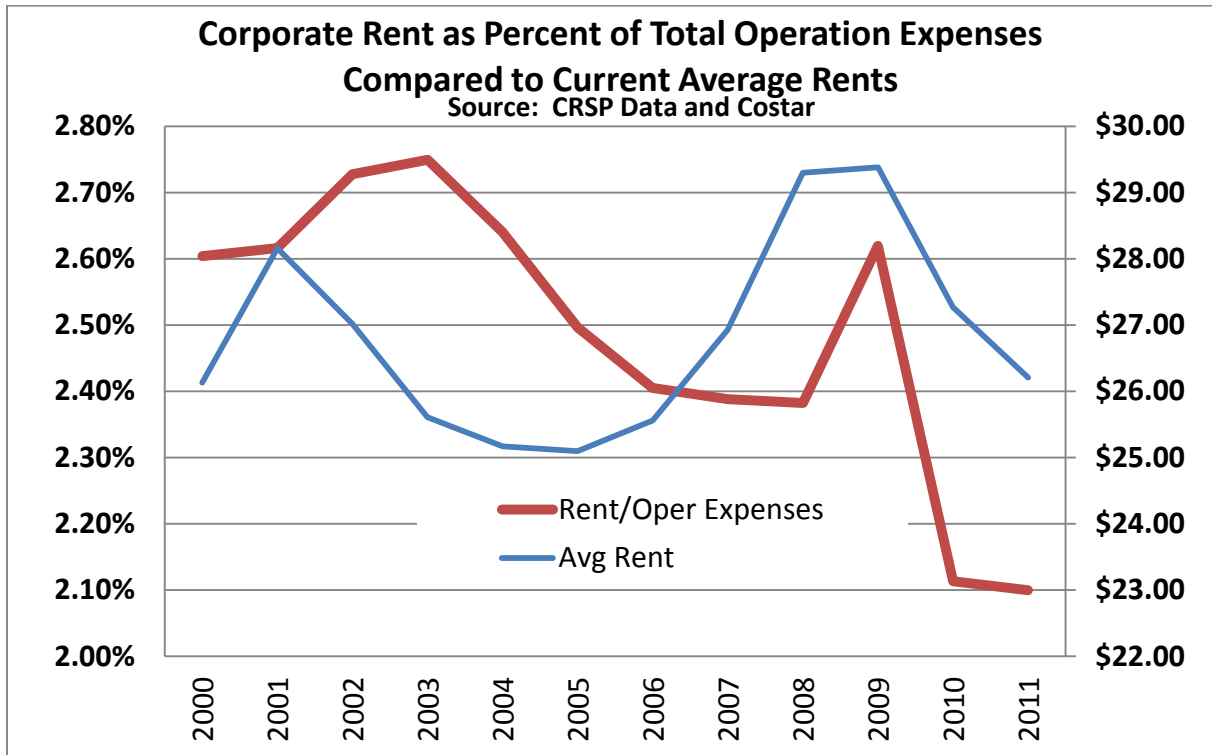
¹² Cushman & Wakefield “Occupancy Optimization Considerations for Professional Service Firms” by Matt Jackson and Nnenna Alintah, 2010, **Business Consulting Report**.

¹³ One assumption, verified in many studies suggesting office hoteling, is that many professionals are often out of the office in meetings, on sales calls, or engaged in business travel.

¹⁴ See IFMA 2010 Space Benchmarking Report.

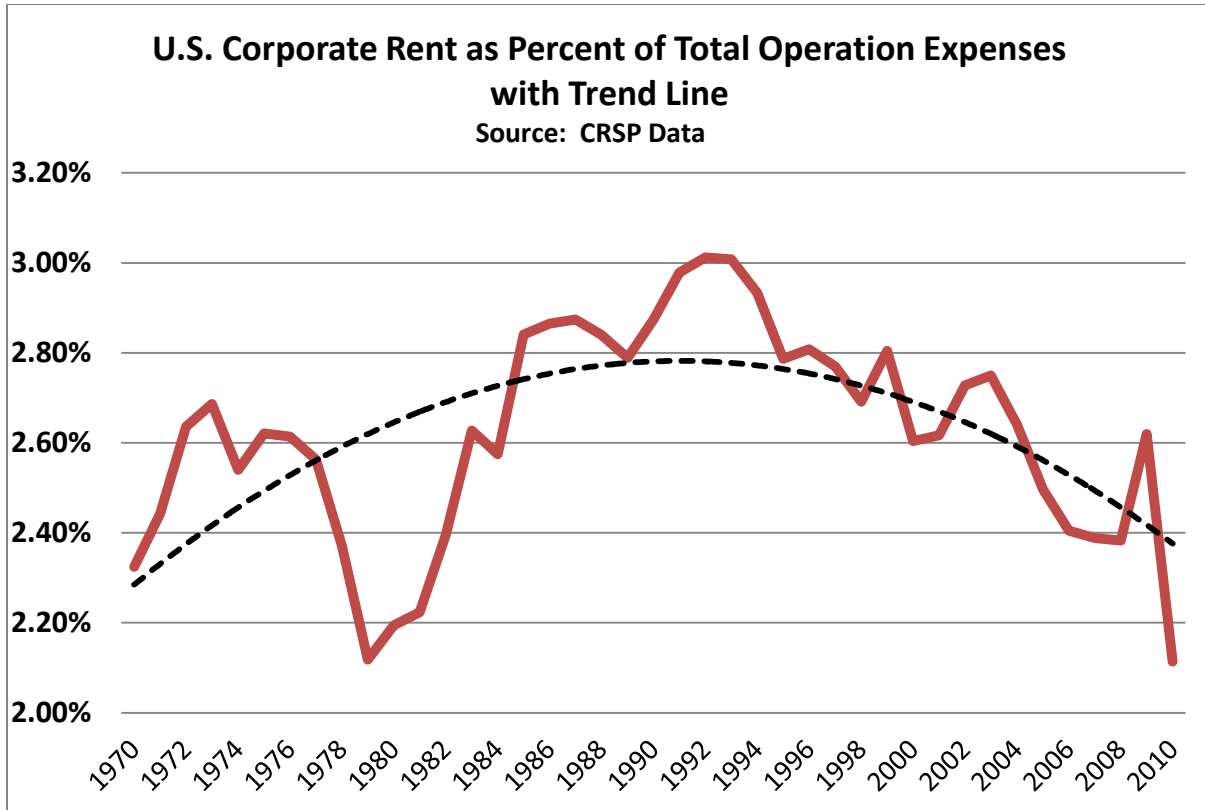
expenses are proportional to and lag average rents, so that as rents go up or down, so do the rent to operational costs for the firm.

