SUPPLY-SIDE ANALYSIS OF THE COMMERCIAL OFFICE MARKET AND A REPLACEMENT COST INDEX

by

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ABSTRACT

From the research undertaken, cost elasticity and normal profits suggest there may exist a series of quality/cost curves which determine the level and type of supply which enters the market in response to demand and the willingness for participants to pay for a unit of quality. The dynamics of supply in the Commercial Office Market are considered within the theoretical context of both equilibrium in the office market and urban land rent theory.

Based upon over 44,000 records received from F.W. Dodge, summarizing the cost and characteristics of commercial office buildings built in the U.S. since 1967, a hedonic office replacement cost index is developed for sixteen Metropolitan Statistical Areas. (These data are proprietary, and their use in this thesis is by permission.) The basis for the index is the methodology popularized by both house price indices and a commercial office rent index. Utilizing the output from the cost index, the elasticity of supply and cost elasticity within the commercial office market are analyzed to provide a framework for understanding the dynamics of supply. This research also provides a comparative analysis with other popular industry-standard cost indices and compares the level of cost with inflation. An example is provided which demonstrates the functional use of the index to determine the level of rent necessary for the development of new supply.

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And to my wife, Adriana, I dedicate this thesis.

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Chapter One

The question addressed is, can we construct a useful commercial office cost index which will allow us to value "average" buildings over time, and allow us to develop a model which would determine the minimum level of rents required for new development to occur, given a range of building quality. Furthermore, by understanding the level of prices in a market for an average building, will the cost series allows us to effectively analyze the cost elasticity and the elasticity of supply in the commercial office market?

For investors and users of office space, such information can be critical for long term decision making. For investors, if the supply is relatively elastic, how stable are rents if new supply can enter the market with relative ease? Will the new supply compete with the existing supply or will the new supply exist for a different segment of the market? For the user of space, if supply is "highly" inelastic, is it better to incur a long term lease at presumably relatively lower real rental rates. Conversely, if the supply is relatively less inelastic, what is the option value for waiting for new space to enter the market and thus secure comparable real rental rates but purchase a higher level of quality? Furthermore, for accounting and insurance purposes, what cost represents a valid "replacement cost" in any given year?

The various models that address demand in the commercial office market use the change in vacancy to forecast trends in demand as well as indirectly capture changes in supply. In the simplest sense, such models therefore assume that as long as vacancy trends towards lower rates, the casual relationship with rents will cause increased returns. Such an argument holds that so long as vacancy remains high and occupied space is low, minimal construction should occur. If this is true, given the high levels of vacancy still occurring, why did a city like Chicago add 1 billion dollars worth of space[1] comprising 2.25 million square feet since 1990? This amount of new supply would represent an obsolescence rate of 1.48% when various researchers (Barth, et al. 1990) estimate the obsolescence rate at only 0.6%.

This analysis assumes two reasons for continued, and perhaps, excessive construction activity in the presence of low obsolescence and high vacancy. First, with the onset of technological advances, the rate of obsolescence seeks different levels across building types and fluctuates over time. Secondly, owners of commercial office space chase yields by capitalizing the rent stream. From a developer's perspective, if the capitalized rent exceeds the cost of construction, marketing, development and interest costs (and normal profits are assured), then construction should take place (in this simplified net present value argument). From an investor's perspective, if the capitalized rent and terminal value of the asset exceed the purchase price and allow for normal profits given the risk of the asset class, then the purchase should be made. But still, the efficient market hypothesis suggests that users should bid down existing rents, absorb the excess supply and that only minimal construction should occur. Do commercial office users pay different rents based upon a level of "quality"?

[1] 1993 dollars.

By developing a replacement cost index controlled for quality and capitalizing the replacement cost index, the level of rents necessary to bring about additions to supply can be forecast. In conjunction with a rent index, we can forecast the changes in the commercial office market. With respect to cost elasticity and the elasticity of supply, given an average building type and a level of stock, we can estimate the relative elasticity in order to make decisions regarding investments in a particular market.

Chapter two of the thesis will discuss the dynamics of office supply within the context of urban land rent theory and office market equilibrium. The "four-quadrant model," developed by Wheaton and DiPasquale, will be presented to establish a framework for how the supply of office space interacts with demand for both the user and the investor.

Chapter three discusses the data received by FW Dodge and considers the general trends in the supply cycles of the office market over the past number of years.

Chapter four develops the methodology behind the replacement cost index. Extending the principles of hedonic price indices for housing and rents for commercial office space, an explanation will be given for the hedonic replacement cost index. The results of the hedonic index are presented along with a description of the model parameters. An explanation is provided which highlights and distinguishes the differences across markets. The cost elasticity with respect to the individual building attributes are also calculated and an explanation of the results is presented. Utilizing the index, a nominal cost time series is presented for the Boston market which highlights the cost of a structure based upon various quality characteristics. Given average building characteristics, the office replacement cost index for each market is calculated and the results, on both a nominal and real basis, are compared with the popular "Means Construction Cost Index." Not surprisingly, there are striking differences between the Means Index and the Replacement Cost Index. For the comparison, both indices are scaled to 1982.

In chapter five, the elasticity of supply is presented for certain markets along with a preliminary model which forecasts the level of supply in selected markets. Chapter six concludes the empirical analysis and suggests areas for further research.

Chapter Two

DYNAMICS OF OFFICE SUPPLY: EQUILIBRIUM

Presumably, the profitability of new development is dependent upon the cost of construction, the cost of short term financing and the level and "speed" of demand in the marketplace. Thus, the supply of space is a function of the level of stock, absorption, vacancy, employment growth and rents. Addressing the supply of commercial office space in its most basic form, we can look to both the "four-quadrant" model described by Wheaton and DiPasquale[2] as well as the theory of the urban land market as described by Alonso.

As described in the four-quadrant model, from a supply perspective, equilibrium is reached when capitalized net-rents equal the cost of construction. The supply function is inelastic and the slope of the curve depends upon construction interest rates. At equilibrium in the four-quadrant model, the amount of space supplied is a function of both demand through the asset market as well as the obsolescence, physical depreciation or abandonment of older lower-quality office space in the property market.

Economically, the marginal cost of replacing the depreciated stock will be a function of the costs necessary to secure the resources (land, labor and capital) to build the space. Applying a standard supply schedule, the cost of securing these resources increases as other sectors in the economy bid for like resources. Presumably, the elasticity of the

[2] Wheaton and DiPasquale (forthcoming).

supply schedule will vary across metropolitan areas and determine the relative cost of these resources. In the model, this supply schedule depends upon the replacement cost of the obsolete structure. To advance this theory, the level of the replacement cost in a given year will embody advances in building technology and quality over time in a rational market. That is to say, if the market were irrational, a developer might construct a building today of inferior (though not necessarily lower) quality and thus a lower replacement cost in order to capture abnormal profits. The assumption though is that the users of such space do not survey the market for the lowest quality at the highest price. Thus, we will assume an efficient demand market. Therefore, a rational developer will increase quality at the margin in order to be competitive and secure rents.

In the supply quadrant, the cost for a "unit of quality," on a life-cycle basis, presumably decreases. If we draw an analogy from the labor market, the "productivity of assets," in a qualitative sense, increases over time for the office market. We can extend this to say, while the quality delivered over the life of the asset may be higher than previously experienced in structures of similar sizes and locations, the capital costs for "smart" buildings, as an example, may indeed be lower in real terms. The assumption in this thesis is that obsolescence is dynamic and to some degree, accounts for the continued development of office space.

As a result of the massive supply created in the 80's, one might argue that this obsolescence might also include suitable structures not put towards productive uses if buildings were simply "built in the wrong place" during the 80's. One can certainly question the logic of such an argument. However, despite the presence of historically low rental rates during a period of an abundant supply of office space, the recent advance of design-build projects (at a time when replacement costs exceed capitalized rental rates) would seem to indicate that the discounted present value of location characteristics outweigh the benefits of historically low rental rates. If such a hypothesis is valid, the equilibrating function should result in a higher dynamic structural vacancy rate.

In his article forecasting office space needs for the year 2000,[3] Birch identifies other types of obsolescence as well, namely, "image-based obsolescence," in addition to technological obsolescence. For the former, Birch indicates a continued demand for prestigious buildings and locations. He sites as an example reallocations by Wall Street investment banks. Such reallocations cause obsolescence over time as firms upgrade their space. In response to obsolescence, landlords respond in one of three manners. They can either upgrade their space (as in the Renaissance Tower, Dallas), convert their space to a new use (Chicago Savings bank and Trust-converted to apartments), or decrease rents. If we were to construct a series of "cost/quality" curves, the first example above would be considered a shift of the curve in this negatively sloped function. Increasing or decreasing rents, in contrast, would be a shift along the quality curve.

[3] David L. Birch, et. al., "America's Future Office Space Needs: Preparing for the Year 2000," National Association of Industrial and Office Parks (1990), pp. 14-25.

In response to technological obsolescence, the onset of the information age placed tremendous demands upon the infrastructure of a building. For example, if a structure cannot accommodate the physical requirements of computer rooms, that is, independently zoned air conditioning systems, stand-by generators and advanced electrical systems, then those buildings will incur a form of "quality" obsolescence, distancing themselves from a segment of the market. Birch gives an example of a building that was "cable-bound." This structure simply did not have the room to install the necessary wiring demanded by a firm's employees.

URBAN LAND RENT THEORY

With respect to obsolescence relative to location characteristics, Alonso states in his theory of the urban land market[4], "a landowner purchases two goods - land and location." In the simple agricultural model, profits derived from the land are based upon location and the fixed cost of commuting and production. Assuming a competitive market for the farmer's products as well an equal cost to produce the products, the profit, or residual to the land received as a result of selling the product at market will be the sales price less the cost of production and delivery. Since the cost of production is fixed, the variable cost is the distance to the market times the unit cost per mile. In this theory, the amount bid for a parcel of land is inversely related to the distance to the market. If a farmer bids higher for the land than the location warrants, he will operate at a loss. Thus, under this theory, normal profits are assured by all farmers.

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[4] William Alonso., "A Theory of The Urban Land Market," Papers and Proceedings of the Regional Science Association (Volume 6, 1960), pp.149-157

Extending this theory to differentiate between products, those products that command a higher price at market can afford to pay more for land closer to the market if we assume that profits are normal across all product types.[5] In this fashion, a series of bid-rent curves emerge. Firms receiving greater revenues based upon greater volume with equal costs of commuting will pay more for land. Thus, assuming a firm maximizes profits, the firm will be indifferent to their location along their given bid rent curve.

Applying this theory to the office market, and more specifically to office cost, if the cost of the inputs is constant across all building types, then the variation in the supply would be evidenced by merely the physical characteristics of a structure - or rather - the size of an individual structure. Thus, the cost per square foot would be equal for all buildings in the market. As we shall see in the hedonic cost model though, the quality of a building, as measured by its attributes, varies across building characteristics as a result of cost elasticity. As such, like Alonso's bid/rent curves, this thesis advances the theory that under an efficient market where normal profits are returned to the land, there exist a series of quality/cost curves which, in light of high vacancy levels and low rents relative to replacement cost, reconciles continued increases in supply in response to dynamic obsolescence, and rent differentials. Let us turn to the data to see if we can confirm such a hypotheses.

[5] If a particular product experienced higher than normal, or abnormal profits, and there were minimal barriers to entry, firms would enter the market and bid prices down to a point where excess profits no longer existed.

Chapter Three

PRESENTATION OF THE DATA

The principal data for the study comes from F.W. Dodge's database for office construction for categories coded, 7, 305, 306, 405 and 406 for sixteen Metropolitan Statistical Areas (MSA's). These categories include offices, banks and financial buildings segregated into two categories of one to three story offices and four or more story offices.

The MSA's were selected for their diversity as a sample of the population of buildings nationwide. Mature cities like Chicago, New York, and Boston are included in the study as are new "higher" growth cities, like Dallas and Atlanta. Washington D.C. is included because of its "stable" demand for office space by users outside the traditional FIRE sector.[6] Charlotte and Raleigh are included as "emerging" cities, while San Jose is included for its emergence over the last decade due to the explosion of Silicon Valley. Aurora, Peoria and Gary are included to represent cities which presumably have a lower percentage of its workforce within the FIRE category. These cities also represent older, smaller cities. San Francisco and Oakland are included as representation for the West Coast as well as this regions role as a "financial" center. The data contains over 44,000

[6] While some may debate the stability of Washington D.C., office demand theorists contend the large presence of "office-users" outside the traditional Fire, Insurance and Real Estate SIC sectors act to stabilize the office market. Presumably, the large number of service-sector employees provide "stability" to the occupancy level. Thus, is the growth of office space more or less stable than the other markets tested.

records of either new construction or additions as reported by architects, engineers, owners and contractors dating to 1967.[7]

This study will address only those records which comprise "new" office construction. In 1993 dollars, the cost of this space represented 123 billion dollars spent on office construction.[8] This data is also recorded on a county level basis. As reported by other researchers, county level data will provide useful information when addressing the supply response to metropolitan vacancy since metropolitan data often includes county wide statistics.

From this database, information on reported values of construction for both new construction and construction additions were tabulated by year.[9] The trends and the cost were estimated through regression analysis of the "value" data against time and building attributes.

Addressing the building attributes, the raw data included information on square footage in thousands of square feet, building height by stories, structural frame type and of course, total reported value of construction. The data was categorized by year, MSA, builder type and planner type (either architect, engineer, or contractor). Since this study is

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[7] The appendix includes summary statistics of the data by MSA.

[8] As will be addressed shortly, this by no means constitutes the total amount spent on office construction. For "shell" construction, the amounts recorded would represent perhaps 60%-80% of the total cost of construction.

[9] The F.W. Dodge database lists each record by month of report. For this study, though, the 12 months were summed and the corresponding values were recorded as if the reported values with respect to supply occurred in the last quarter of the year.

concerned with the hedonic cost per square foot across time, the builder type and planner type were omitted from the analysis. Once the data was categorized into individual cases by year and MSA, it was further refined. Those cases which indicated a "zero-number" for value, story height or square footage were removed from the dataset.[10]

Addressing the frame category, the data was segregated into one of twelve code types as shown in tables one and two below:

Table 1 - Frame Code Definitions

Code	Framing Type
A	Load Bearing
B	Steel
C	Wood
D	Reinforced Concrete
E	Prefabricated or Pre-Engineered
F	Others not known or Classified
G	Unknown
H	Steel and Concrete
I	Load Bearing and Steel
J	Load Bearing and Wood
K	Load Bearing and Concrete
L	Unassigned

FW Dodge Frame Type Classifications

[10] These deletions accounted for only a nominal amount of observations.

Table 2 - Frame Type Cumulative %				
MSA	A,B	A,B,C	A,B,C,D	A,B,C,D,I
Aurora	80.8%	83.8%	85.3%	88.3%
Atlanta	70.5%	82.9%	90.5%	92.5%
Boston	71.3%	82.6%	84.9%	86.0%
Charlotte	79.7%	88.2%	91.0%	92.1%
Chicago	82.8%	84.1%	87.9%	90.0%
Dallas	78.9%	83.2%	89.8%	90.7%
Fort Worth	77.8%	87.1%	89.7%	90.8%
Gary, IN	69.8%	87.0%	87.6%	88.8%
Joliet, IL	74.2%	81.9%	84.0%	86.2%
New York City	79.1%	80.7%	83.9%	86.3%
Northern New Jersey	78.9%	85.0%	86.4%	87.7%
Oakland	45.8%	69.6%	71.9%	72.1%
Raleigh-Durham	73.6%	84.6%	87.9%	90.0%
San Francisco	39.5%	59.1%	62.6%	62.8%
San Jose	48.1%	70.5%	73.0%	73.3%
Washington DC	70.0%	73.9%	88.0%	90.1%
Average	70.0%	80.3%	84.0%	85.5%
Standard Deviation	13.0%	7.7%	7.7%	8.2%

The predominant frame types consisted of steel and load bearing structures. These two frame types accounted for between 70% and roughly 83% of all frame types with the exception of San Francisco, San Jose and Oakland. For these three cities, the categories of "wood" and "unknown" accounted for a large percentage of the cases. In fact, across all of the cities, the categories of wood and unknown accounted for the third and fourth largest categories. In order to maintain consistency and achieve greater explanatory power for the index, categories "A", load bearing and "B", steel, were used in the study. Along with the other segmentation as previously noted, this reduced the dataset to just over 25,000 cases.

GENERAL TRENDS IN OFFICE SUPPLY

Reviewing the raw data presents some general trends across the MSA's with respect to the level of office supply since 1967. The periods shown in the following tables correspond well across the MSA's with the natural vacancy patterns reported by Voith & Crone (1988). The period from 1967-1974 is characterized by an upward trend in the supply and lag the demand peaks reported by approximately one year. However, the construction boom from 1970 to 1973, fueled by increased investment capital from real estate investment trusts, was more than adequate to meet the expected demand and as a result, vacancy rates climbed to a peak in 1974. Generally, the data reveals a decline in the level of new supply in 1974 over the previous period.

While the second period noted in the table (1975-1981) is characterized by a downward trend, the nation still produced nearly the same amount (90%) of office space as was constructed in the previous seven years. During this period, the "natural" vacancy rate reported declined to roughly 6% in 1979 in response to increased demand after 1976. During the period, the supply responded strongly in 1977 to 1979, but tapered off towards the end of this cycle.

With tax law changes and an abundant supply of capital along with rises in real rents, the supply trend again turned positive in 1982, again, a one year lag.[11] This period, as has

[11] It should be noted, FW Dodge records the value of new construction at the beginning of the construction phase or shortly after the work has been "bid". Thus, the actual supply does not "come on the market" until six to eighteen months after the reporting date. For further research into project duration, please see the bibliography for OSHA's report on the "Estimation of Project Duration."