Exhibit 5: Corporate Rent Relative to Total Operational Expenses of All Public Companies and Average Rent



What we observe in Exhibit 6 is that from 1970 - 2009, occupancy costs relative to total operational costs (including labor and all costs) increased in the 1980s and then have generally declined. From a peak of some 3% of all operational costs in 1993, we see that rent declined to around 2% of total operational expense in 2009, a relative decline of 50%, suggesting the real costs of occupancy have declined significantly from 1990 - 2010.

Exhibit 6: Public Corporation Rent as a Percent of Operational Expenses



Importance of the Space per Worker Estimate: Many analysts need to translate the changes in employment to expected changes in demand for space. Aside from adjustments for particular industries, if the average presumed is based on something slightly less than the current U.S. space per worker as the long-run equilibrium estimate, we might use 300 Square feet per worker. If we relied upon the targets of the managers from IFMA or CoreNet Global we might use something closer to 150 or even 100 square feet, and the difference in total space demanded is enormous, in the billions of square feet, with one estimate at double or triple the other. The truth probably lies in between and in the next section we will explore how we might reconcile the goals for space per worker with the actual observed market evidence. We will not try and differentiate demand for space as a function of quality (Class A, B or C or with the CoStar 5 Star System) but leave that to future research.¹⁵

¹⁵ We do know that historically as the office market weakens and real rents decline tenants often upgrade to better space.

V. Office Space per Worker Demand Generated from an Operations Management Perspective¹⁶

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.¹⁷ Still this is a useful framework for modeling space demand, consistent with 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 Space, Q , that balances these two costs. If these two costs were equal then we would end up seeking the amount of Q that has a 50% probability, P , of being too much or too little space. In this case, we seek to find Q that satisfies the following condition:

$$P(Q) = C_u / (C_u + C_o) \text{ such that } P(Q) < X = .5 \text{ where } X \text{ is the actual space required.}$$

But most often 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-fourth that of too little space, we end up seeking the following solution:

$P_x < Q = 4 / (4 + 1) = 4 / 5 = 80\%$ 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 solution is 80% then 20% of the time there will not be enough space and temporary space will need to be provided at a much higher cost.¹⁸

The approach used in operations management is no different from that used in microeconomics where we set the marginal benefits equal to the marginal costs as the minimal sufficient condition for an investment decision, such that the last unit of space added, Q^* , 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.

¹⁶See Silver, E.A., D.F. Pyke and R. Peterson “Chapter 10: Style Goods and Perishable Items” in *Inventory Management and Production Planning & Scheduling*, John Wiley & Sons, Third Edition, 1998. Note that if we took a space planners’ perspective, we might start with a cubicle or office and make assumptions about how many times and what size of conference space and team space that employee type might need to generate a total space demand model. In either case we should end up with an average target of space per worker, when the worker is actually present.

¹⁷ One can imagine shorter-term leases with lots of options to renew and lots of expansion rights as a solution to such problems, but these lease clauses are not free and need to be priced. These issues will be addressed later.

¹⁸ The higher the cost of temporary space the higher this optimal ratio, so that if the temporary space on average costs 4 times the regular space the solution is 80% and if the temporary space costs 9 times the regular space the solution is 90%, using the above formula.

A key determination in the size of the space decision is the confidence we wish to have that we will have enough space. Given the costs of too little space compared with the costs of too much space in the framework shown above. The greater the variance of the actual space that will be required, the greater the total space that must be secured at the start of the lease since this extends the optimal Q when we are targeting a certain confidence level. If the space is not expandable, the space secured must also take into account the growth rate of the space required, which can be thought of as another form of variance. If we can secure an option for more space and reduce initial leased space, we can determine the maximum charge for such an option based upon the savings in the stock-out costs, or lack of sufficient space, during the initial time period at a given confidence level.¹⁹

The Effect of Friction: When internal spaces are not substitutable.

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 transactions 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 we can conclude that the less substitutable the space, the higher will be the summed average space per worker in a firm, all other things equal.

One can also envision the effects of turnover on optimal space decisions. The lower the level of turnover – often a sign of a well-managed and well-motivated workforce – the easier it is to plan for space needs. Some firms have turnover rates above 30% and rather than constantly moving workers to empty offices, many desks or cubicles are likely to remain unoccupied pending the time required to recruit, train and re-staff. So, the higher the turnover rates of any given firm the

¹⁹ We will leave the pricing of option space as a separate research question, but suggest it could be modeled within this framework.

higher the variance of total space demand and the increased likelihood of needing more space per worker.

Simulation Analysis of Optimal Space per Worker

We can simulate many of the effects discussed above and will do so below. The key variables for the simplest model, where all workers are treated the same (no difference in space per worker) are as follows, with the low, base and high figures provided:

	Low	Base	High
Initial number of workers		119	
Average space per worker as targeted by space planners	165	185	205
Annual turnover rate in employees	10%	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%	10%
Length of initial lease	3	5	10

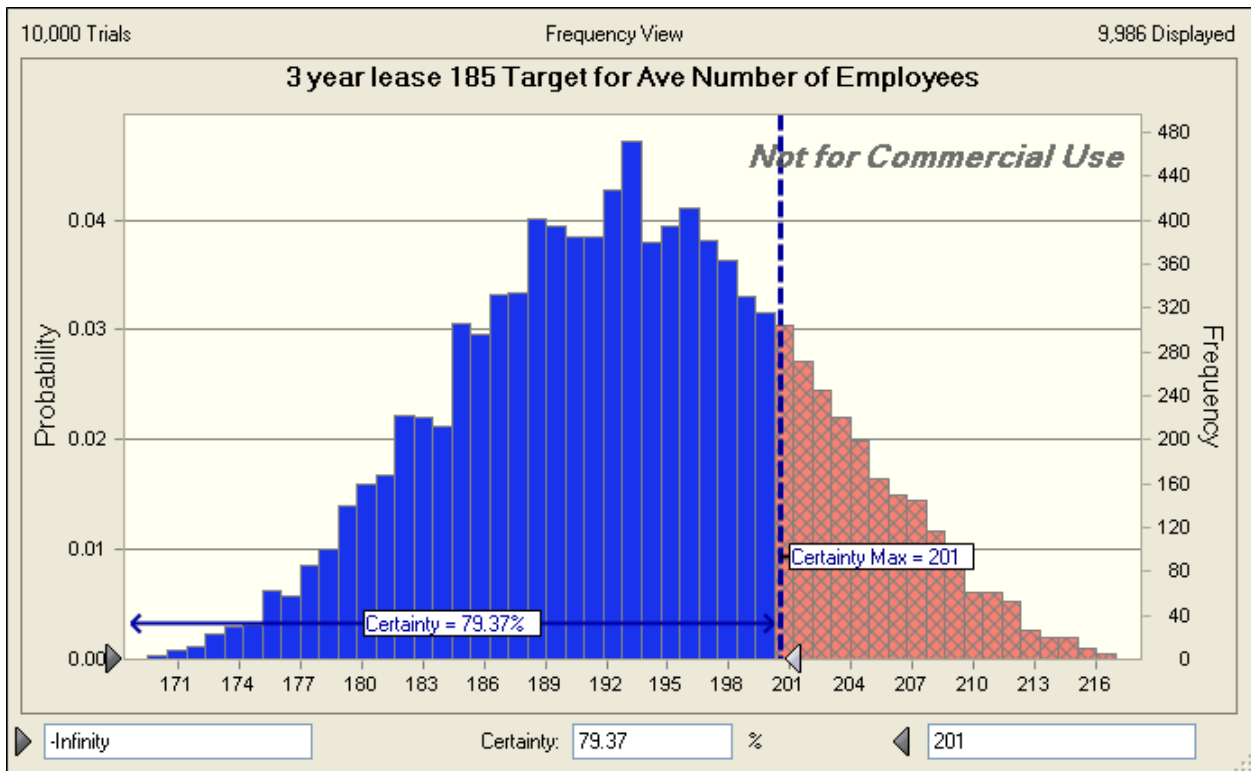
Triangular distributions were utilized in a Monte Carlo style simulation. Space required equals the initial target space per employee times the number of workers, which may vary over the term of the leases as we allow turnover, variance in growth of employees, and could have even accounted for downsizing. The model is a rather simple multiplication process with a great deal of variance. When we introduce non-substitutable space we merely use three demand models simultaneously and sum the results. First, we will compare the results from varying lease terms, then we will examine volatility in employment growth and last we will introduce friction in space substitutability.