	Table 3: Cost of New Square Footage				
	Millions of 1984 Dollars				
MSA	1967-74	1975-81	1982-89	1990-93	Total
Atlanta	1,465.7	1,129.9	3,361.7	321.0	6,278.2
Aurora	61.1	78.3	93.3	47.2	279.8
Boston	2,300.9	1,044.6	2,869.0	165.0	6,379.6
Charlotte	450.8	262.6	983.1	118.0	1,814.4
Chicago	4,029.6	2,906.7	4,589.6	707.0	12,232.8
Dallas	1,381.4	2,773.3	4,509.6	509.6	9,173.9
Fort Worth	310.8	495.8	653.6	56.0	1,516.2
Gary, IN	92.8	122.6	64.4	32.6	312.3
Joliet, IL.	30.2	51.8	28.9	23.4	134.3
New Jersey	982.9	894.3	1,331.1	275.1	3,483.4
New York City	7,743.0	2,242.5	4,731.0	547.0	15,263.5
Oakland	569.6	601.7	2,225.4	292.4	3,689.0
Raleigh-Durham	266.7	236.2	852.2	119.2	1,474.4
San Francisco	1,813.9	1,699.1	1,792.0	147.7	5,452.6
San Jose	428.6	667.4	1,234.4	206.4	2,536.9
Washington D.C.	2,917.3	3,235.3	8,183.2	825.0	15,160.8
Total	24,845.3	18,441.9	37,502.5	4,392.3	85,182.1

	Table 4: Amount of New Square Footage				
	1000's of Square feet				
MSA	1967-74	1975-81	1982-89	1990-93	Total
Atlanta	31622	23836.4	68198	7344.9	131001.3
Aurora	985.7	1307.4	1681	1114.1	5088.2
Boston	25978.1	16993.8	47834.5	2390.1	93196.5
Charlotte	8847.8	4712.7	17070.2	2237.6	32868.3
Chicago	53646.4	47437.2	79400.4	13704.5	194188.5
Dallas	26758.5	55704.1	87405.1	7157.6	177025.3
Fort Worth	6262.8	9672.1	13363.4	1069.4	30367.7
Gary, IN	1634.8	2045.8	1207.3	649.2	5537.1
Joliet, IL.	480.1	792.3	583.2	428.6	2284.2
New Jersey	14807.8	14426.3	22242.1	3848.6	55324.8
New York City	76500.6	25879	53938.1	6096.1	162413.8
Oakland	9650	10149.6	39458.3	3765.6	63023.5
Raleigh-Durham	5042.6	4218.4	17010.2	2245.9	28517.1
San Francisco	26512	23149.4	25961.6	2315	77938
San Jose	8005.2	11640.3	21379.4	4047.5	45072.4
Washington D.C.	53012	57266	143991	15464	269733
Total	349746	309231	640724	73879	1373580

	Table 5: Number of New Buildings				
	Period				
MSA	1967-74	1975-81	1982-89	1990-93	Total
Atlanta	1092	762	1932	359	4145
Aurora	74	105	86	41	306
Boston	698	515	1050	185	2448
Charlotte	403	380	673	252	1708
Chicago	1210	1244	1287	1411	5152
Dallas	987	1285	2399	443	5114
Fort Worth	396	539	879	194	2008
Gary, IN	185	237	161	134	717
Joliet, IL.	57	84	55	44	240
New Jersey	539	385	567	87	1578
New York City	645	262	575	178	1660
Oakland	506	526	773	232	2037
Raleigh-Durham	259	263	632	167	1321
San Francisco	467	394	460	88	1409
San Jose	420	461	870	177	1928
Washington D.C.	748	903	1981	337	3969
Total	8686	8345	14380	4329	35740
S.F./Building-1000's	40.3	37.1	44.6	17.1	38.4

Source: FW Dodge

been well reported, produced an unfettered supply of capital and resulted in a tremendous amount of supply placed on the market. During the period of 1982-1989, the amount of square footage constructed, as reported in the Dodge data, equaled the amount built in the previous fourteen years. However, in 1984 dollars, the amount spent per square decreased. This is not to suggest, though that productivity increased. The wide spread amount of speculative construction suggests "shell" buildings without tenant finish-out improvements were constructed. So, not only were we building more raw square footage, we weren't necessarily completing as much either in a relative sense.

Additionally, in terms of averages, some interesting events occurred. In Chicago, for instance, almost the exact number of buildings were constructed from 1975-1981 as were constructed from 1982-89, however, the square footage per structure doubled over the two time periods. For contrast, Dallas nearly doubled the amount of buildings constructed, but reduced the amount of space constructed per building by 25%. Did these changes occur because of land value fluctuations and the fact that an acre of land in Dallas cost less than a similar acre in Chicago, thus in order for there to be any residual to the land, or profit to the developer, a building in Chicago had to capture greater "total rents"? Or since buildings built in Chicago presumably cost more to build than those in Dallas, developers had to build more for the same reasons cited above? As many real estate professionals will agree, while we would like to believe urban economics played a role in determining the quantity of supply constructed, the supply of capital surely played a greater role.

Still, as is so evident in the housing market where the cost of constructing a home is relatively inelastic and the supply responds quickly to changes in price, why doesn't such a price clearing mechanism exist in the office market supply cycle? Does the cost of construction not increase as developers demand new buildings. Are the factors of input, namely wages and materials, relatively elastic allowing an unfettered supply of space in response to the capital markets? In order to answer these questions, we need to determine in a straight forward manner, the cost required to construct an average office building to lend a greater understanding of office market supply characteristics. The following chapter outlines such a model and provides encouraging results for determining a time series cost structure.

Chapter Four

METHODOLOGY OF THE OFFICE REPLACEMENT COST INDEX

The basis for the model for a construction cost index will be patterned after models developed by various researchers of house prices as well as a model recently presented by Torto/Wheaton (1992) in their analysis of office rent indices. Court (1939) and Griliches (1971) pioneered hedonic price analysis in which the independent components of a heterogeneous good are determined through regression analysis.[12] Whereas the rent and house price index models seek to find the most probable market price, this index will address the most probable market cost.

Like the hedonic rent and price indices, the replacement cost index will value the cost per square foot in current cost/nominal dollars through the hedonic equation and thus create a cost index with current cost terms. A methodological issue arises because of the variation in both the general price level and changes in building quality over time and whether the index captures changes in cost for quality over time.

Of the latter, buildings constructed later are subject to greater regulatory requirements. Cost increases can be experienced for a variety of reasons. As a possible move towards attracting tenants and reducing life-cycle costs, "smart" buildings have been developed which increased the cost of security systems as well as control systems for heating and electrical purposes, to name just a few of the advancements. One may also hypothesize

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[12] Norman G. Miller, "Residential Property Hedonic Pricing Models: A Review," Research in Real Estate (Volume 2, 1982), pp. 31-56

that reduced capitalization rates in the 80's also contributed to a higher "class" of building with a greater amount of funds expended for architectural finishes and vertical transportation. The assumption considered in this thesis is that given the current state of the commercial real estate market and sustained levels of high vacancy, a developer of commercial space will have to respond to the quality of structures existing in the market. Assuming a sustained level of material and labor productivity for commercial building products and construction, the real cost of construction will not disinflate. This argument can be expanded to say emerging telecommunication technology, regulatory requirements like the American Disabilities Act, and clean-air reform (through the abolishment of CFC's) will increase the real cost of construction over time in the absence of returns to scale for labor and material production. However, the evidence suggested by the data indicates the opposite holds true.

Considering the investors perspective, such technological advancements may reduce the life-cycle cost of the building as noted above. Thus, the investor may be willing to lower his/her capitalization rate and pay "more" for the asset in return for higher cash flows as a result of reduced operating costs. Such actions would induce continual quality improvements in building technologies.

Another methodological issue arises when considering development and site acquisition costs as well as short-term interest rates. If one is to employ the hedonic construction cost index to assess supply conditions in the marketplace, a model should be developed which captures land rent. Theoretically, the residual between a capitalized rent index and a cost index less development and site acquisition costs should represent the potential profit to the land. By combining the two models, an effective method for determining highest and best use land value emerges.

However, while the cost model captures the qualitative costs of an office building over time relative to the height, area and frame, it does include all the costs associated with development. The costs not included are engineering and design fees, site preparation, demolition, change orders and any lease inducements for capital improvements. Estimates for this additional work range from 20% to 40%. Still, if these extra costs are proportional to the "shell" costs of a structure, the movements and changes of the replacement index would hold because of the relative nature of the index.

The last methodological issue to be raised is the population of observations. The data set includes offices from the one to three story category as well as the four and above category as provided by FW Dodge. While this index captures changes over time for the reported population of buildings in the office category, a subset of indices can be developed which addresses categories of building types with more narrowly defined attributes.

PRESENTATION OF THE HEDONIC COST MODEL

A log linear model was selected over a multiplicative production function for the simple reason that the research is not attempting to determine probable cost through productive inputs. Rather, the research attempts to determine cost for the hypothesized relationship through qualitative explanatory variables. As such, an index is developed which calculates cost over time for an average building. The results of the equation estimate the average cost over time for buildings with different qualitative characteristics. The approach uses the natural log of current cost (nominal dollar)[13] per square foot by simply dividing the reported value in the data by the reported amount of square footage.

By using a natural log form, each term in the equation has a constant percentage impact upon cost rather than a current cost/nominal dollar impact. For example, if the coefficient for STORY were .022, an increase of one story for a building would represent an increase in cost per square foot of approximately 2.2%, while a ten story building would increase the cost approximately 25%.[14] Dummy variables were created for the year of the reported project. The dummy variables shift the equation multiplicatively. For instance, if the value of the coefficient for 1982 in a given city is 1.033, then the cost for any building in this market will be 103.3% higher than the default year (say, 1967). The equation used for the analysis was of the following form:

[13] Not adjusted for changes in general purchasing power

[14] The actual impact upon cost will be: e raised to .022 times 10, or 1.246

$$\ln(COSTSF) = \alpha_0 + \alpha_1 STORY + \alpha_2 FRAME + \alpha_3 AREA + \sum_{i=1968}^{1990} \beta_i D_i$$

where:

COSTSF	=	Reported value / reported square feet
STORY	=	Number of stories[15]
FRAME	=	(= 1 if steel, = 0 if load bearing)
AREA	=	Square feet in 1000's of square feet
D_i	=	Dummy variable for each year (1967 default ; i = 1968, 1993)
α, β	=	estimated statistical parameters

From the equation, an average cost index was calculated based on an office building of varying types of quality characteristics. As would be expected, when indexed to 1982, the index remained constant for any average building type constructed in a given MSA. An average cost index was then calculated based upon a modified mean of the building types for each MSA for use in constructing a model of the level of supply which will be addressed shortly.

REPLACEMENT COST INDEX: ANALYSIS & COST ELASTICITY

The results of the tests are reported in tables six through nine. The test results are encouraging and indicate striking similarities across metropolitan areas. The index also confirms various hypothesis regarding returns to scale relative to quality characteristics for those markets which had a large population with an assumed normal distribution.

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[15] In certain MSA's, stories 1-3 were assigned the value "0" and the balance of the observations were treated as continuous variables. This increased the explanatory power of the model.

Smaller markets with a lower-tail skewed distribution showed some interesting contrasts as well.

Table 6 - Hedonic Commercial Office Cost Index Coefficients

Variable	Atlanta,GA		Aurora, IL		Boston, MA		Charlotte,NC	
	Beta	**t-stat**	**Beta**	**t-stat**	**Beta**	**t-stat**	**Beta**	**t-stat**
Constant	2.7580	**60.5880**	2.6284	**16.9840**	3.0105	**70.8080**	2.5210	**35.9010**
Story	0.0225	**4.8160**	-0.0710	-2.0750	0.0224	**6.9340**	0.0404	2.3580
Frame	-0.0429	-2.9740	0.1382	2.5840	-0.0705	**-4.1160**	0.0125	*0.4710*
Area	-0.0010	**-5.0450**	-0.0006	*-0.8010*	-0.0004	-2.9000	-0.0002	*-0.4330*
Dummy 1968	-0.0254	*-0.4180*	0.1712	*0.6210*	-0.0262	*-0.4610*	0.1665	*1.9560*
Dummy 1969	-0.0516	*-0.7650*	0.4381	2.1510	-0.0182	*-0.3160*	0.1839	2.1350
Dummy 1970	0.0807	*1.3590*	0.7096	3.7210	0.1226	2.0810	0.3215	3.5830
Dummy 1971	0.1477	2.6810	0.5431	2.5960	0.1235	1.9620	0.4623	**5.0070**
Dummy 1972	0.2033	**3.7360**	0.5416	3.0160	0.2631	**4.2780**	0.3393	**4.0510**
Dummy 1973	0.2973	**5.6210**	0.8082	**4.0800**	0.3087	**5.2540**	0.5698	**6.1590**
Dummy 1974	0.4829	**8.9330**	0.7460	**4.1100**	0.3970	**6.8120**	0.5734	**5.8630**
Dummy 1975	0.4653	**6.3050**	0.9124	**4.5970**	0.5525	**9.6170**	0.7925	**8.0010**
Dummy 1976	0.6332	**8.4360**	1.0429	**6.0600**	0.5181	**8.3530**	0.7873	**9.0020**
Dummy 1977	0.7259	**11.1690**	0.9314	**5.4950**	0.7069	**12.4550**	0.9917	**10.8880**
Dummy 1978	0.8436	**14.5010**	0.8678	**5.2340**	0.5629	**8.9390**	1.0833	**12.6140**
Dummy 1979	0.8436	**14.9340**	1.0560	**6.2330**	0.7580	**12.3270**	1.1617	**13.6640**
Dummy 1980	0.9824	**17.3150**	1.4695	**7.9900**	0.8204	**13.6740**	1.2274	**14.5550**
Dummy 1981	0.9562	**17.8640**	1.5813	**5.6810**	0.9172	**14.7890**	1.1988	**14.4640**
Dummy 1982	1.0333	**18.8340**	1.2324	**4.4460**	0.9150	**15.3310**	1.2517	**13.7370**
Dummy 1983	1.0970	**20.5880**	1.5106	**8.0240**	0.9943	**18.4790**	1.2599	**15.0470**
Dummy 1984	1.1352	**22.5010**	1.5710	**8.5500**	1.0976	**20.8140**	1.3176	**15.3210**
Dummy 1985	1.0948	**21.9510**	1.3903	**7.1810**	1.0914	**21.6300**	1.3922	**18.0750**
Dummy 1986	1.1493	**22.3290**	1.4717	**7.8650**	1.1664	**22.0340**	1.3738	**17.4620**
Dummy 1987	1.2620	**23.6690**	1.5684	**8.5750**	1.2787	**24.2530**	1.4813	**18.2080**
Dummy 1988	1.2612	**23.2980**	1.5866	**8.9450**	1.2370	**23.7380**	1.5165	**18.6270**
Dummy 1989	1.4417	**26.6390**	1.8201	**10.4210**	1.3794	**23.9200**	1.6162	**19.5730**
Dummy 1990	1.5586	**23.7890**	1.7199	**9.5590**	1.4686	**20.2260**	1.6041	**17.6270**
Dummy 1991	1.5259	**27.9390**	1.7938	**8.8190**	1.5005	**22.5800**	1.7624	**21.1750**
Dummy 1992	1.4244	**21.6320**	1.6761	**7.9680**	1.3989	**19.6120**	1.6660	**19.3730**
Dummy 1993	1.3584	**18.3040**	1.7021	**9.0100**	1.3508	**22.2600**	1.7374	**20.1050**
R^2	0.6516		0.6828		0.6887		0.6647	
Observations	2834		252		1744		1352	
Story Mean	1.66		1.50		2.58		1.42	
Story Std. Dev.	2.61		0.82		3.93		1.60	
95% C.Int.	0.10		0.10		0.18		0.08	
Area Mean	20.09		15.75		42.43		14.30	
Area Std. Dev.	68.18		37.32		113.52		43.61	
95% C.Int.	2.51		4.61		5.33		2.32	

Bold figures indicate coefficients significant at the 99.99% level.

Italicized figures indicate coefficients not significant at the 95% level. All others are significant.

Table 7 - Hedonic Commercial Office Cost Index Coefficients

Variable	Chicago, IL		Dallas, TX		Fort Worth, TX		Gary, IN	
	Beta	t-stat	Beta	t-stat	Beta	t-stat	Beta	t-stat
Constant	2.9648	**102.315**	2.6230	**54.8830**	2.7434	**26.8210**	2.8742	**23.5980**
Story	0.0158	**6.8250**	0.0092	3.0000	0.0211	3.1260	-0.0261	*-0.8530*
Frame	-0.0265	**-2.2370**	-0.0222	-2.2030	0.0205	*1.1830*	0.0873	*1.6810*
Area	-0.0003	**-4.8480**	-0.0002	-2.2970	-0.0008	-3.0350	0.0004	*0.3650*
Dummy 1968	nic		0.0665	*1.1420*	0.0762	*0.5630*	0.1935	*1.3300*
Dummy 1969	0.0066	*0.1650*	0.1788	2.9580	-0.0929	*-0.8020*	0.1277	*0.8910*
Dummy 1970	0.1113	2.5690	0.1961	3.5060	0.1963	*1.7080*	0.1663	*1.0900*
Dummy 1971	0.1815	**4.4640**	0.2248	**4.1580**	0.2476	2.2510	0.3589	2.2430
Dummy 1972	0.2222	**5.6300**	0.3777	**7.0870**	0.2613	2.4010	0.3979	2.6180
Dummy 1973	0.2955	**7.5280**	0.4525	**8.6110**	0.2944	2.7080	0.4347	2.8430
Dummy 1974	0.3996	**10.0780**	0.5741	**10.9320**	0.4693	**4.3430**	0.3405	2.5640
Dummy 1975	0.3820	**9.0860**	0.6274	**11.2250**	0.4564	**4.1160**	0.4021	2.9860
Dummy 1976	0.3928	**9.6900**	0.6095	**11.4520**	0.4486	**4.1580**	0.5084	3.7190
Dummy 1977	0.5338	**14.8720**	0.6599	**12.5440**	0.5819	**5.3730**	0.5920	**4.3080**
Dummy 1978	0.5818	**15.8050**	0.8695	**16.5950**	0.6350	**5.8820**	0.6078	**4.5930**
Dummy 1979	0.7705	**21.0380**	0.9863	**19.1010**	0.8502	**7.7750**	0.7134	**5.0540**
Dummy 1980	0.8902	**23.8820**	1.1117	**21.3440**	0.9444	**8.7900**	0.9966	**6.1980**
Dummy 1981	0.8952	**22.6690**	1.1314	**22.1640**	1.0517	**9.5870**	1.3296	**7.7970**
Dummy 1982	0.9840	**21.9260**	1.2766	**24.5410**	1.0840	**9.9300**	1.1607	**7.5040**
Dummy 1983	1.0290	**24.5310**	1.3576	**27.0210**	1.2614	**11.9470**	1.2106	**7.5660**
Dummy 1984	1.0093	**26.6070**	1.4036	**28.3020**	1.2992	**12.3270**	1.0526	**6.9250**
Dummy 1985	1.0233	**26.9540**	1.4048	**28.5820**	1.2712	**12.0070**	1.0781	**6.8920**
Dummy 1986	1.0562	**27.9060**	1.4203	**28.3010**	1.2890	**12.2990**	1.0675	**5.9900**
Dummy 1987	1.2156	**31.4750**	1.3816	**27.1610**	1.2568	**11.8550**	1.3961	**7.2490**
Dummy 1988	1.2048	**31.9220**	1.3749	**27.0200**	1.2891	**11.9770**	1.4428	**8.6600**
Dummy 1989	1.3054	**34.7410**	1.5231	**28.7370**	1.3867	**12.6900**	1.4247	**8.9920**
Dummy 1990	1.4358	**38.6980**	1.5033	**29.3580**	1.3886	**13.1760**	1.4865	**9.8550**
Dummy 1991	1.3429	**41.3750**	1.7380	**32.4630**	1.6757	**14.8480**	1.5156	**11.1430**
Dummy 1992	1.3377	**40.2350**	1.8566	**30.3590**	1.7158	**12.4100**	1.4846	**10.7770**
Dummy 1993	1.4789	**45.7650**	1.8471	**28.2740**	1.6412	**13.3690**	1.6260	**11.7830**
R^2	0.7098		0.7437		0.7225		0.6564	
Observations	4208		3999		1535		503	
Story Mean	1.90		1.53		1.32		1.23	
Story Std. Dev.	3.91		2.82		1.49		0.71	
95% C.Int.	0.12		0.09		0.07		0.06	
Area Mean	28.47		20.06		11.66		7.19	
Area Std. Dev.	134.37		85.01		45.15		19.40	
95% C.Int.	4.06		2.63		2.26		1.70	

Bold figures indicate coefficients significant at the 99.99% level.

Italicized figures indicate coefficients not significant at the 95% level. All others are significant.

Table 8 - Hedonic Commercial Office Cost Index Coefficients

Variable	Joliet, IL		New Jersey		New York		Oakland, CA	
	Beta	t-stat	Beta	t-stat	Beta	t-stat	Beta	t-stat
Constant	2.5941	**7.1200**	2.9812	**63.5960**	2.9880	**77.2410**	2.9458	**33.3490**
Story	-0.0345	*-0.5110*	0.0182	3.0840	0.0142	**8.2000**	0.0351	**6.1550**
Frame	-0.0255	*-0.3480*	-0.0857	**-4.0620**	-0.0004	*-0.0180*	0.0822	2.5940
Area	-0.0008	*-0.3570*	-0.0003	-2.0300	-0.0001	*-1.0490*	-0.0010	**-7.4410**
Dummy 1968	0.6609	*1.7470*	0.1096	*1.8150*	0.0242	*0.4580*	No Obs.	No Obs.
Dummy 1969	No Obs.	No Obs.	0.0770	*1.2620*	0.1210	2.0640	Default	Default
Dummy 1970	0.7085	*1.7900*	0.2784	**4.3310**	0.2080	**3.7930**	0.1188	*0.8400*
Dummy 1971	0.7302	*1.8520*	0.4505	**6.4870**	0.3521	**5.9100**	0.1652	*1.3530*
Dummy 1972	0.8329	2.1750	0.2865	**4.0970**	0.3336	**5.3380**	0.2166	*1.7340*
Dummy 1973	0.7576	*1.8970*	0.5917	**7.4550**	0.4986	**8.0810**	0.1090	*0.9630*
Dummy 1974	0.8726	2.3290	0.4463	**6.5020**	0.6132	**10.0000**	0.3548	3.0914
Dummy 1975	0.8156	2.2000	0.6111	**9.6610**	0.5694	**8.1610**	0.5224	**3.8380**
Dummy 1976	0.9053	2.4010	0.6750	**9.1370**	0.5797	**7.8520**	0.5512	**4.1820**
Dummy 1977	0.9012	2.4070	0.6252	**8.7350**	0.7115	**8.0020**	0.6620	**5.2660**
Dummy 1978	1.0865	2.8920	0.6988	**9.9570**	0.6470	**9.4710**	0.5169	**4.5000**
Dummy 1979	0.9467	2.2930	0.8006	**12.2150**	0.8231	**11.8030**	0.8322	**6.3240**
Dummy 1980	1.3645	3.6140	0.8381	**12.9970**	0.9236	**12.1670**	0.9309	**8.4300**
Dummy 1981	1.4515	3.6290	1.0393	**13.6530**	1.0023	**11.9250**	0.9641	**9.0550**
Dummy 1982	1.2862	3.1980	1.0832	**15.6740**	1.0853	**14.4970**	1.0266	**9.5650**
Dummy 1983	1.7434	**4.2480**	1.2507	**18.0760**	1.1332	**16.5510**	1.0436	**10.6550**
Dummy 1984	1.2075	2.9100	1.2811	**19.8380**	1.2607	**20.4250**	1.1782	**12.2840**
Dummy 1985	1.2408	3.0780	1.3311	**21.9260**	1.1903	**20.6940**	1.0710	**11.1940**
Dummy 1986	1.4377	3.6610	1.2217	**19.7390**	1.2572	**23.1610**	1.1615	**12.2360**
Dummy 1987	1.6850	**4.3840**	1.3155	**19.1000**	1.2790	**25.1230**	1.1500	**11.7610**
Dummy 1988	1.6506	**4.3870**	1.3714	**21.6250**	1.3520	**23.8180**	1.1739	**11.9670**
Dummy 1989	2.0923	**4.1260**	1.4317	**21.4610**	1.3172	**21.9990**	1.1593	**11.9720**
Dummy 1990	1.8238	**4.8880**	1.4083	**18.0910**	1.4433	**25.8170**	1.3181	**13.6590**
Dummy 1991	2.0845	**4.7070**	1.4483	**16.1820**	1.4672	**20.3470**	1.3635	**13.8890**
Dummy 1992	1.9259	**5.0820**	1.5196	**14.7420**	1.6040	**20.2230**	1.3788	**14.1530**
Dummy 1993	1.7338	**4.4210**	1.3004	**10.0460**	1.4649	**19.2730**	1.5544	**14.9360**
R^2	0.6442		0.6724		0.7089		0.6031	
Observations	172		1258		1325		788	
Story Mean	1.32		2.14		4.85		2.01	
Story Std. Dev.	0.63		2.05		9.51		2.63	
95% C.Int.	0.09		0.11		0.51		0.18	
Area Mean	9.45		37.23		94.75		40.40	
Area Std. Dev.	15.73		83.15		290.64		104.24	
95% C.Int.	2.34		4.60		15.65		7.28	

Bold figures indicate coefficients significant at the 99.99% level.

Italicized figures indicate coefficients not significant at the 95% level. All others are significant.

Table 9 - Hedonic Commercial Office Cost Index Coefficients

Variable	Raleigh, NC		San Francisco		San Jose, CA		Washington DC	
	Beta	t-stat	Beta	t-stat	Beta	t-stat	Beta	t-stat
Constant	2.7513	**32.9230**	2.9964	**25.4470**	2.7563	**18.8930**	2.9260	**75.2030**
Story	0.0270	2.8430	0.0234	**7.6630**	0.0186	2.9410	0.0126	**4.2700**
Frame	-0.0248	*-0.9680*	0.0214	*0.7150*	0.0166	*0.4830*	-0.0739	**-5.4380**
Area	-0.0018	**-4.1520**	-0.0006	**-4.4770**	-0.0010	**-4.7420**	-0.0004	**-4.5240**
Dummy 1968	0.1246	*1.1520*	No Obs.	No Obs.	No Obs.	No Obs.	-0.0485	*-0.9150*
Dummy 1969	0.1597	*1.4620*	Default	Default	Default	Default	0.0793	*1.3470*
Dummy 1970	0.2654	2.5310	0.0954	*0.6720*	0.4996	2.8500	0.1871	3.2190
Dummy 1971	0.3009	2.4130	0.1680	*1.1770*	0.5423	3.2510	0.2425	**4.3380**
Dummy 1972	0.3022	2.9540	0.2866	2.0670	0.4884	3.0270	0.2451	**4.4110**
Dummy 1973	0.5495	**5.5080**	0.1732	*1.0790*	0.5218	3.2360	0.3015	**5.5060**
Dummy 1974	0.5739	**4.8560**	0.3710	2.6010	0.5827	3.2590	0.6224	**10.5090**
Dummy 1975	0.6214	**5.1800**	0.3826	2.5950	0.7200	**4.3490**	0.6703	**10.5110**
Dummy 1976	0.7445	**5.8550**	0.6508	**4.4990**	0.7723	**4.6290**	0.6191	**9.5690**
Dummy 1977	0.8649	**7.8430**	0.4745	2.9580	0.8305	**5.1470**	0.6943	**12.3670**
Dummy 1978	0.8304	**7.9070**	0.4500	3.2550	0.7751	**4.6010**	0.7406	**15.0980**
Dummy 1979	0.9810	**9.4730**	0.8005	**6.1500**	1.1314	**6.7580**	0.8249	**17.3450**
Dummy 1980	1.0447	**10.2570**	0.8649	**6.5370**	1.1923	**7.1980**	0.9219	**19.1490**
Dummy 1981	1.0695	**10.6060**	1.0442	**8.0650**	1.2420	**7.5590**	1.1011	**21.5950**
Dummy 1982	1.1379	**11.1680**	1.1620	**9.1110**	1.3518	**8.3970**	1.0526	**21.2200**
Dummy 1983	1.2521	**13.0840**	1.1402	**8.7920**	1.3843	**9.1040**	1.0951	**23.4310**
Dummy 1984	1.2689	**13.9060**	1.1196	**8.9010**	1.4340	**9.4920**	1.1153	**25.1600**
Dummy 1985	1.2221	**13.1700**	1.2147	**9.6820**	1.2871	**8.4880**	1.1633	**26.2070**
Dummy 1986	1.3052	**13.7260**	1.1620	**9.3040**	1.4259	**9.4830**	1.2118	**27.4850**
Dummy 1987	1.3742	**14.2780**	1.1240	**8.8680**	1.3457	**9.0630**	1.2892	**28.7800**
Dummy 1988	1.3631	**14.3240**	1.1574	**9.3280**	1.3779	**9.2650**	1.2731	**27.6600**
Dummy 1989	1.5279	**15.9280**	1.2465	**9.7100**	1.4191	**9.5620**	1.3679	**28.5720**
Dummy 1990	1.5763	**14.8680**	1.3373	**10.5990**	1.4939	**9.9340**	1.3767	**28.7830**
Dummy 1991	1.5661	**15.2740**	1.3393	**9.4310**	1.5597	**9.9520**	1.4871	**25.3380**
Dummy 1992	1.4934	**14.8720**	1.4842	**11.0590**	1.6256	**10.4320**	1.3898	**20.4920**
Dummy 1993	1.6238	**15.9320**	1.3898	**8.9620**	1.5843	**9.9790**	1.4812	**22.2580**
R^2	0.6332		0.6786		0.5182		0.6275	
Observations	962		529		890		2744	
Story Mean	1.67		4.50		1.68		2.50	
Story Std. Dev.	1.48		7.51		1.88		2.27	
95% C.Int.	0.09		0.64		0.12		0.08	
Area Mean	19.40		75.60		26.20		41.35	
Area Std. Dev.	38.59		165.47		64.36		93.20	
95% C.Int.	2.44		14.10		4.23		3.49	

Bold figures indicate coefficients significant at the 99.99% level.

Italicized figures indicate coefficients not significant at the 95% level. All others are significant.

Considering the first coefficient of interest, STORY was significant with respect to cost in all but two markets namely, Gary, Indiana and Peoria, Illinois. Furthermore, except for these two markets as well as Aurora, Illinois, the signs for the coefficients were positive. The positive sign indicates a percentage premium in cost for each additional story constructed on a building. Thus, the commonly held notion that it is more expensive to build a taller building then a shorter building with an equally sized floor plate was not violated in the larger markets. For the smaller markets, the preponderance of lower buildings with a concrete frame may have been more expensive on a per square foot basis than taller structures with a steel frame. Further segmenting of this market is required, though to confirm such a hypothesis.

Interestingly, cities like San Francisco and Oakland commanded a larger premium for taller buildings, ranging from 2.35% to 3.5%, versus either New York (1.4%) or Chicago (1.58%). One of a couple of reasons may account for this variation. First, due to seismic requirements, buildings on the west coast require addition structural bracing and therefore require a premium to construct taller buildings. Secondly, the preponderance of the frame type used, which will be explored shortly, as well as the "narrow distribution" of the STORY mean may also explain the variation in STORY,.

Charlotte and Raleigh-Durham also incurred large premiums for tall buildings at 4% and 2.7% respectively. This may be accounted for by the large subset of structures in the 1-3 story category. In Raleigh, this category of one to three story structures accounted for

86% of the Dodge records whereas in Charlotte, this category accounted for 92%. In other cities, like Chicago or New York, this category of story height accounted for 71% and 72.6%, respectively. Fewer, taller and more expensive buildings on a per square foot basis relative to the smaller structures, may tend to exaggerate the premium for the story height if the observations were not normally distributed.

Addressing the coefficients for FRAME, this attribute may shed some light on the premiums afforded to STORY in the various cities, as indicated above. In the case of New York and Chicago, the sign for the coefficient was negative. Since a load bearing frame was the default attribute, the negative sign indicates a discount for steel structures in these markets. Whereas in San Francisco, San Jose and Oakland, the positive sign indicates a premium for steel structures. Notably, in addition to New York and Chicago, Atlanta, Boston, Joliet, New Jersey, Dallas, Raleigh and Washington offered discounts for steel frames. The conclusion to be drawn from the sample is that it is more expensive to build load bearing structures than steel frame structures in the MSA's noted above while it is less expensive to build load bearing structural frame buildings versus steel frame buildings in Aurora, Charlotte, Fort Worth, Gary and the west coast MSA's included in the study.

There may be many reasons for these differentials. For instance, the construction productivity of the workforce relative to the structure type may cause these premiums and discounts. For example, since Peoria does not "frequently" build high-rises, they may have to premium to secure the necessary resources when they decide to build one. Another reason may exist because of building codes and material efficiencies. For instance, "pound-for-pound" steel is a more efficient material for carrying loads. However, certain building codes will specify greater or lesser amounts of structural bearing capacity for a frame type. Thus, the differences in material composition and the cost for transportation and installation (relative to "heavier" or "lighter" material weights), will cost discriminate between frame types.

Not surprisingly, the mean story height for those MSA's which command a premium for a steel buildings (like Fort Worth, Aurora and Gary), 2.27 as opposed to a story mean of 2.52 for those MSA's which offer a discount for steel[16] (cities like Chicago, New York and Boston). Certainly, the propensity to use a given frame will depend upon the building codes, the "natural design habitat" of a given market as well as the productivity of the inputs.

The next coefficient of interest is AREA. In all cities, with the exception of Gary, Indiana, the sign for the coefficient was negative. Even still, in Gary, the increased square footage accounted for a premium of 0.04%. Given the default case in Gary for a structure built in 1993, the increased cost per 1000 square feet would add about $0.04 at the margin or a total of $40 for a 1000 square foot building. To put this in perspective,

[16] When the high mean and low mean were omitted to compute a sample mean, the story mean of those MSA's which offered a premium for a steel frame was 1.98, versus 2.33 for those MSA's which offered a discount.

the total cost of a 1000 square foot one story concrete frame structure building located in Gary would cost $87,750. The amount contributed to the total cost by the square foot coefficient amounts to a nominal amount of $40.[17]

In the remainder of the cities, eleven of sixteen cities reported statistics significant at the 95% level for AREA. The negative sign reported indicates both a discount for larger floor plates, that is, a larger amount of square feet per floor, as well as increasing returns to scale from a cost elasticity viewpoint with respect to area. As will be addressed in a moment, this does not mean the overall cost elasticity demonstrates increasing returns to scale, though.

The range of the AREA coefficients accounted for a low discount of 0.01% in New York for each additional 1000 square feet, to a high discount in Raleigh-Durham of 0.18%. Ten of the sample MSA's reported discounts in the range of 0.02% to 0.08% for every 1000 square feet built. Thus, in contrast to Gary, each 0.01% value of the beta parameter decreases the total cost of the 1000 square foot structure by roughly $10. Given the risk of development and the risk of construction, the relatively small discount would not seem to represent a great incentive to build larger buildings.

Still, the research confirms a widely held notion that building larger, flatter buildings create increasing returns to scale versus taller, narrower buildings which create decreasing

[17] However, this does represent a decreasing return to scale for the cost elasticity.

returns to scale. The relative magnitude between the various markets for the cost elasticity varied, as shown in Table 10. The figures identified below combine the relative effects of STORY and AREA to determine the cost elasticity for each MSA. Because of relative multiplicative effects of the dummy variables for time and frame, the cost elasticity hold regardless of the time period or frame type for an average type of building with the specifications noted in the table.