Comparing Three-, Five-, and 10-Year Leases

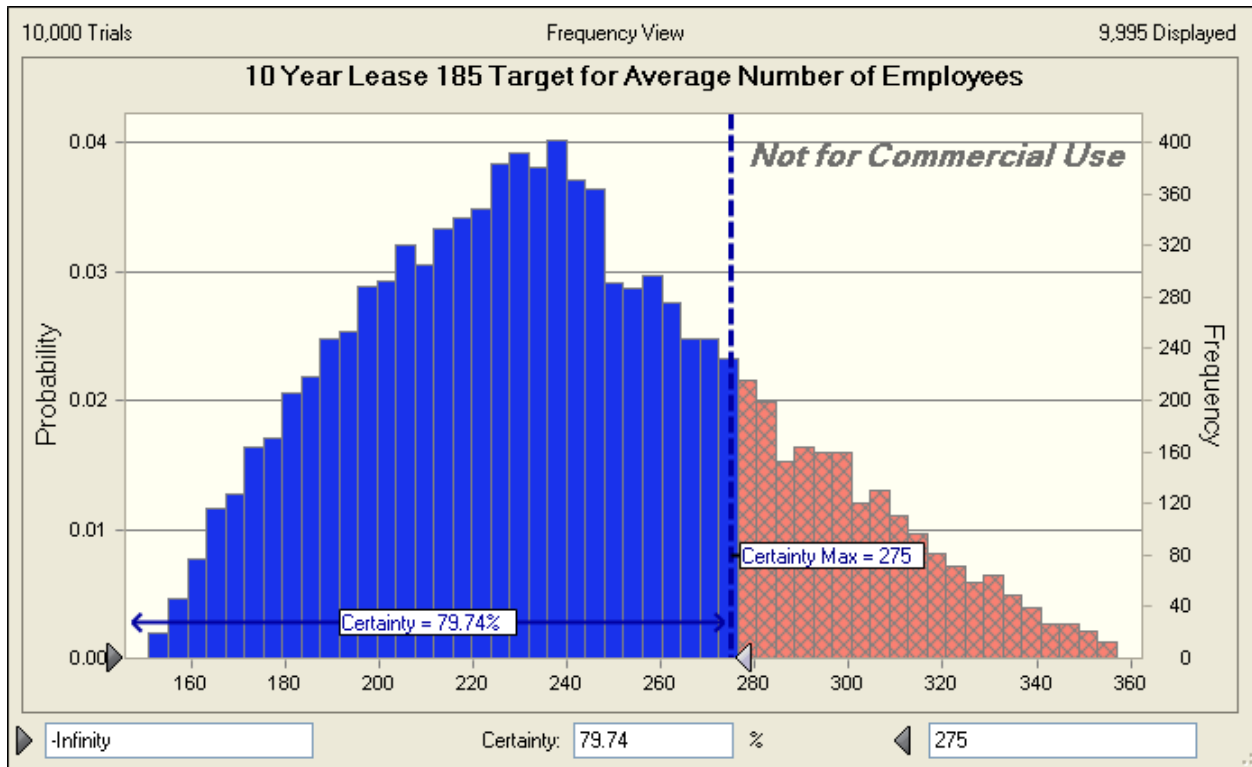
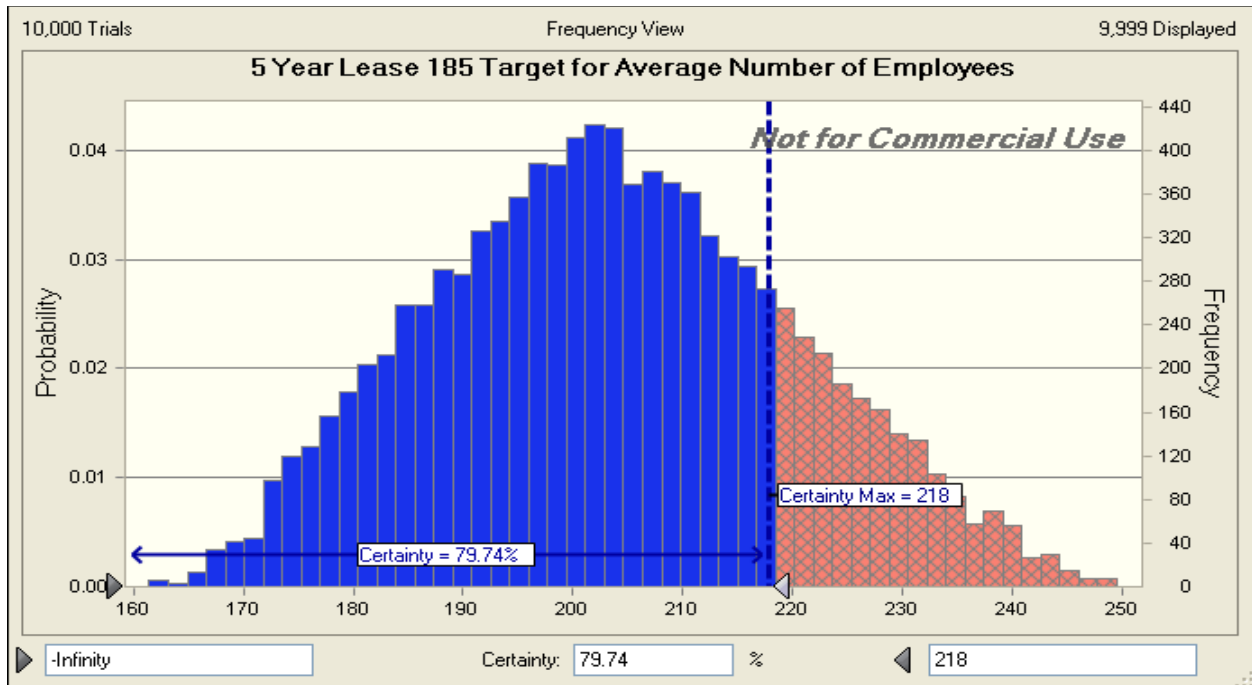
The longer the term of the lease, the more space that must be leased now relative to the average number of employees using that space over the term of the lease. Here we see the initial target set at 185 square feet allocated per worker, but with the turnover and growth of the firm and the need to secure more space than the initial number of workers need, we end up with significantly higher averages per worker: 201 square feet for the three-year lease, 218 square feet for the five-year lease and 275 square feet for the 10-year lease when using a confidence target of 80%. If one was using a 100% confidence limit that there would be enough space, the results would be 216, 250 and 316 square feet respectively for the three-, five- and 10-year leases. These results are shown in Exhibits 5a, 5b and 5c below. If we base our square feet per person on the initial employees working in the same space, the results would be even higher, decreasing with each

year of the lease, so the period in which one samples the space per worker relative to the lease term is quite significant in understanding the results.