Table 10 - Cost Elasticity: Vary By Height and Floor Plate

Floor Plate Area	15000		30-60000	Floor Plate Change
Change in Story	10 to 20		5	Story Height
Change in Total SF	150,000		150,000	Change in Total SF
MSA	**Elasticity**	**Rank**	**Elasticity**	**MSA**
Charlotte	1.9245	16	0.7299	Atlanta
Oakland, CA	1.4410	15	0.5153	Gary, IN
Boston, MA	1.3709	14	0.4977	New York
San Francisco, CA	1.2944	13	0.4941	Charlotte
New York	1.2832	12	0.4912	Dallas
New Jersey	1.2771	11	0.4874	Chicago
Chicago	1.2269	10	0.4871	New Jersey
Fort Worth	1.2077	9	0.4867	Boston, MA
Atlanta	1.1655	8	0.4857	Washington DC
Washington DC	1.1418	7	0.4785	Aurora, IL
Dallas	1.1162	6	0.4760	San Francisco, CA
San Jose, CA	1.0634	5	0.4721	Fort Worth
Raleigh-Durham, NC	1.0066	4	0.4698	Joliet, IL
Gary, IN	0.6381	3	0.4625	Oakland, CA
Joliet, IL	0.2540	2	0.4618	San Jose, CA
Aurora, IL	N.M.	1	0.4348	Raleigh-Durham, NC

> 1, indicates decreasing returns to scale
= 1, indicates constant returns to scale
< 1, indicates increasing returns to scale

The cost elasticity[18] for each MSA was computed in the following manner. For the first case (as shown on the left hand side of the table), the area specified was a 15,000 square foot floor plate 10 stories tall indicating an area total of 150,000 square feet. The total cost for this structure was then computed using the coefficients for STORY, AREA, FRAME and the CONSTANT and the specifications as noted above. Another building specification was valued through the coefficients this time increasing the STORY height to 20 floors. The figures noted in the column below the specification thus indicate the percentage change in total cost associated with a percentage change in output, or in this case, square footage. In the case of Charlotte, a 100% increase in square footage increased the total cost by roughly 192%. The conclusion to be drawn is that in Charlotte, you can expect the cost of construction to increase at the margin for taller buildings because the discount associated with AREA is less than the premium charged for STORY.

With the exception of Gary, Joliet and Aurora, all the MSA's experienced decreasing returns to scale. Caution should be noted, however, with respect to computing an elasticity outside the relevant range of the data. As shown for Aurora, a negative sign was incurred which was not meaningful. With cost elasticity, this is not realistic since cost elasticity has a lower bound of zero.[19] In Aurora, the data indicates there wasn't a structure built which exceeded six stories in height, over the time horizon analyzed.

[18] Described as the percentage change in total cost divided by the percentage change in total square footage, thus measuring the relative change in total cost over the range of the example.

[19] Due to the discount from STORY, the calculation yielded a total cost for the 20 story structure which was **less** than the 10 story structure. Cost elasticity has a lower bound of zero. Thus, the lower price for the taller building violates the definition of a cost elasticity.

Since this building is outside the relevant range, the cost elasticity is suspect. In the Washington D.C. MSA (which includes portions of Maryland and Virginia), there were only six office buildings which exceeded 15 stories. Thus, extending the example outside the range of the data to twenty stories, may cause one to question the validity of the cost elasticity.

Nonetheless, the table does provide insight into the fact that across the balance of sample cities for buildings of this average type and quality, office construction cost indicates decreasing returns to scale[20]. The newer and "stable" cities, like Atlanta, Dallas, San Jose and Washington, all exhibited a "better" return to scale than the more mature cities like New York or Chicago. The example presented in column 1 of the table represents doubling the height of the average building and focuses on STORY as an indicator of cost elasticity. In column two, the analysis concentrates on holding the height constant and increasing the AREA by 100%.

The change associated with doubling the AREA indicates increasing returns to scale across the MSA's sampled. In the case of Atlanta, doubling the floor plate as well as the total square footage increased the total cost by roughly 73%. In this instance, the building specification is within the relevant range for the sample MSA's. Nearly all of the observations hover within a few percentage points of 50%. Thus, by doubling the

[20] Gary and Joliet are also outside the relevant range.

square footage of this average building type, one would experience a total cost of 150% of the base condition, that is, a 5 story, 150,000 square foot building.

A series of scenarios were tested for two other types of building specifications. By doubling the height and doubling the floor plate, thereby increasing the total square footage by 400%, the range of cost elasticity was from 200% to 400%, demonstrating decreasing returns to scale. When the floor plate was reduced by 50% and the height increased by 100%, decreasing returns to scale were experienced in the range of 104% to 119%. Thus, despite the same square footage, the total cost increased. This highlights the premium associated with increasing the story height. Thus, while these statistics allow us to infer greater productivity for the specified building type for those cities with "slower" decreasing returns to scale, greater research into a productive construction input model may provide greater conclusive evidence.

Still, the results seem to suggest a propensity for certain building types to be built within a given MSA (and perhaps, a propensity for certain types during a given time frame) and answers some questions about the characteristics of supply of office space. While cost elasticity does not necessarily inhibit the growth of stock in the market, the evidence suggests that cost elasticity may act to inhibit or to restrain the physical volume and type of individual buildings constructed when the flow of capital into the market is "low" and cap rates are "high." This issue will be addressed further in the section which discusses the elasticity of supply.

Addressing the goodness-of-fit, or "R-square", the hedonic model yields a fair amount of consistency across all of the markets. With the exception of Oakland, the attributes in the model explained anywhere from 63% (Washington DC) to 74.4% (Dallas) of the variation in price and quality across the time period analyzed. New York, Chicago, Dallas and Fort Worth all reported R-squares in excess of 70%. Changes in building components across time, such as architectural finishes, vertical transportation, environmental and telecommunication systems will likely have contributed some portion to the explanatory power of the model. Still, the results are encouraging. Furthermore, prior tests explored segmenting the STORY attribute and creating a dummy variable instead of a continuous variable.[21] The results experienced were not as superior though.

In those markets which experienced a high R-square, they also indicated a larger confidence interval thus capturing "broader representation" in the model. In virtually all of the markets for most of the periods, the coefficients for the YEAR dummy variables were significant at the 99.99% level. This represents a strong time-series and suggests a consistent level of cost per square foot for an average building type in any given year. Reviewing some of the coefficients, a building built in 1993 in Boston cost roughly 385% more than the average building constructed in 1967.[22] Looking down the tables, various increases and decreases were experienced in all the different markets within one to two

[21] Buildings were segmented into two categories of story. For the dummy variable, "0" represented office buildings of 1-3 stories, while "1" represented buildings 4 stories or higher. The tests resulted in a goodness of fit one to four percent lower than the results reported herein.

[22] "e" raised to the power of 1.35 equals 3.857, or 386%.

years of one another. In markets like Chicago, Gary, Aurora, and Washington, prices dropped from high levels in 1989 and 1990 to low levels in 1992 and increased last year. This seems to follow the recession experienced in the earlier years followed by the growth experienced over the last 18 months.

In Atlanta, San Francisco, San Jose, New York and New Jersey, prices dropped from 1992 to 1993. This may indicate that the recession hit these markets later than the previously mentioned markets. Dallas has experienced a slight drop in costs from 1992 to 1993 after "riding" an upward curve from 1984 to 1986, then dropping in 1987 and 1988 and increasing ever since. During this period, Dallas experienced a large number of corporate relocations such as JC Penny, GTE, and Exxon as well as expansions by EDS. During this time frame, there were also a large number of relocations to the suburbs, away from downtown which added to the increases in supply as well as the increase in vacancy.

NOMINAL COST SERIES & FUNCTIONAL USES OF THE INDEX

Given the strength of the time-series, we can now construct an index which captures the changes in the cost per square foot for an average building type. To do this, an average building type of a given amount of square feet, story height and frame was run through the model for each year analyzed. The cost calculated for each year was then indexed to 1982. Given the nature of relative cost within the hedonic model, the index itself remains constant for any building specification since the cost in any year is a percentage of the base year. However, the level of cost in nominal terms will vary depending upon the type of building constructed. Still, the relative change of the nominal building cost will be the same as indicated in the index for the particular MSA. An example is constructed in table 11 to demonstrate the level of cost per square foot in Boston for various building types.

By examining the table, one can see the how cost varies for different building specifications. Except for two-decimal rounding errors, the indexed cost in a given year will be a percentage of the 1982 base year cost. This will hold across each of the specifications. Thus, costs in Boston varied from a low of \$78.80 per square foot for a 5 story 100,000 square foot steel building in 1993, to a high of \$134.18 per square foot for a 40 story, 1 million square foot concrete structure.[23] This example also demonstrates the importance the index holds for constructing "value-engineering" models in response to the discounts and premiums afforded by the coefficients of the estimated parameters. If the model indicates a cost of \$134.18 to build a concrete or load bearing frame structure in contrast to a cost of \$125.04 to construct a steel frame building with the same volume

[23] Again, caution should be used in extrapolating square foot costs beyond the relevant range of the data. There wasn't an observation for a load bearing structure beyond six stories.

Table 11 - Hedonic Office Cost Comparison - Boston, MA.										
Building Quality Characteristics										
No. of Stories	10	20	20	10	10	40	40	40	5	5
Frame Type	Steel	Steel	Steel	Concrete	Concrete	Steel	Steel	Concrete	Concrete	Steel
Square Feet/Floor	16400	16400	25000	16400	25000	25000	30000	25000	20000	20000
Total Square Feet	164000	164000	500000	164000	250000	1000000	1200000	1000000	100000	100000
Time Series-Cost Per Square Foot										
1967	22.31	26.31	24.75	23.94	23.22	32.39	30.16	34.76	21.90	20.41
1968	21.73	25.63	24.11	23.32	22.62	31.55	29.38	33.86	21.34	19.88
1969	21.91	25.84	24.31	23.51	22.80	31.81	29.62	34.13	21.51	20.04
1970	25.22	29.75	27.98	27.06	26.25	36.61	34.09	39.29	24.76	23.07
1971	25.24	29.77	28.01	27.09	26.27	36.65	34.13	39.33	24.78	23.10
1972	29.03	34.23	32.20	31.15	30.21	42.14	39.24	45.22	28.50	26.56
1973	30.38	35.83	33.70	32.60	31.61	44.10	41.07	47.32	29.82	27.79
1974	33.18	39.14	36.82	35.61	34.54	48.18	44.86	51.70	32.58	30.36
1975	38.77	45.72	43.01	41.60	40.34	56.28	52.41	60.39	38.06	35.47
1976	37.45	44.18	41.55	40.19	38.98	54.38	50.63	58.35	36.77	34.27
1977	45.24	53.36	50.19	48.54	47.08	65.68	61.16	70.48	44.41	41.39
1978	39.17	46.20	43.46	42.03	40.77	56.87	52.95	61.02	38.46	35.84
1979	47.61	56.15	52.82	51.09	49.55	69.12	64.36	74.17	46.74	43.56
1980	50.67	59.77	56.22	54.38	52.74	73.57	68.51	78.95	49.75	46.36
1981	55.83	65.85	61.94	59.91	58.10	81.05	75.47	86.97	54.81	51.08
1982	55.70	65.70	61.80	59.77	57.97	80.87	75.30	86.78	54.69	50.96
1983	60.30	71.12	66.90	64.71	62.76	87.54	81.52	93.94	59.20	55.17
1984	66.86	78.86	74.18	71.75	69.58	97.07	90.39	104.16	65.64	61.17
1985	66.45	78.37	73.72	71.30	69.15	96.47	89.83	103.52	65.24	60.79
1986	71.62	84.48	79.46	76.85	74.54	103.98	96.82	111.58	70.31	65.53
1987	80.13	94.52	88.90	85.99	83.40	116.34	108.33	124.84	78.67	73.31
1988	76.86	90.66	85.28	82.48	80.00	111.59	103.91	119.75	75.46	70.32
1989	88.62	104.53	98.32	95.10	92.23	128.66	119.81	138.07	87.01	81.08
1990	96.89	114.28	107.49	103.97	100.84	140.66	130.98	150.94	95.12	88.65
1991	100.04	117.99	110.98	107.35	104.11	145.23	135.24	155.84	98.21	91.52
1992	90.37	106.59	100.26	96.98	94.05	131.20	122.17	140.79	88.73	82.68
1993	86.13	101.58	95.55	92.42	89.63	125.04	116.43	134.18	84.56	78.80

characteristics, the logical choice would be to build the steel frame structure assuming the building codes allow this choice.

The index can also be used to determine the “hurdle” rent necessary to allow new construction to occur. First, a proportional allowance should be added to the index which accounts for any necessary site preparation work, consultant’s fees as well as any other incidental costs. Once these estimates have been made and added to the expected building cost, one simply multiplies the nominal construction cost per square foot by the current or expected capitalization rate. The resultant spread, in this simple model, represents the "residual-to-the-land" since the capitalization rate embodies the yield expected from the project. Thus, for our ten story steel structure in Boston, assuming 35% proportional additions for the items noted above, as well as assuming a cap rate of 9.6%,[24] the minimum net effective rent[25] necessary to cover the cost of development is $16.20 per square foot. This figure does not include the cost of the land. Thus, a market rent in excess of $16.20 net, would represent the residual to the land in this simplified model.

COMPARATIVE ANALYSIS WITH INFLATION

From the nominal cost/square foot model shown above, the commercial office replacement cost index was calculated for each of the MSA's. "Replacement cost" is used as the term to describe the index because the index represents the nominal price necessary to construct the average building in any given year. The index captures both the changes due to quality as well as the general level of prices in the economy. (The indices are presented in tables 12 through 14.)

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[24] This figure is derived from statistics received by the American Council of Life Insurance for Quarterly and Annual Totals for loans and interest rates for 1993.

[25] "Triple-net" rents are assumed, that is, the tenant assumes common area maintenance, taxes, and insurance.

Table 12 - Commercial Office Replacement Cost Index

Base Year 1982 = 100

Year	Atlanta, GA		Aurora, IL		Boston, MA		Charlotte, NC		Chicago, IL		Dallas, TX	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
1967	35.58	102.81	29.16	84.25	40.05	115.72	28.60	82.63	---	---	27.90	80.60
1968	34.69	96.20	34.60	95.95	39.02	108.19	33.78	93.68	37.38	103.66	29.82	82.68
1969	33.79	88.86	45.19	118.82	39.33	103.42	34.38	90.39	37.63	98.94	33.36	87.72
1970	38.58	95.94	59.28	147.45	45.28	112.61	39.44	98.10	41.78	103.91	33.94	84.42
1971	41.25	98.29	50.19	119.59	45.32	107.98	45.41	108.20	44.82	106.80	34.93	83.23
1972	43.61	100.67	50.12	115.70	52.11	120.30	40.15	92.70	46.68	107.77	40.70	93.96
1973	47.91	104.12	65.43	142.20	54.53	118.53	50.56	109.89	50.23	109.18	43.86	95.33
1974	57.68	112.90	61.49	120.35	59.57	116.61	50.74	99.33	55.74	109.11	49.54	96.96
1975	56.67	101.64	72.62	130.25	69.59	124.83	63.18	113.32	54.77	98.24	52.24	93.71
1976	67.03	113.67	82.74	140.32	67.24	114.04	62.85	106.59	55.37	93.90	51.32	87.03
1977	73.54	117.11	74.01	117.85	81.21	129.32	77.10	122.78	63.75	101.51	53.97	85.94
1978	82.72	122.44	69.45	102.78	70.32	104.08	84.50	125.07	66.89	98.99	66.55	98.50
1979	82.73	109.96	83.83	111.43	85.47	113.61	91.39	121.48	80.78	107.37	74.81	99.43
1980	95.05	111.31	126.75	148.44	90.97	106.54	97.60	114.30	91.05	106.62	84.80	99.31
1981	92.59	98.29	141.75	150.48	100.22	106.39	94.84	100.69	91.51	97.14	86.48	91.81
1982	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1983	106.58	103.26	132.07	127.96	108.25	104.88	100.82	97.68	104.60	101.35	108.43	105.06
1984	110.73	102.84	140.30	130.31	120.03	111.48	106.81	99.20	102.57	95.26	113.54	105.45
1985	106.34	95.37	117.10	105.02	119.29	106.98	115.08	103.21	104.01	93.28	113.67	101.95
1986	112.31	98.89	127.04	111.85	128.58	113.21	112.98	99.48	107.49	94.64	115.45	101.65
1987	125.70	106.78	139.94	118.88	143.86	122.20	125.81	106.87	126.07	107.09	111.06	94.34
1988	125.60	102.45	142.51	116.24	137.99	112.56	130.31	106.29	124.71	101.73	110.32	89.99
1989	150.44	117.08	179.99	140.07	159.10	123.82	143.97	112.04	137.90	107.32	127.94	99.57
1990	169.11	124.86	162.83	120.23	173.94	128.43	142.24	105.02	157.11	116.00	125.45	92.62
1991	163.67	115.96	175.32	124.22	179.59	127.24	166.65	118.07	143.17	101.44	158.63	112.39
1992	147.87	101.71	155.84	107.19	162.24	111.59	151.33	104.08	142.44	97.97	178.59	122.84
1993	138.42	92.44	159.96	106.82	154.62	103.26	162.52	108.53	164.03	109.54	176.91	118.14
Descriptive Statistics												
Comp. Avg.	5.16%	-0.39%	6.51%	0.88%	5.13%	-0.42%	6.65%	1.01%	5.85%	0.21%	7.08%	1.43%
Mean	90.38	105.03	102.94	120.54	97.32	113.62	90.85	105.17	89.71	102.65	85.34	96.47
Std.Dev.	41.44	9.03	45.77	16.53	44.51	8.21	41.71	9.92	39.02	5.65	44.46	10.20
Inflation	[Compound Average: 5.57%]:[Mean: 82.48]:[Std. Dev.:36.40]											

Table 13 - Commercial Office Replacement Cost Index

Base Year 1982 = 100

Year	Fort Worth, TX		Gary, IN		Joliet, IL		N. Jersey		New York	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
1967	33.83	97.73	31.33	90.51	27.63	79.84	33.85	97.80	33.78	97.59
1968	36.50	101.22	38.01	105.41	53.51	148.39	37.77	104.74	34.60	95.96
1969	30.82	81.05	35.60	93.59	54.80	144.09	36.56	96.13	38.12	100.24
1970	41.16	102.38	37.00	92.01	56.12	139.58	44.72	111.22	41.59	103.44
1971	43.33	103.24	44.85	106.87	57.35	136.65	53.11	126.56	48.03	114.45
1972	43.93	101.41	46.64	107.67	63.55	146.72	45.08	104.07	47.16	108.87
1973	45.40	98.68	48.39	105.16	58.95	128.11	61.17	132.95	55.62	120.88
1974	54.08	105.86	44.04	86.20	66.13	129.44	52.89	103.53	62.37	122.08
1975	53.39	95.76	46.83	84.00	62.46	112.04	62.37	111.87	59.69	107.07
1976	52.97	89.84	52.09	88.34	68.33	115.88	66.49	112.76	60.31	102.28
1977	60.53	96.38	56.63	90.17	68.05	108.36	63.26	100.73	68.81	109.57
1978	63.83	94.47	57.53	85.15	81.91	121.22	68.09	100.77	64.51	95.48
1979	79.15	105.21	63.94	84.99	71.21	94.66	75.38	100.20	76.93	102.26
1980	86.98	101.86	84.87	99.39	108.15	126.65	78.26	91.65	85.07	99.62
1981	96.83	102.79	118.41	125.70	117.97	125.24	95.70	101.59	92.03	97.70
1982	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1983	119.42	115.70	105.12	101.85	157.98	153.06	118.24	114.56	104.90	101.64
1984	124.01	115.18	89.75	83.36	92.43	85.85	121.88	113.20	119.16	110.68
1985	120.59	108.15	92.07	82.57	95.56	85.71	128.13	114.91	111.07	99.61
1986	122.75	108.08	91.11	80.22	116.36	102.45	114.85	101.12	118.76	104.56
1987	118.87	100.97	126.55	107.50	149.00	126.57	126.15	107.16	121.37	103.10
1988	122.77	100.15	132.59	108.16	143.97	117.44	133.40	108.82	130.55	106.50
1989	135.35	105.33	130.22	101.34	223.92	174.26	141.68	110.26	126.10	98.13
1990	135.61	100.13	138.52	102.27	171.20	126.40	138.41	102.20	143.04	105.61
1991	180.72	128.04	142.60	101.04	222.19	157.42	144.07	102.07	146.50	103.80
1992	188.10	129.38	138.25	95.09	189.60	130.41	154.70	106.41	167.97	115.53
1993	174.59	116.59	159.26	106.36	156.46	104.49	124.26	82.98	146.16	97.61
Descriptive Statistics										
Comp. Avg.	6.27%	0.66%	6.21%	0.60%	6.63%	1.00%	4.93%	-0.61%	5.58%	0.00%
Mean	91.32	103.91	83.41	96.85	104.99	123.00	89.65	105.93	89.04	104.60
Std.Dev.	46.77	10.13	39.83	10.62	53.15	22.89	38.36	9.81	39.20	7.04
Inflation	[Compound Average: 5.57%]:[Mean: 82.48]:[Std. Dev.:36.40]									

Table 14 - Commercial Office Replacement Cost Index Base Year 1982 = 100										
Year	Oakland, CA		Raleigh, NC		San Francisco, CA		San Jose, CA		Washington DC	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
1967	---	---	32.05	92.60	---	---	---	---	34.90	100.84
1968	---	---	36.30	100.66	---	---	---	---	33.25	92.20
1969	35.82	94.20	37.60	98.86	31.29	82.27	25.88	68.04	37.78	99.35
1970	40.34	100.33	41.79	103.94	34.42	85.60	42.65	106.07	42.09	104.67
1971	42.26	100.69	43.30	103.17	37.01	88.19	44.51	106.05	44.48	105.99
1972	44.49	102.71	43.36	100.10	41.67	96.20	42.17	97.36	44.60	102.95
1973	39.95	86.83	55.52	120.67	37.20	80.85	43.61	94.78	47.19	102.56
1974	51.08	99.98	56.90	111.37	45.34	88.75	46.34	90.71	65.04	127.31
1975	60.40	108.34	59.66	107.01	45.87	82.27	53.17	95.36	68.23	122.39
1976	62.17	105.43	67.48	114.44	59.98	101.73	56.02	95.00	64.83	109.94
1977	69.45	110.59	76.11	121.20	50.28	80.07	59.38	94.55	69.89	111.29
1978	60.07	88.91	73.53	108.83	49.07	72.62	56.17	83.14	73.20	108.34
1979	82.34	109.44	85.48	113.62	69.67	92.60	80.22	106.63	79.64	105.86
1980	90.87	106.42	91.11	106.70	74.30	87.01	85.26	99.85	87.75	102.76
1981	93.95	99.74	93.39	99.14	88.89	94.37	89.60	95.12	104.97	111.44
1982	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1983	101.72	98.55	112.10	108.61	97.85	94.80	103.30	100.09	104.34	101.09
1984	116.37	108.08	113.99	105.88	95.85	89.02	108.57	100.84	106.48	98.89
1985	104.55	93.76	108.79	97.57	105.41	94.54	93.73	84.06	111.71	100.18
1986	114.44	100.76	118.21	104.08	100.00	88.05	107.69	94.82	117.26	103.25
1987	113.14	96.11	126.66	107.59	96.28	81.78	99.39	84.43	126.70	107.63
1988	115.87	94.52	125.27	102.18	99.54	81.20	102.65	83.73	124.67	101.70
1989	114.20	88.87	147.70	114.94	108.82	84.69	106.97	83.24	137.07	106.67
1990	133.85	98.82	155.02	114.46	119.17	87.98	115.27	85.11	138.28	102.09
1991	140.07	99.24	153.46	108.73	119.40	84.60	123.11	87.22	154.43	109.41
1992	142.22	97.82	142.69	98.15	138.02	94.93	131.50	90.45	140.11	96.37
1993	169.52	113.21	162.57	108.57	125.59	83.87	126.18	84.26	153.52	102.52
Descriptive Statistics										
Comp. Avg.	6.41%	0.74%	6.20%	0.59%	5.72%	0.08%	6.54%	0.86%	5.64%	0.06%
Mean	89.57	100.13	91.11	106.41	78.84	87.92	81.73	92.44	89.35	105.10
Std.Dev.	36.78	6.74	40.54	7.00	32.51	6.77	31.00	8.96	38.28	7.15
Inflation	[Compound Average: 5.57%]:[Mean: 82.48]:[Std. Dev.:36.40]									

As with the coefficients for the dummy YEAR variables, the index reflects the same changes. Cost have declined rapidly in Atlanta and Boston while they have increased in

Chicago and Dallas over the 1990-1993 period. Still, it is difficult to ascertain, for instance, why costs escalated so much in Joliet in 1989 and 1991. Was there a shortage of labor and materials which caused the index to increase 55% in one year? Given the small sample of this market, a few expensive buildings with higher quality materials may have caused the increase.[26]

On a compound annualized basis, the average increase across all of the individual MSA indices was 6.28% in comparison to the CPI deflator index which increased 5.6% over the same period. Thus, the national average cost of an office building increased by roughly by 68 points over inflation. Across the individual markets, though, there were differences. For instance, New Jersey nominal prices increased 5.1%, while nominal prices in Dallas increased 7.4% over the 26 year period. This could be indicative of Dallas' growth and its movement from a small centralized central city in the 60's to a diverse transportation and corporate hub in the 90's with higher quality buildings . Atlanta and Boston experienced cost increases 20 to 30 points lower than inflation while the midwestern cities experienced price movements from 110 to 130 points higher than inflation. Over the long term, there doesn't appear to be a common reason for the changes across markets.

[26] The data indicates there were three offices constructed in 1989 and five in 1991, while there were 12 and 15 buildings built in the respective preceding years. While this market certainly experienced oscillations during the time frame in question, the drop in prices in light of increasing supply seems to indicate this was a rise in "quality" rather than a price response to supply.

Looking at a shorter term period, from 1982 until the present, as would be expected given the growth of the 80's, prices were greater than inflation by 60 to 200 points in a majority of the MSA's. While New York hovered around inflation, New Jersey, San Francisco, San Jose and Atlanta increased at a rate of roughly 40 to 130 points lower than inflation. Again, there does not seem to be a simple explanation for these differences except to infer that perhaps the access to material and labor encouraged lower costs in San Jose and Atlanta and may have contributed to the real growth in those economies while in New Jersey, the diverse mature economy didn't require the amount of resources necessary to construct new buildings which would presumably fuel price increases. Nonetheless, prices over the long and near term have held close to inflation. The volatility though, as measured by the standard deviation, presents some interesting observations.

Dallas, despite its higher than average price over inflation, has had the most steady price movements over the 26 year period, while smaller cities like Aurora and Joliet have experienced extreme fluctuations in the range of 18.8% to 29.3%. With respect to the stock cycle, which we will address in a moment, there did not seem to be a relationship between the amount of correlation in the stock and price cycle and the level of volatility in prices. Nonetheless, cities like Chicago, Raleigh, Dallas, Atlanta, New York, Washington and Boston experienced price fluctuations lower than 9.1%. Fort Worth, Oakland, Aurora, San Jose, New Jersey experienced price fluctuations greater than 11.6%. Thus, one causal relationship that may exist would be the given MSA's percentage of employment with the FIRE or service sectors. Certainly, for those cities which experienced lower volatility, cost may not inhibit the growth of office supply as much as those cities which experience higher volatility.

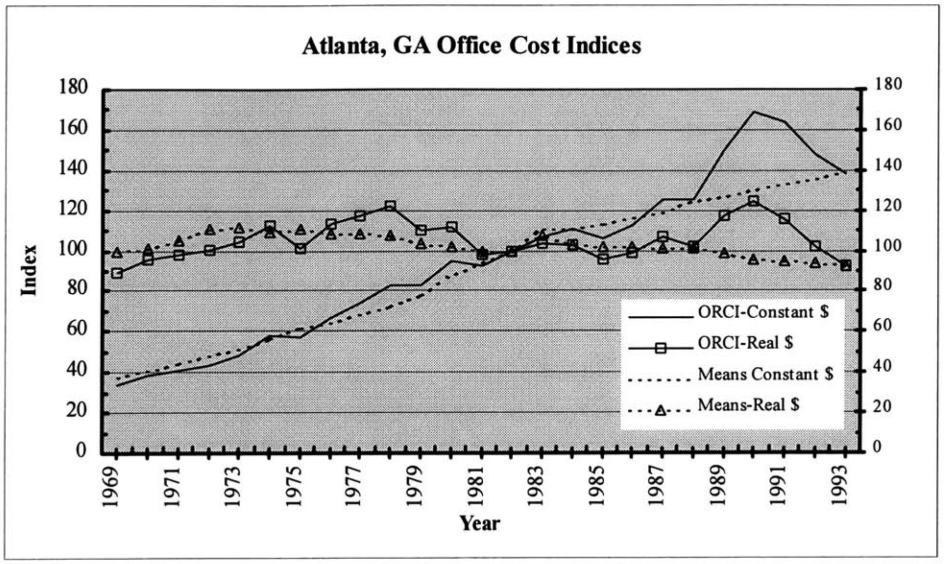
COMPARATIVE ANALYSIS WITH "MEANS"

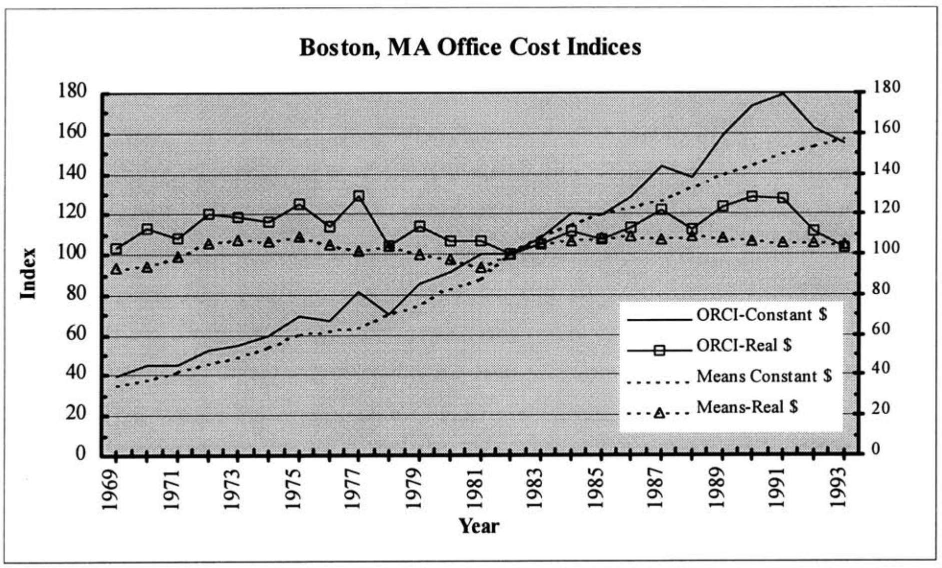
The "Means Construction Cost Index" is a popular industry standard which approximates the cost per square foot of a given structure type over time. The Means index has been characterized as not capturing the actual cost of construction, thus the figures that result are oftentimes held suspect. Still, it is probably the most widely used "rule-of-thumb" index. As shown in the following charts, the Means index for each MSA is compared with the Office Replacement Cost Index (ORCI).

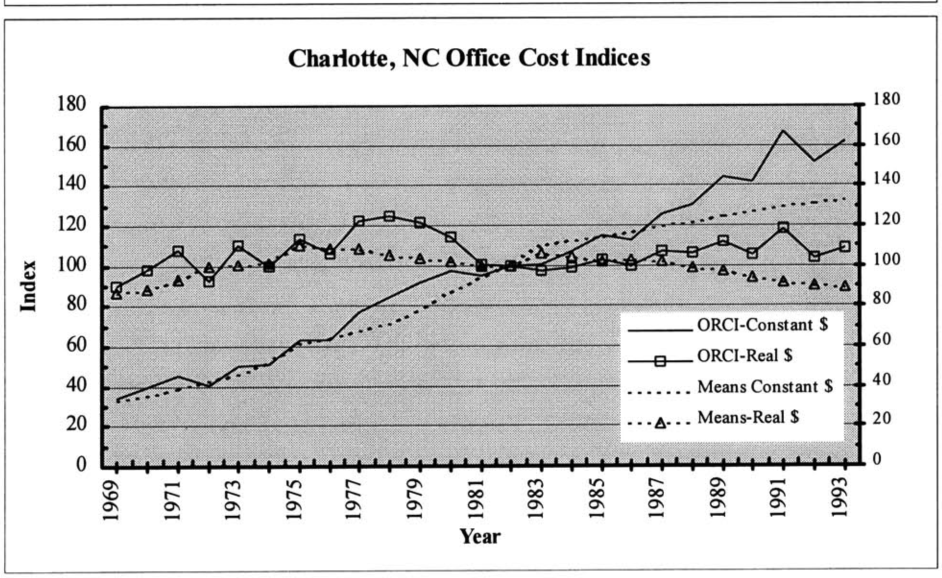
What is revealing about the comparison, is the general tendency for the ORCI to track quite closely with Means. As might be expected though, the ORCI bounces along on either side of the Means index. Thus, while the two indices follow a similar general trend, the Means index does not capture the subtle variations of the ORCI. Still, given the Means index computation, it covers the general movements of cost of all building types, not merely offices. Thus, one should expect the deviations from the Means index for the ORCI.

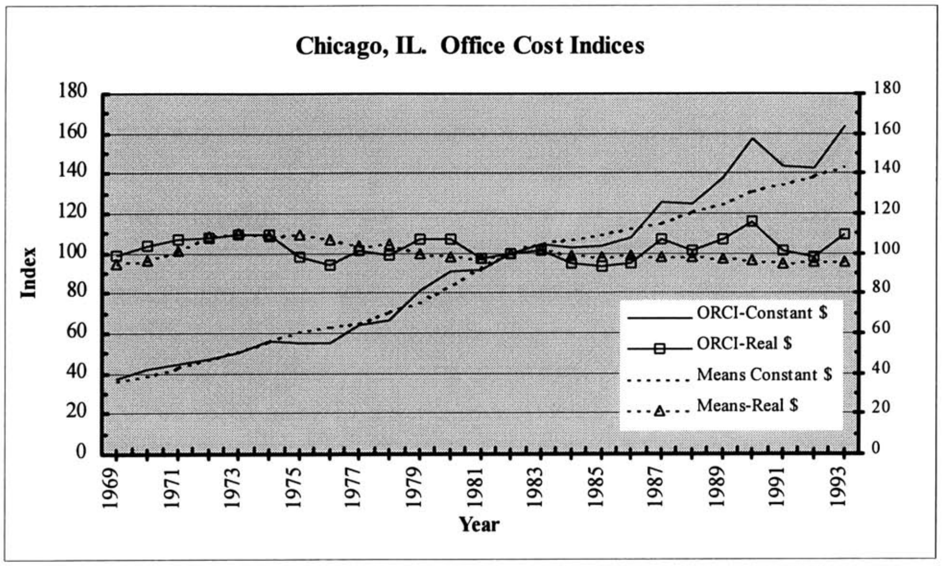
When we consider the "real" indices over time, the national index reveals the real cost of buildings have increased 9.68% over the 26 year period. This change in real prices either suggests additional "amounts of quality" changes over time or the construction of buildings with lower returns to scale. However, certain markets, like New Jersey and New York, have experienced lower real prices from 1967. Additionally, virtually all of the markets experienced a surge in prices relative to the means index in roughly the period 1989 to 1991. This time frame marks the strongest "visual" departure from Means. Escalating lumber and fuel prices during this time, in response to both national and international events, may have caused the increase. Loan commitments[27] were still on the rise through the end of 1989. This may have induced rising prices as well.

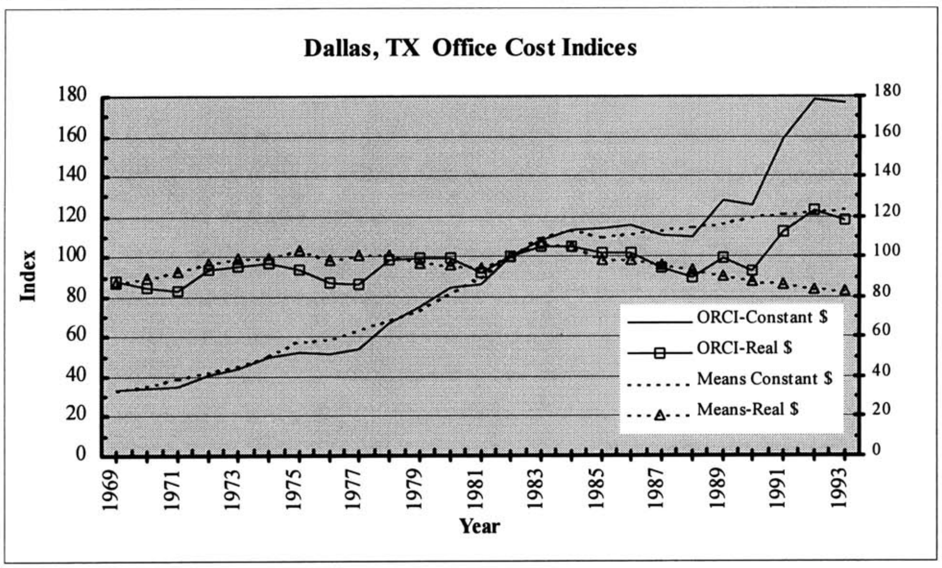
[27] As reported by the American Council of Life Insurance.