Exhibit 5a: The Impact of Lease Term

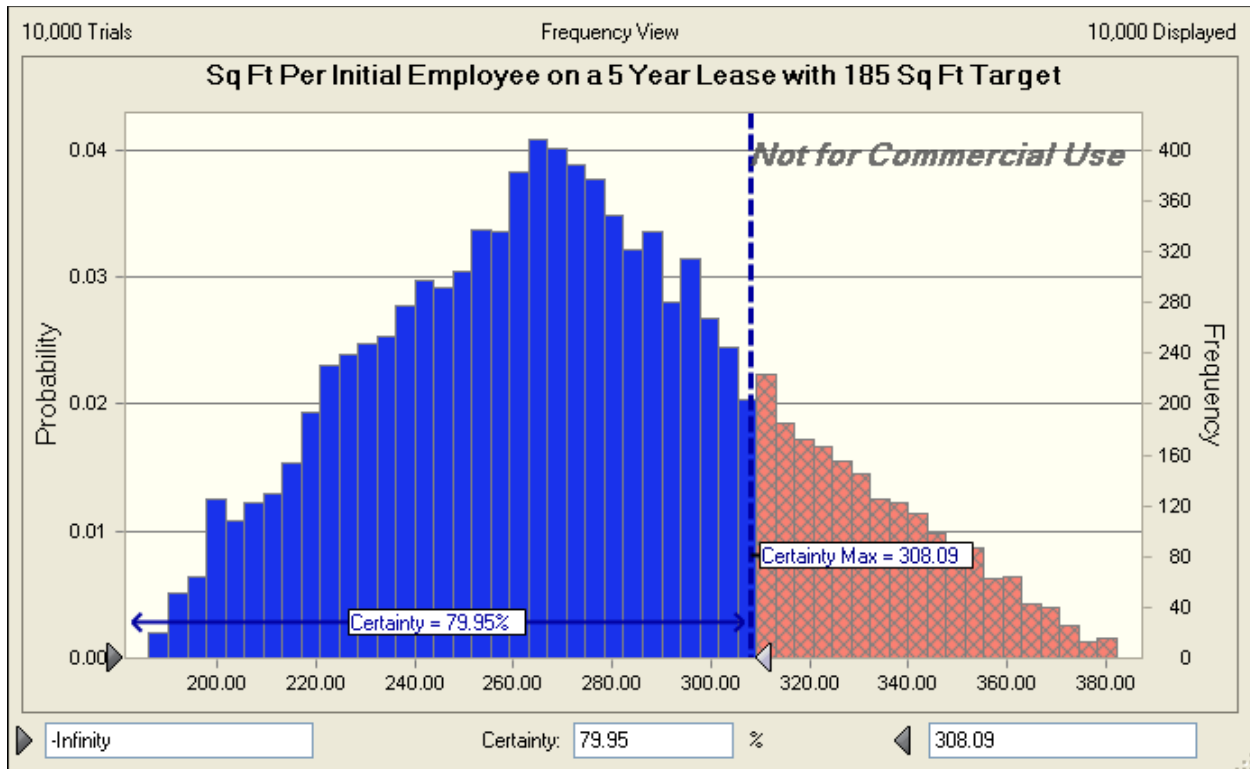


Exhibits 5b and 5C: The Impact of Lease Term



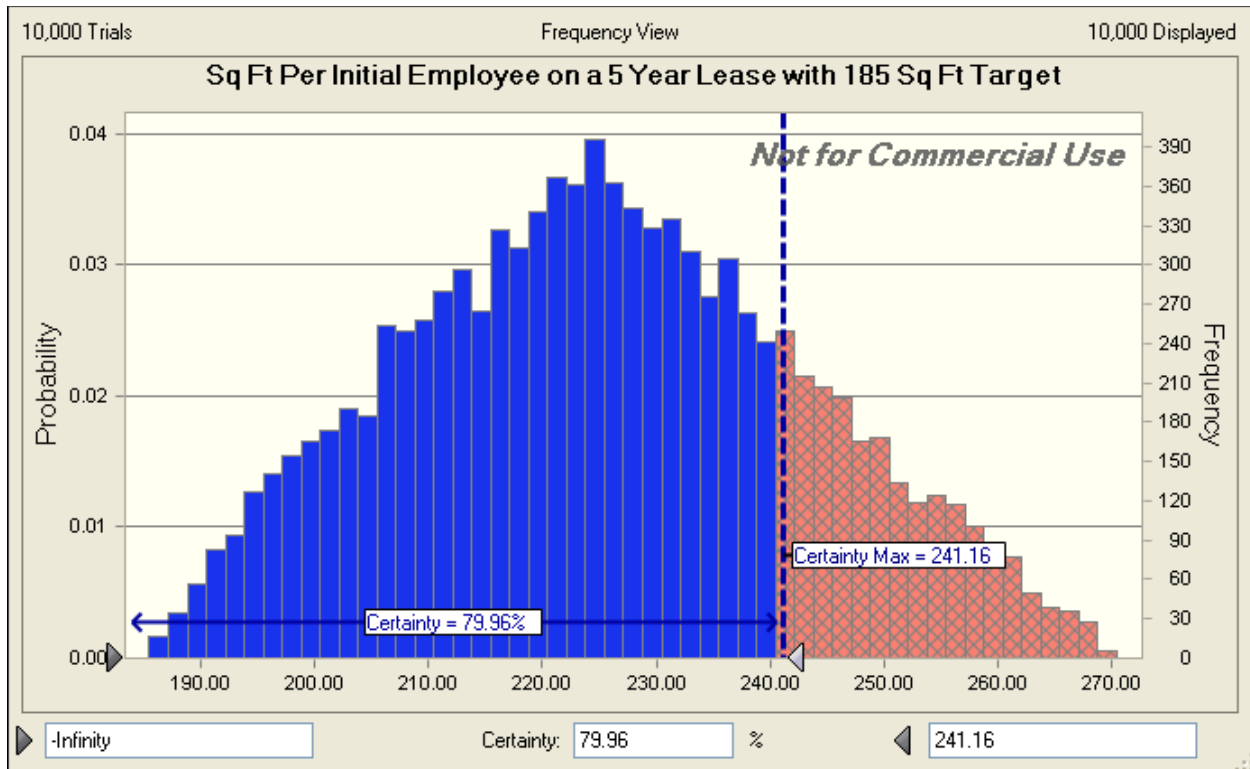
The impact of a faster growth rate on the initial space required per worker over a five-year lease with a target allocation of 185 square feet per worker is shown below in Exhibit 6. Here we see that if we want to be 80% confident that we will have enough space per worker, we will need to lease approximately 308 square feet per initial employee when the firm is growing from a range of 0 to 20% per year with a mean expected growth rate of 10%. This compares to 220 square feet per worker for a firm growing at 5% per year. Obviously rapidly growing firms need to lease extra space or else plan to double up if space planning allows for doubling up.