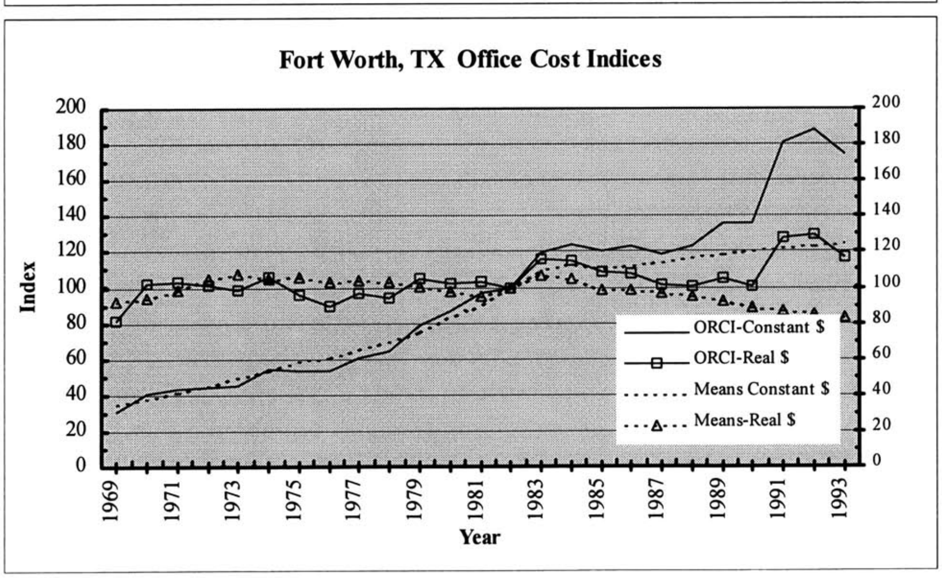

Atlanta, GA Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

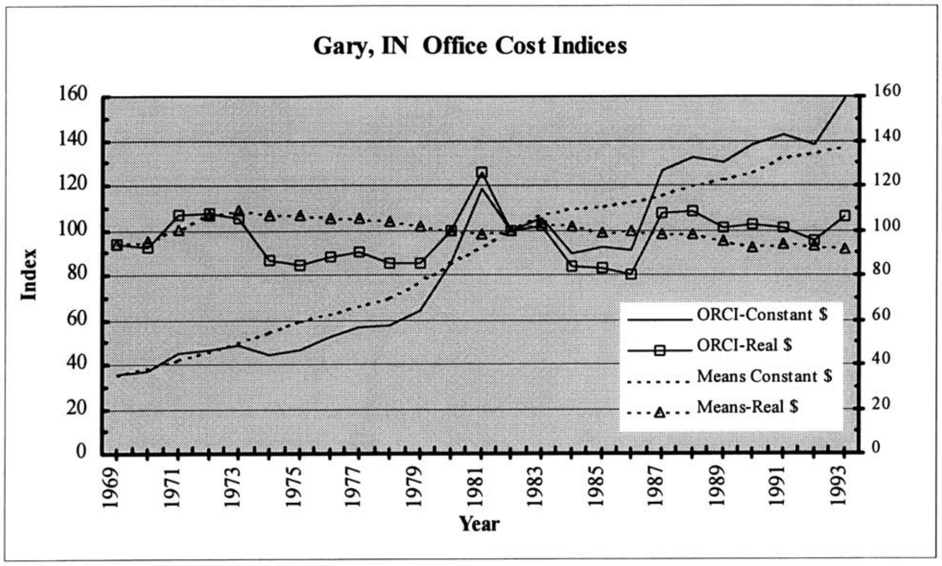

Boston, MA Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

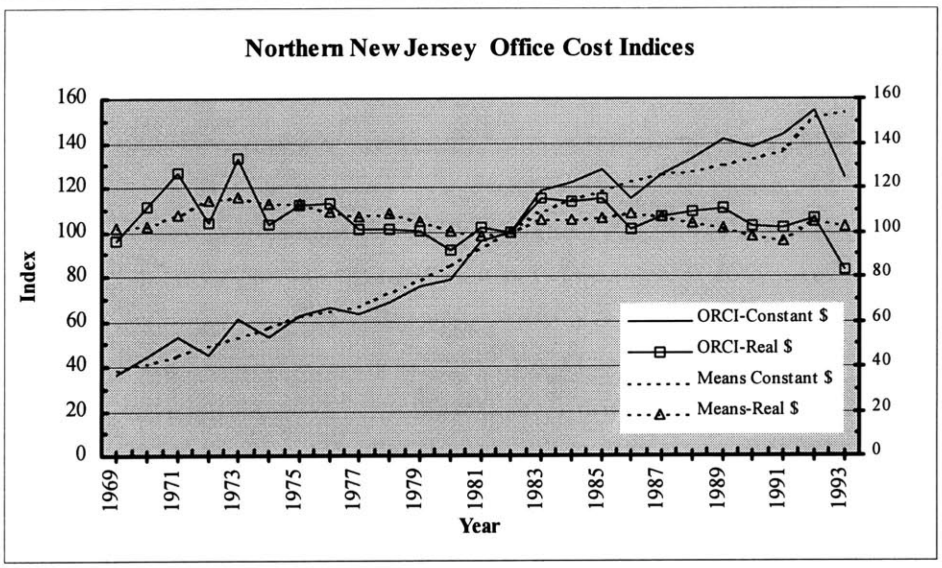

Charlotte, NC Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

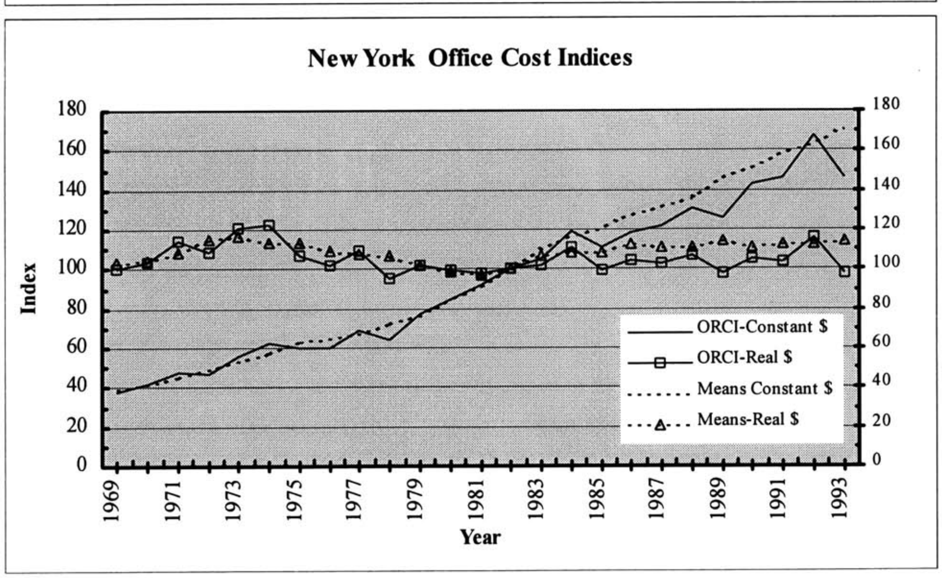

Chicago, IL. Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

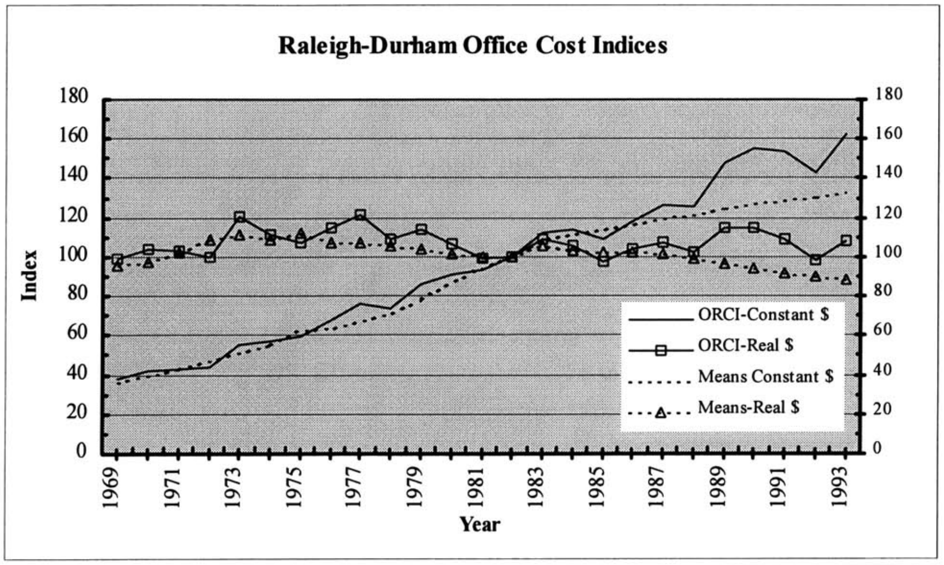

Dallas, TX Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $


Fort Worth, TX Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

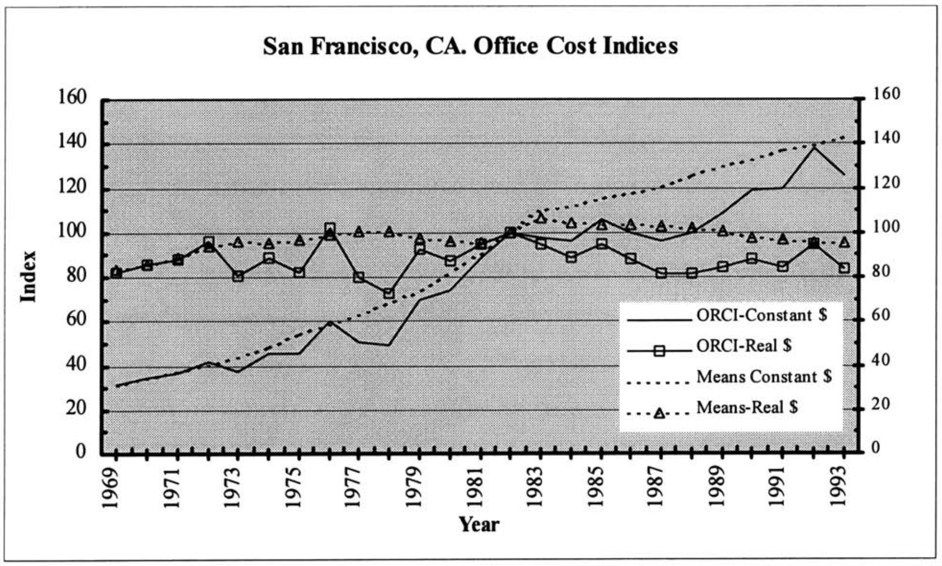

Gary, IN Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $


Northern New Jersey Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $

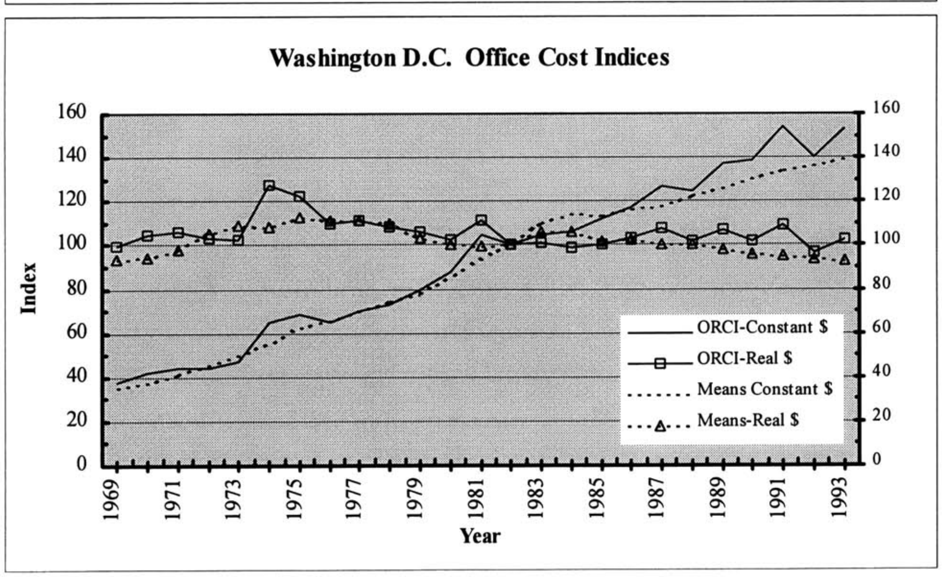

New York Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $



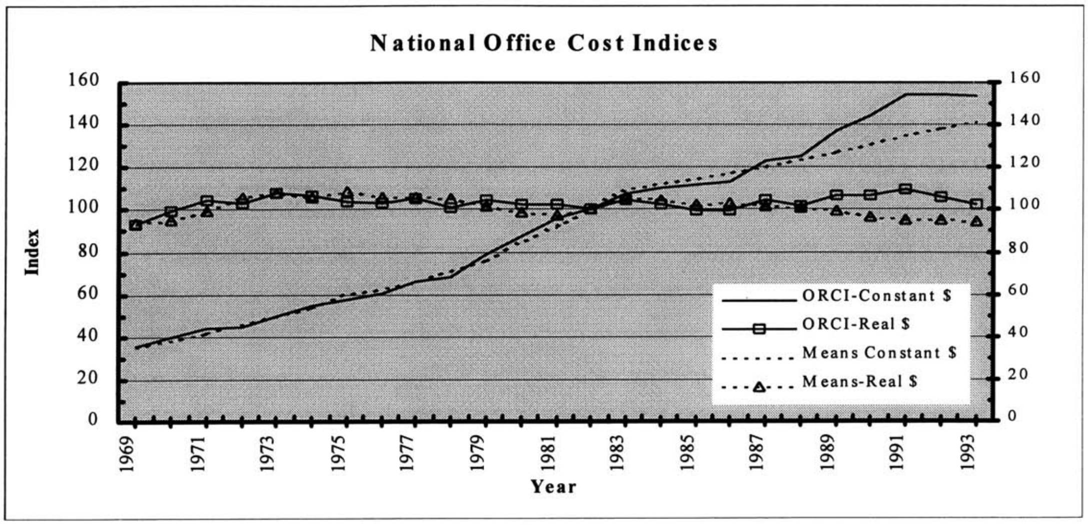
Raleigh-Durham Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $



San Francisco, CA. Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $



Washington D.C. Office Cost Indices
Index
Year
ORCI-Constant $
ORCI-Real $
Means Constant $
Means-Real $



Certainly the buildings in those cities did not decrease in quality over the time period, however, there may have been less speculative building.

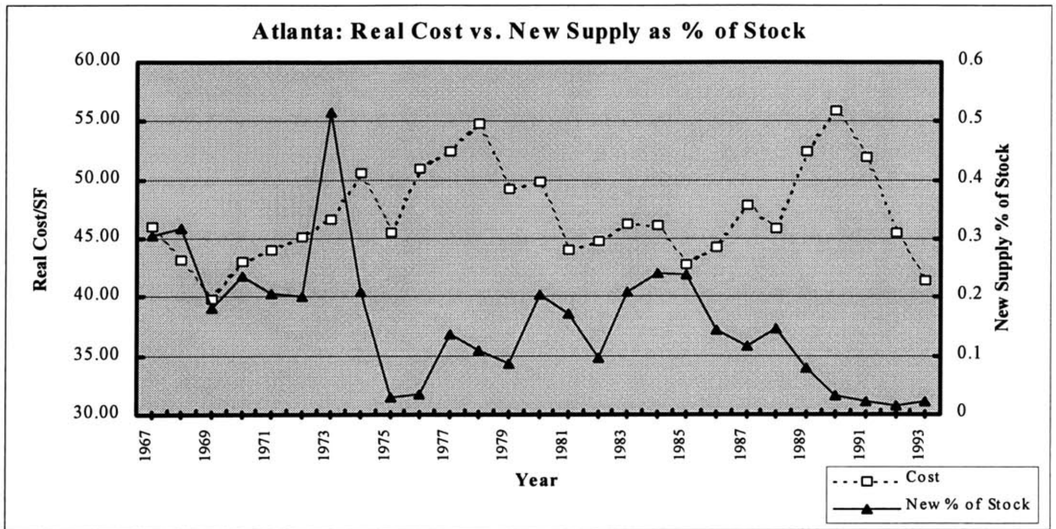
If we consider real prices from 1967 to 1990, there is a much more dramatic price increase. The graphs indicate a sharp increase in prices in most markets at approximately this same time period. Atlanta's price increase represented a change in real terms of 40% versus a change of negative 8% over the longer period. Boston experienced a 23% increase over the shorter interval versus 3.25% increase over the longer interval and Charlotte experienced a rise of 31% over the shorter term and 20% over the long term. In Chicago, prices grew 17% over the shorter term and 11% over the longer term. This pattern suggests the nation constructed a different "level" of building in 1991 than we do today. This is certainly true given the restraints the capital markets have imposed upon real estate in the last few years. Thus, it appears with increased capital, the market built buildings which had a higher level of quality.

Chapter 5

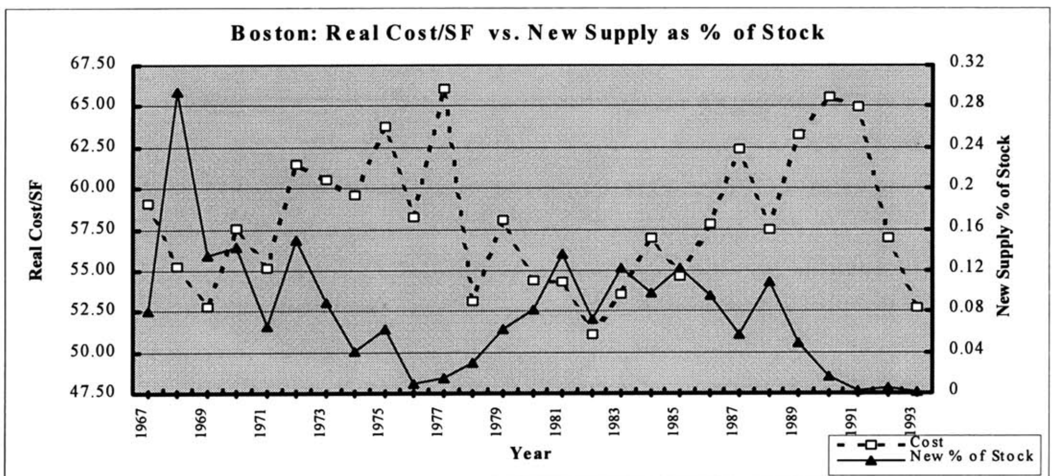
STOCK/COST CYCLES & THE ELASTICITY OF SUPPLY

For the following graphs, the percentage of new supply relative to the level of the existing stock was graphed in relation to the real cost per square foot of office construction. The periodic FW Dodge data was added to a stock series (starting in 1967) provided by CB Commercial. Real cost terms were used in constructing the charts in order to extract rising prices due to the general change in prices.

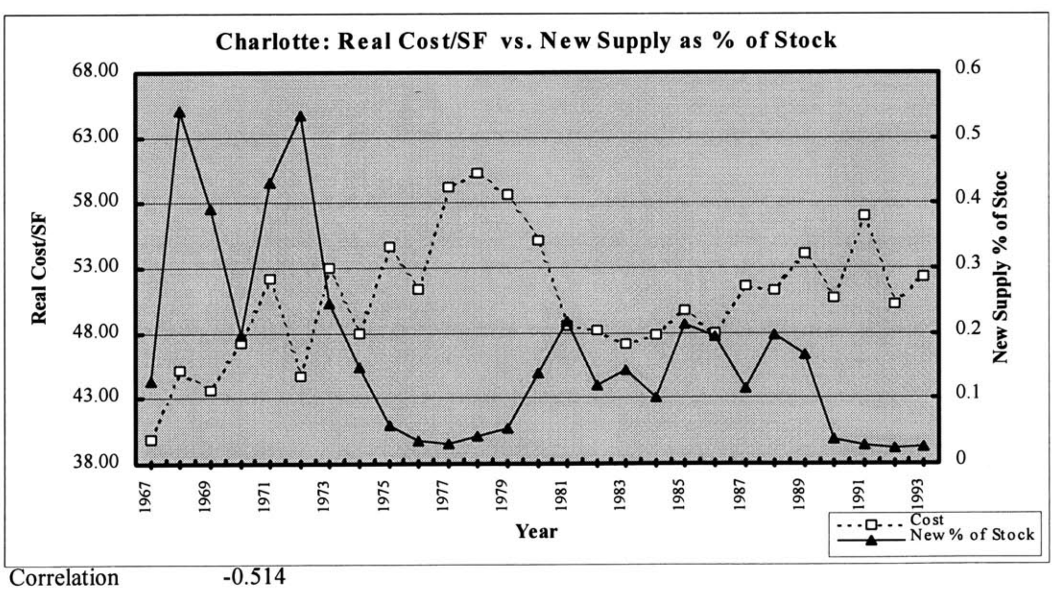
From these charts, we explore an MSA's ability to add stock. If the real cost increases in response to a large percentage increase in the supply relative to the stock (or, figuratively, the supply/stock ratio), then we would expect that costs may act to inhibit the growth of supply. From this, we might infer the office market must bid up the price to build these assets in an effort to secure the necessary resources. If, on the other hand, costs do not rise relative to the supply/stock percentage, we might infer that a particular MSA has a diverse construction market and/or there is an "ebb & flow" in the construction market with respect to other industries or projects "demanding" construction inputs. That is to suggest that the construction market is mobile between project types and that negatively correlated cycles exist between the office market and other construction markets. Also, if prices do not rise, the cost of construction will not act to inhibit the growth of supply.



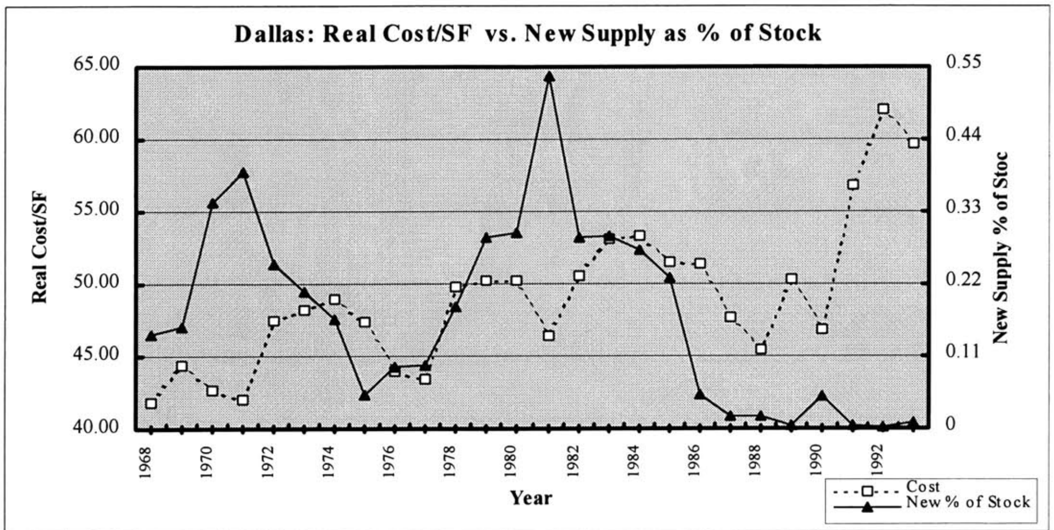
Correlation -0.3156



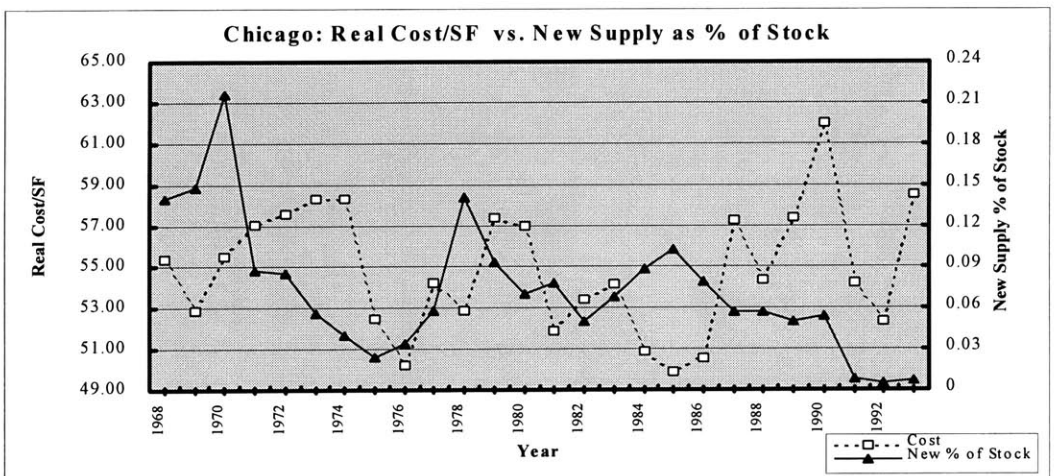
Correlation -0.3389



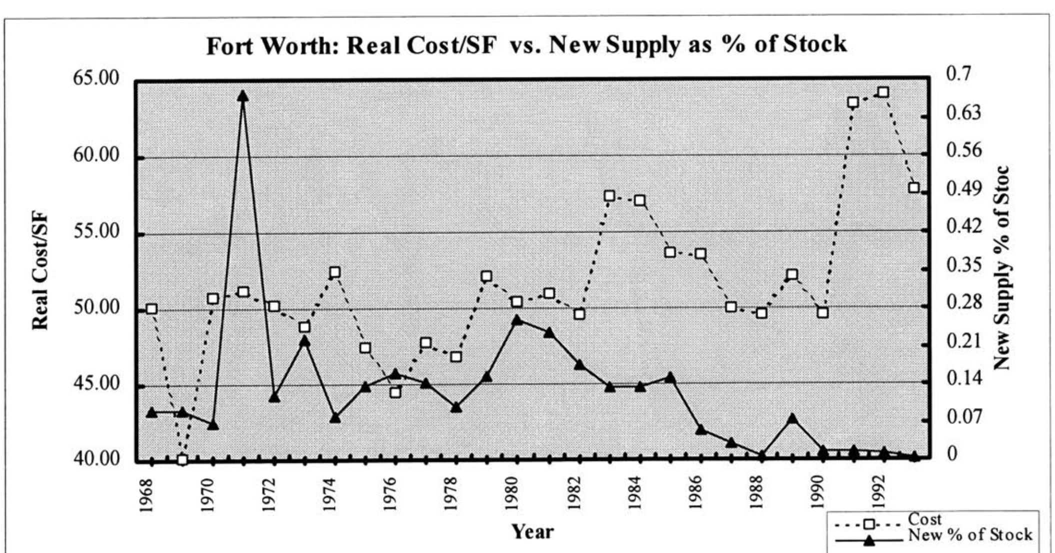
Correlation -0.514



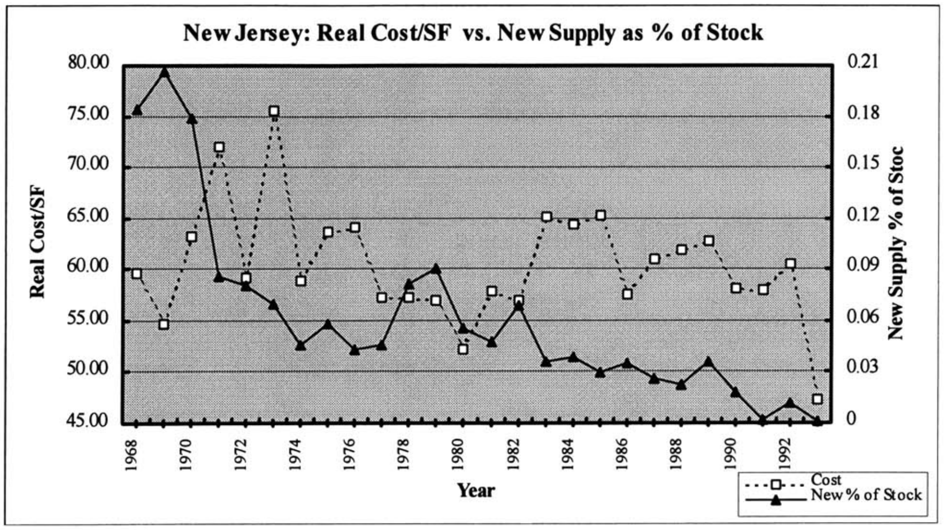
Correlation -0.2436



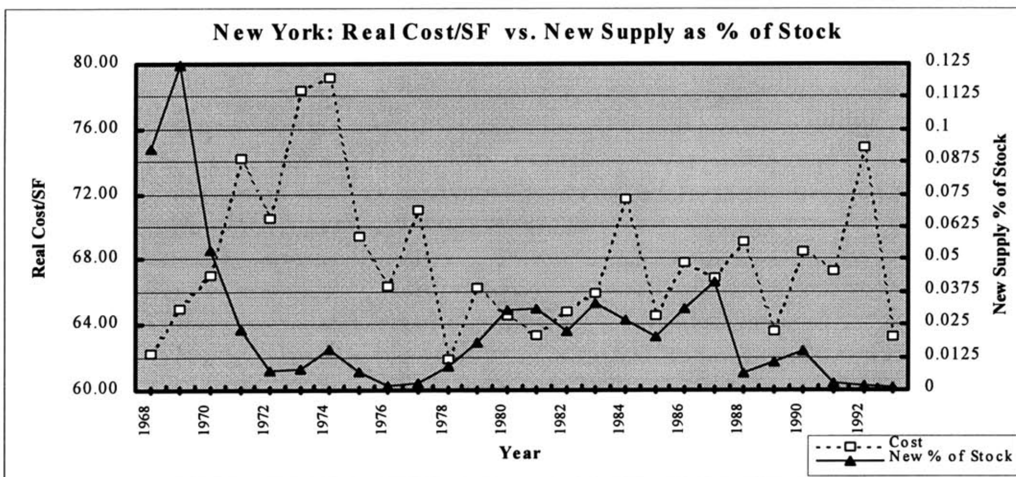
Correlation -0.0992



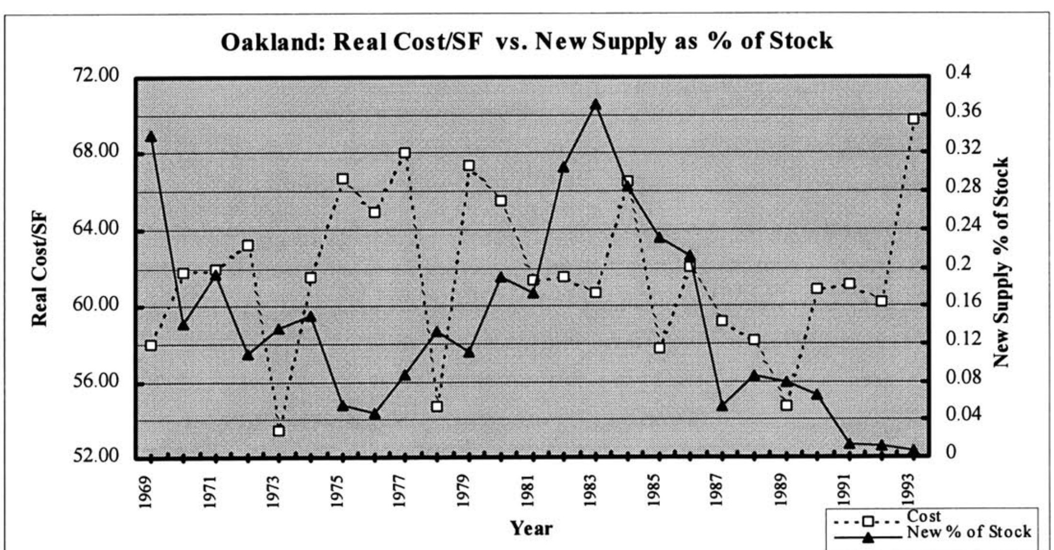
Correlation -0.2214



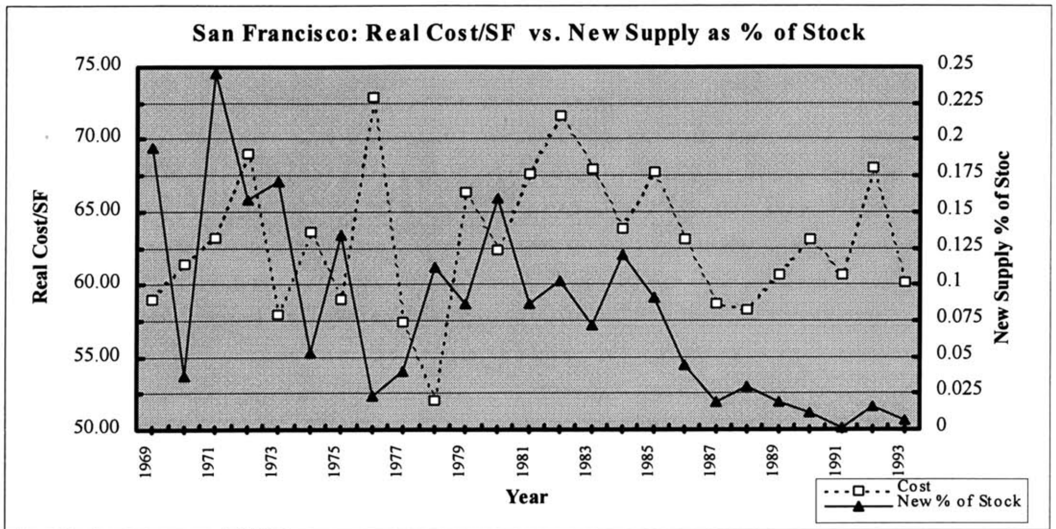
Correlation 0.0343



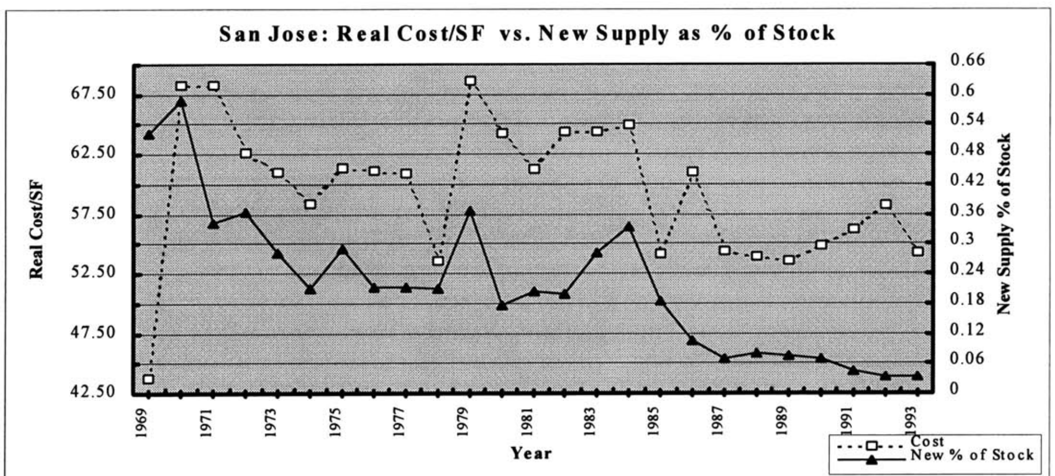
Correlation -0.3357



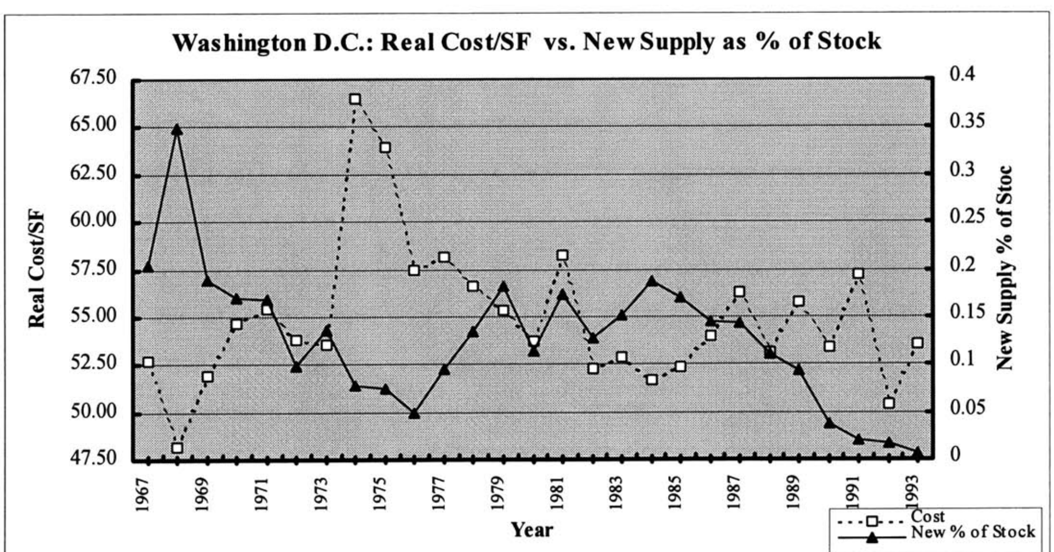
Correlation -0.1477



Correlation -0.0402



Correlation 0.3469



Correlation -0.3863

With the exception of San Jose and New Jersey, the correlation between the percentage of new stock in relation to the existing supply and the real cost of the supply is negative. Thus, cost likely does not act to inhibit the flow of supply in these markets. Even when the percentage of space being added was large with respect to the stock in the earlier periods, say 1967-1969, real costs dropped substantially. In Chicago, the real price dropped by nearly 4% even as the supply/stock ratio increased by roughly 1%.