Exhibit 6: Sensitivity of Space Demand to Growth Rates



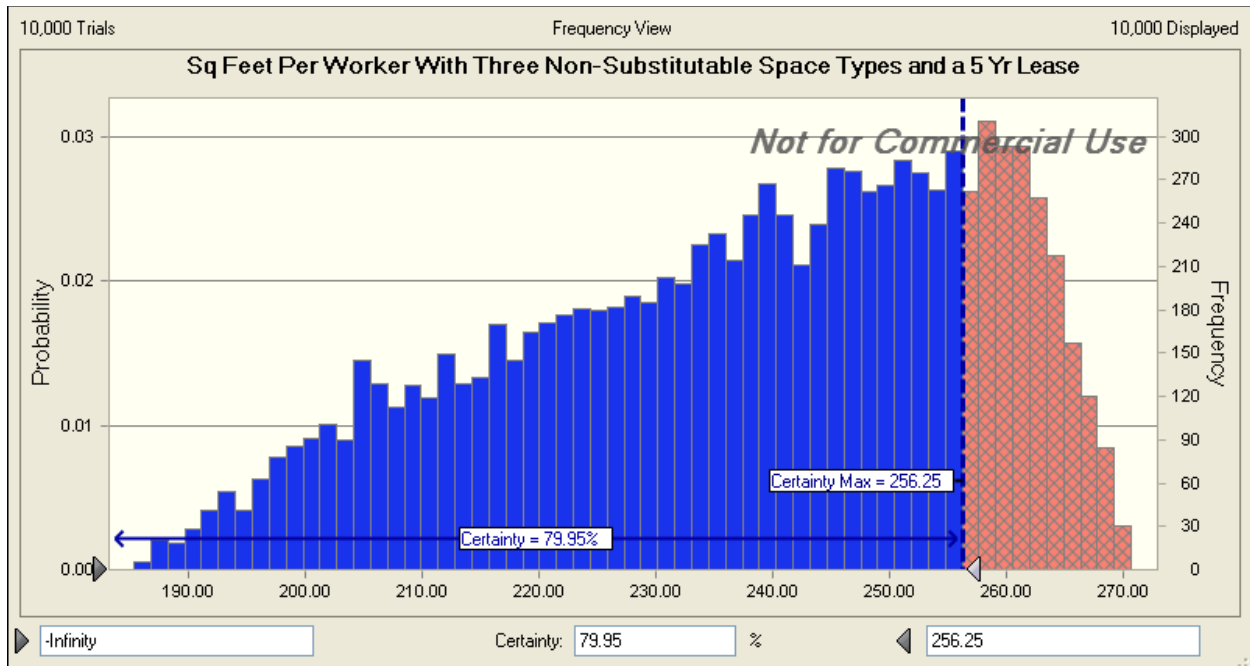
Below in Exhibit 7 we go back to our base case but increase the churn rate of the employee turnover. While there is some impact, it is modest as long as the time to fill positions is modest with low volatility.

Exhibit 7: Sensitivity of Space Demand to Churn Rates



As we increase only the uncertainty over the time to fill positions, so that the minimum is one month and the maximum is eight months with a mean of three we see no impact on the space required since more people may be out of the office and not need space. As long as this absence is somewhat predictable and we have standardized and substitutable space, it does not have much impact. But when we introduce three types of space that are not substitutable and allow frictions in all three spaces with the same general assumptions as in the base case, except that staff space is not substitutable with middle management and neither are substitutable with senior management, we get a result that is much larger than in the case of homogeneous space, all of which may be substituted. This is shown in Exhibit 8 where 60% of the space is staff, 30% middle management and 10% senior management. The result is a significant increase in total space required.

Exhibit 8: Sensitivity of Space Demand to Three Levels of Non-Substitutable Space

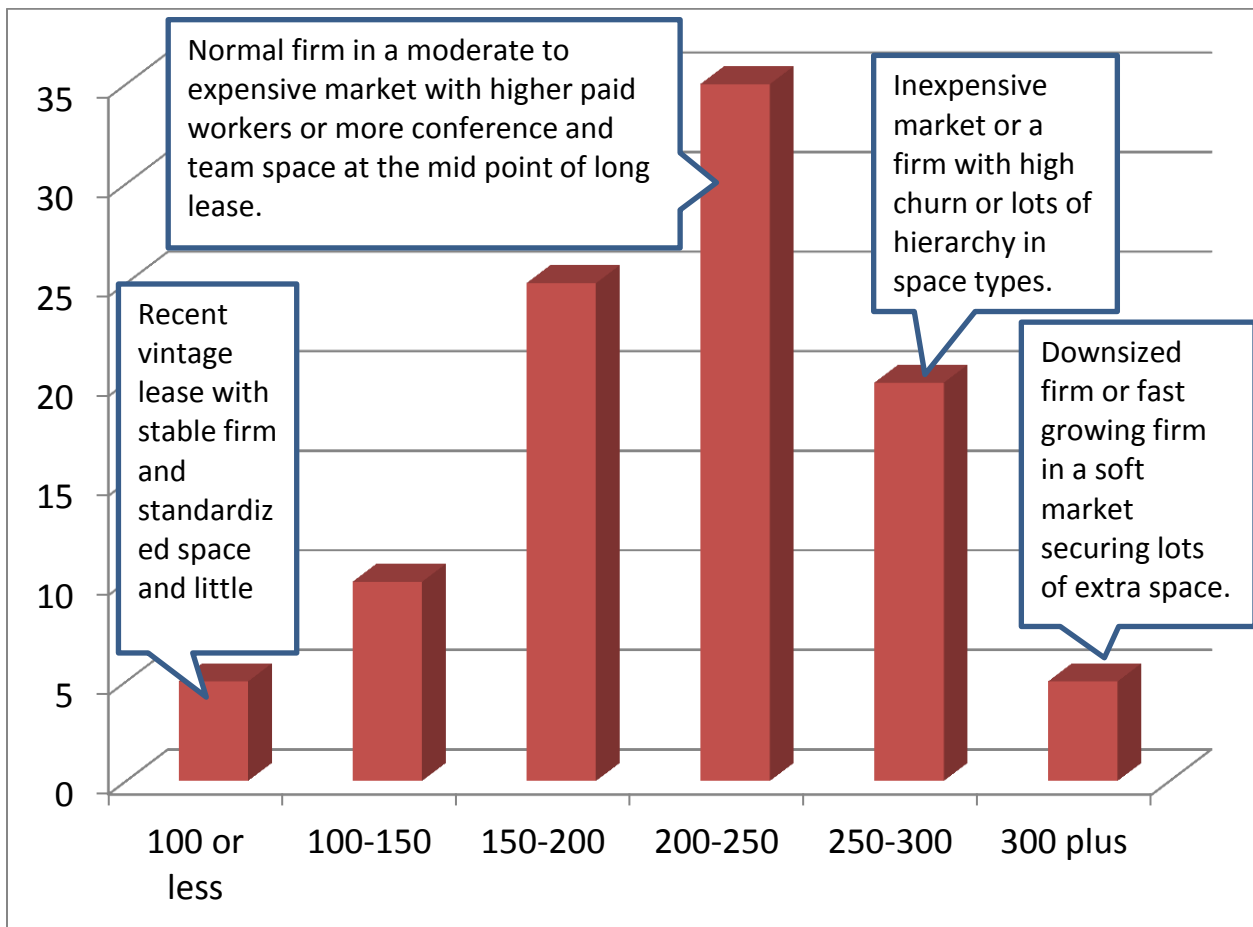


Findings

- 1) While firms may target 205, 185 or figures as modest as 100 square feet per worker, only a firm with an extremely stable worker base, a significant portion of remote flexible workers, little turnover and modest growth could possibly get close to achieving the targets on average over the course of an entire lease and then they would require the occasional use of temporary space providers. Had we started with space targets of 100 square feet we would have ended up with something closer to the range of 125 to 150 square feet person for such firms. To get to 100 square feet per worker, one must start with targets as low as 60 square feet per employee.
- 2) The higher the confidence limit required that all workers will have sufficient office space, the larger the space per worker required. As we relax assumptions about worker stability and firm growth, we find that much more space is required relative to initial worker counts at the start of a lease than expected at lease expiration for any multi-year lease. The longer the initial lease, the more space required per initial worker, unless additional space options are built into the lease and the firm has the ability to easily add increments of space.
- 3) The faster the growth rate of the firm in terms of required workers, the more space required at the start of a lease. Of course shrinking firms will far exceed space per worker targets.
- 4) The greater the churn rate of workers, the more space required per worker.

- 5) More time required to fill a position does not impact space per worker as long as the time required is consistent and predictable.
- 6) More homogeneous and standardized office space configurations will be able to have much lower space required per worker than offices with several different types of space that are not substitutable. Thus, an office with the same type of space for both staff and middle management with only senior management having larger or unique offices, will be able to greatly reduce space requirements compared to firms with several different types of non-substitutable space. The implication is that branch operations with more standardized space will be able to use the space more efficiently than headquarters and those with more managerial delineation for office space allocations.

Exhibit 9: Descriptive Results of the Square Feet Per Worker Simulation Models



VI. Conclusions

One reason why space planners and facilities managers perceive the space per worker as lower than the real estate players who develop and lease space is merely definitional in nature. IFMA and Corenet Global use definitions that result in space estimates per worker that are some 16% smaller than those used by NAIOP and BOMA.²⁰ Even when we make adjustments for these definitional differences a significant chasm remains with respect to targeted space per worker and actual space per worker, as represented by the last few decades in the US office market.

Since the turn of the millennium, we have seen office space per worker in the U.S. average more than 300 square feet, while at the same time many space planners were aiming at much lower targets. Office space per worker peaked near 370 square feet at the end of 2009, a year or so after the trough of the recession. In the years that followed, leases finally expired and firms were able to downsize space that was no longer needed. Clearly, significant shadow space remains as of 2012, and some will be eliminated as the lease cycle facilitates the ability to wring out even more excess. How much we will continue to reduce space per worker is not an easy assessment, but it is a critical assumption in all forecasting models of office space demand.

Team space, game and fun and fitness space for gen x employees, and conference space and even temporary space allocations for visiting colleagues all add to the space per worker equation and these figures are less likely to be decreasing even while the individual work space per worker are decreasing. It is total space per worker that is relevant to those of us forecasting future office space demand.

We have seen office space design move toward improvements in natural light access, as required by such standards as LEED.²¹ This, in turn, has led to the use of more cubicle space with lower partitions and possibly also led to more standardized space. If we move to more standardized worker space, we will see space per worker decline since space substitution, or the lack thereof, is one of the major reasons why firms do not use space as efficiently as desired. Firms retaining a multi-level hierarchy of management, with 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.

Other trends that might help explain the seeming excess of space compared to space planning targets include the trend toward multi-office branches and the existence of global firms that require occasional office space for visiting colleagues and clients. Many a senior management person retains an empty office in one city while using a visiting office space in another city.

²⁰ IFMA is the Institute of Facilities Managers Association and NAIOP is the International Association of Industrial and Office Properties. BOMA is the International Building Owners Managers Association.

²¹ LEED, leadership in energy and environmental design, as developed by the US Green Building Council, requires that 75% of the occupants have access to natural light. See www.usgbc.org. LEED certified office space now accounts for about 15% of the total space of all US office space.

Changing the culture of American workers towards shared and standardized space is not likely to happen quickly in traditional firms like most law firms.

Technology has been touted as one factor that will result in firms requiring less space per worker in the future than in the past. Certainly machines have gotten smaller and all workers have become more mobile. New software has enabled many firms, like call centers, to let workers stay home, linked by automated systems, shifting the space required from a central workplace to home. But the demise of the office market has certainly been exaggerated, and we will likely see a continuation of space demand far in excess of the targets espoused by space planners. 100 square feet per worker is not realistic for most firms for space in the United States. 150 square feet is possible but requires a culture change for many firms as well as the use of temporary and remote work space.

One factor working against the pressure to reduce excess space is the decline in the real occupancy cost per square foot over time during the last two decades, both in terms of real rent and as a percent of total corporate operating expenses. Option costs inherent in holding onto excess space for future expansion are not that costly compared to the transaction costs of finding more space and fitting it out. Labor costs continue to dominate the operational costs by a factor of about 10 to 1 within professional services, and productivity increases of 10% would more than offset the typical rental charges in most markets.²²

In a series of simulations that were based on a stock-out model, we find that even with modest targets of 185 square feet per worker and five-year average lease terms, we are likely to observe figures closer to a range of 200 to 225, not unlike the assumptions in many forecasting models used today. Targets of 100 square feet per worker or less are even harder to imagine, unless you are running a call center or utilizing extreme sharing models with lots of standardized space and lots of temporary space availability.²³

If the economy is growing faster than average or merely in turmoil with winners and losers, we could easily see figures nearer 250 square feet per person, and even more space for those firms maintaining a hierarchy of different types of non-substitutable space.²⁴ These results are based on U.S. averages and certainly more expensive markets will see less space per worker, while cheaper cities will see higher space per worker averages. Culture will play a part in how quickly, if ever, the U.S. market can adjust to international standards of adequate space per worker, which tend to run much smaller than in the US even with fewer remote workers.

²²See N. Miller and D. Pogue “Green Buildings and Productivity” *The Journal of Sustainable Real Estate*, Vol. 1, No. 1, Fall 2009.

²³ See CoreNet Global Research: “Office Space per worker to drop to 100 sq. ft or below for many companies within five years” *Facilities Management News*, March 2, 2012

²⁴ Note that as we move toward more standardized space such as cubicles, these are not adaptable to sharing or doubling up as we have seen in the past where in larger offices two desks were squeezed into the space planned for one.

We could use the framework provided here to estimate the value of space options and shorter-term leases as that is the only way we find that firms can easily start with actual space planning closer to the longer-term targets. Those firms concerned about locking in long term space at attractive rates and making sure they do not have a stock-out of space will need to over-consume near term space relative to stated space per worker targets, just as they have the last decade or more.

Last, when forecasting office space demand in the future, one should pay attention to the actual empirical evidence of what we have consumed in the past, as much as to the targeted figures one hears from space planners. In the real world of worker turnover – with both growing and shrinking firms – it is extremely hard to reduce actual space per worker to the stated goals.

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