In eight of the twelve markets analyzed though, real prices have declined since about 1992 or 1993. In Charlotte, Chicago, Oakland and Washington D.C., prices have risen. With respect to the correlation, there does not seem to be a general trend except to say that the four markets mentioned are negatively correlated.

Referencing the previous graphs comparing the ORCI and Means indices, those markets which indicated a sharp increase in real prices from 1989-1991 also indicate a sharp departure from the trend in the supply/stock ratio. After incurring declines until about 1987 or 1988, there is a sharp increase. Of late, all of the markets have settled to a nominal supply/stock ratio of approximately 0.1% to 0.5%. Certainly this reduced amount of new supply is in response to both regulatory and capital market restraints. However, these additions to supply may shed new light on the level of obsolescence in a given market.

Considering supply elasticity, a bivariate regression test was conducted on certain markets. Real cost per square foot was used as the dependent variable, while the supply/stock ratio (as a percentage) was used as the independent variable. The year was also used as an independent variable to detrend the series. The results of the tests are shown in Table 15 along with changes in real cost per square foot assuming a given change in the supply/stock ratio.

The results of the tests are not significant at the 95% level with only a few exceptions. Dallas, Fort Worth and Washington D.C. reported reasonable r-squares. The t-stats in each each of these markets were significant for the intercept and year, but were not significant for the stock/supply ratio. Given the correlation as shown in previous graphs, we would not necessarily expect a strong linear relationship between the variables. In order to increase the predictive capacity of this model, future research may include information relative to the level of construction activity in the market to ascertain the level of "total activity" in the market and its impact on cost.

Table 15-Cost Changes Relative To % Change In The Supply/ Stock Ratio								
City	Descriptive Statistics					Cost Change as Result of % Change:New to Stock		
		Intercept	Year	Supply/Stock	R. Square	1%	5%	10%
Atlanta	*Coeff.*	-43.2362	0.0464	-0.0957	0.1048	49.16	49.15	49.15
	t Stat	-0.1754	0.3737	-1.1001		49.16	49.15	49.14
						0.00	*0.00*	*-0.01*
Boston	*Coeff.*	137.4060	-0.0391	-25.4133	0.1188	59.28	57.00	57.00
	t Stat	0.5821	-0.3286	-1.6977		59.03	55.72	54.45
						-0.25	*-1.27*	*-2.54*
Charlotte	*Coeff.*	-59.4051	0.0569	-15.1587	0.2700	53.87	52.51	52.51
	t Stat	-0.2316	0.4405	-2.1982		53.72	51.75	50.99
						-0.15	*-0.76*	*-1.52*
Chicago	*Coeff.*	133.8061	-0.0395	-10.1739	0.0160	54.99	54.07	54.07
	t Stat	0.6465	-0.3793	-0.6112		54.89	53.57	53.06
						-0.10	*-0.51*	*-1.02*
Dallas	*Coeff.*	-982.2923	0.5205	2.6176	0.5795	55.09	55.33	55.33
	t Stat	-5.1838	5.4491	0.4867		55.12	55.46	55.59
						0.03	*0.13*	*0.26*
Fort Worth	*Coeff.*	-821.3732	0.4405	4.2190	0.4075	56.68	57.06	57.06
	t Stat	-3.5815	3.8110	0.6037		56.72	57.27	57.48
						0.04	*0.21*	*0.42*
New Jersey	*Coeff.*	728.1851	-0.3362	-35.7536	0.0895	57.70	54.48	54.48
	t Stat	1.6633	-1.5262	-1.0702		57.34	52.69	50.90
						-0.36	*-1.79*	*-3.58*
New York	*Coeff.*	453.9928	-0.1940	-82.3820	0.1954	66.53	59.11	59.11
	t Stat	1.8531	-1.5707	-2.3716		65.70	54.99	50.87
						-0.82	*-4.12*	*-8.24*
Washington DC	*Coeff.*	529.6844	-0.2375	-35.6200	0.3112	55.98	52.78	52.78
	t Stat	2.6647	-2.3755	-3.2375		55.63	51.00	49.22
						-0.36	*-1.78*	*-3.56*
Oakland	*Coeff.*	131.8861	-0.0350	-6.9462	0.0251	62.14	61.52	61.52
	t Stat	0.5169	-0.2719	-0.7520		62.07	61.17	60.82
						-0.07	*-0.35*	*-0.69*
San Francisco	*Coeff.*	43.9957	0.0097	-2.2526	0.0017	63.28	63.08	63.08
	t Stat	0.1122	0.0491	-0.1034		63.26	62.97	62.86
						-0.02	*-0.11*	*-0.23*
San Jose	*Coeff.*	91.3518	-0.0175	13.2125	0.1205	56.51	57.70	57.70
	t Stat	0.1521	-0.0582	0.8703		56.65	58.36	59.02
						0.13	*0.66*	*1.32*

Italics represent real dollar cost changes.
Sources:FW Dodge & CB Commercial

Utilizing the output from the model nonetheless, the change in cost relative to an increase in the supply/stock ratio was calculated. As would be expected, as the ratio increased, the price change was amplified. San Jose, Fort Worth and Dallas indicated small increases in price as the ratio of construction to the stock level increased. The other cities indicated price decreases as the ratio increased. New York reported the largest increase and was followed by New Jersey, Washington D.C. and Boston. Can we infer from the data that those cities which reported lower costs (as the ratio increased) also represent MSA's which produce structures with increasing returns to scale and thus provide greater productivity?

To answer this question, a bivariate regression model was developed to address cost elasticity at the MSA level. Real cost per square foot was again used as the dependent variable. The amount of new supply, in thousands of square feet, and the year were used as the independent variables. The cost elasticity for each MSA was then calculated over the interval of 500,000 to 1 million square feet as well as the interval of 1 to 1.5 million square feet utilizing the output from the tests. The results are shown in Table 16.

Table 16-Cost Elasticity at the MSA Level							
City	Descriptive Statistics					Range of Supply	
		Intercept	Year	New	R Square	.5-1.0 mil.	1-1.5 mil.
Atlanta	*Coeff.*	-251.335	0.15128	-0.000240	0.0961	0.9952	0.9928
	t Stat	-1.225	1.45805	-0.982730			
Boston	*Coeff.*	-76.336	0.06873	-0.000503	0.1007	0.9917	0.9875
	t Stat	-0.370	0.65897	-1.529543			
Charlotte	*Coeff.*	-474.077	0.26607	-0.001660	0.2101	0.9700	0.9543
	t Stat	-2.072	2.29936	-1.625995			
Chicago	*Coeff.*	63.485	-0.00384	-0.000144	0.0319	0.9974	0.9961
	t Stat	0.388	-0.04642	-0.870060			
Dallas	*Coeff.*	-937.975	0.49822	0.000036	0.5779	1.0007	1.0010
	t Stat	-5.366	5.64079	0.374035			
Fort Worth	*Coeff.*	-752.895	0.40614	0.000189	0.3996	1.0033	1.0050
	t Stat	-3.729	3.98177	0.208842			
New Jersey	*Coeff.*	363.315	-0.15353	0.000434	0.0512	1.0075	1.0113
	t Stat	1.289	-1.07865	0.360973			
New York	*Coeff.*	383.516	-0.15835	-0.000364	0.1750	0.9946	0.9919
	t Stat	1.620	-1.32647	-2.211408			
Washington DC	*Coeff.*	80.065	-0.01194	-0.000150	0.0648	0.9973	0.9960
	t Stat	0.407	-0.11987	-1.182437			
Oakland	*Coeff.*	24.440	0.01918	-0.000322	0.0250	0.9948	0.9922
	t Stat	0.099	0.15391	-0.750434			
San Francisco	*Coeff.*	-50.661	0.05693	0.000311	0.0132	1.0049	1.0074
	t Stat	-0.163	0.36383	0.515589			
San Jose	*Coeff.*	619.195	-0.28441	0.002112	0.2190	1.0395	1.0581
	t Stat	2.052	-1.86556	1.904634			

Sources:FW Dodge & CB Commercial

Cost Elasticity > 1, indicates decreasing returns to scale

Cost Elasticity = 1, indicates constant returns to scale

Cost Elasticity < 1, indicates increasing returns to scale

Again, the test results are not significant. Only Dallas indicated any promising results. A negative sign for NEW indicates a reduction in cost as the supply increases. The amount of the reduction is dependent upon the additive nature of the coefficient. In Atlanta , for instance, a level of new supply of 1 million square feet represents a reduction in cost of \$0.24. In Charlotte, a similar level reduces the cost by \$1.66 per foot.

Given the intervals stated above, the cost elasticity for each market resulted in nearly constant returns to scale. Comparing tables 15 and 16, those cities which indicated a reduction or increase in cost as a result of the supply/stock ratio in table 15, also indicated increasing or decreasing returns to scale, respectively, in all but two markets. In New Jersey and San Francisco, the economies of scale were reversed from the changes associated with the supply/stock ratio. In each of these instances, the models did not indicate a high level of explanatory power. The insufficient results are likely the result of omitted variables or an insufficient model. Even for the balance of the cases, the tests were not significant. Does this indicate that real costs per square foot do not hold a strong relationship to the level of supply or that cost does not act to inhibit the level of new supply? The following section addresses these questions through the construction of a supply forecast model.

Considering the supply forecast, the level of new supply, as reported in the FW Dodge data, was the dependent variable used in the linear model. For the independent variables, the real cost, as calculated from the hedonic model, the one-period lagged level of vacancy, as reported by CB Commercial and the one-period lag in "real yield" on commercial mortgages, as reported by the American Council of Life Insurance, were used. The results of the tests are shown in Table 17.

Table 17 - Supply Forecast Statistics						
City		Intercept	Real Cost	Vacancy-1	Real Yld-1	R Square
Atlanta	*Coefficients*	226.74	166.01	-398.87	773.95	0.5138
	t Stat	0.04	1.11	-2.79	4.16	
Boston	*Coefficients*	8209.76	-92.94	-126.68	405.45	0.2653
	t Stat	1.25	-0.80	-1.23	2.34	
Chicago	*Coefficients*	20416.41	-203.58	-428.63	677.42	0.4213
	t Stat	1.78	-0.99	-3.22	2.90	
Dallas	*Coefficients*	-964.19	294.52	-618.45	1069.19	0.2782
	t Stat	-0.07	0.96	-2.78	1.86	
New York	*Coefficients*	24652.77	-219.13	-637.80	242.82	0.4738
	t Stat	1.93	-1.16	-3.99	0.83	
San Francisco	*Coefficients*	11396.28	-95.12	-379.51	299.32	0.3632
	t Stat	2.17	-1.24	-3.39	1.95	
Washington DC	*Coefficients*	5474.54	-1.87	-123.95	1319.42	0.2883
	t Stat	0.25	0.00	-0.44	2.16	

In all cases, the real cost was not significant at the 95% level. In most cases, the lagged vacancy and yield variables were significant at the 95% level. As might be expected, the signs for these variables were appropriate. For the yield variable, an increase in the yield suggested an increase in the supply while an increase in the vacancy rate resulted in a reduction to supply.

Considering the time frame of the tests (from 1969-1993), non-recourse loans were popular. Thus, a causal relationship may result between the yield on mortgages and the level of supply if it is true that the supply of funds from the capital markets had a greater effect on the supply of space in relationship to the fundamental economics of the office market. That is to say that lenders increased the cost of funds to insure against real estate risk as opposed to either restraining the level of capital or requiring recourse loans. With respect to the magnitude of each of the parameters in the model, real yield increases the supply to a greater degree than do either real cost or vacancy act to reduce the level of supply. In all cases, the real cost inhibits supply to a much lesser degree than does the level of vacancy in a market. As such, in the final analysis, history has indicated that the real cost of commercial office space has had minimal influence on restraining supply.

Chapter Six

CONCLUSION

In an efficient market, how do we reconcile a level of supply greater than the amount necessary to cover obsolescence if the cost of the supply is greater than the replacement cost? Demand theorists suggest that there is a dynamic structural vacancy rate as has been applied to the labor markets. If one considers the vacancy rate as a proxy for supply, then this theory is valid. Some demand theorists also suggest obsolescence is rising. Given the cycles in the market, one might suggest that obsolescence is dynamic, with respect to quality, depending upon the speed with which capital flows into the market. The folklore in the 80's suggested, "so long as they keep the money flowing, we'll keep building!" Thus, if there is a "risk-free" dollar to be spent, it just may be spent.

These issues appear to be reconciled if we consider supply within the context of the bid/rent curves proposed by Alonso. From the research undertaken, cost elasticity and normal profits suggest there exist a series of quality/cost curves which determine the level and type of supply which enters the market in response to demand and the willingness for participants to pay for a number of "units of quality."

As was exhibited in the table addressing the cost per square foot for space in Boston, the cost per square foot will depend upon the quality characteristics of the building and the cost elasticity of those characteristics. As noted, the costs will vary over the range of quality. The level of rents in a given marketplace is determined in a competitive property market. Thus, the rents, in this efficient market, are static over the short run, but assume different levels for different building types. Therefore, with cost elasticity fixed in the supply market, and rents fixed in the property market, the capitalized value of the rents discriminate over the type of structure constructed, which will allow a residual to the land. Since the capitalized values vary with the supply of capital provided by the capital markets, the quality level of assets will vary over time[28]. That is, in the presence of fixed cost elasticity, the quality of assets constructed will shift from one level, or quality/cost curve to another level, or curve.

History has provided us with examples of these capital flows and the changes in quality which resulted. The wonderful structures constructed in the 1980's in response to "favorable" capitalization rates, as well as the supply of capital which flowed onto the market in the early 70's from real estate investment trusts, support this hypothesis and reconcile the issues regarding a dynamic structural vacancy and a dynamic rate of obsolescence.

Future research can explore the segments of quality and additional "quality characteristics or attributes" which exist in the market in an effort to establish a more narrowly defined replacement cost index with greater explanatory power. Further research can also explore the variables which cause changes to the index in order to support supply forecasting.

[28] Exceptions to zoning regulations are noted.

Within the context of the quality/cost curves, we can then address the demand functions of this segment of the market. Such research may further our understanding of the oscillations of the commercial office market.

Appendix

F.W. Dodge Database Summary New of Records				
MSA	**Observations**	**Total Sq. Feet**	**Value in 1993$***	**# of Stories**
Atlanta, GA	4145	131001.3	9,072.04	8562
Aurora, IL	306	5088.2	404.34	446
Boston, MA	2448	93196.5	9,218.49	6167
Charlotte, NC	1708	32868.3	2,621.87	2786
Chicago, IL	5152	194188.5	17,676.44	11328
Dallas, TX	5114	177025.3	13,256.26	10189
Fort Worth, TX	2008	30367.7	2,190.90	2807
Gary, IN	717	5537.1	451.31	875
Joliet, IL.	240	2284.2	194.02	294
New Jersey	1578	55324.8	5,033.46	3236
New York City	1660	162413.8	22,055.74	8885
Oakland, CA	2037	63023.5	5,330.67	3523
Raleigh-Durham, NC	1321	28517.1	2,130.49	2271
San Francisco, CA	1409	77938	7,879.07	4202
San Jose, CA	1928	45072.4	3,665.75	3026
Washington D.C.	3969	269733.1	21,907.33	13223
Total	35740	1373579.8	123,088.18	81820
*Value in millions of 1993				
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MSA	Frame Type Unit Frequency Distribution												Total
	A	B	C	D	E	F	G	H	I	J	K	L	
Aurora	232	92	12	6	3	1	21	2	12	1	0	19	401
Atlanta	2252	1332	632	386	124	62	75	32	100	17	5	67	5084
Boston	1475	1115	411	85	39	40	245	20	39	7	1	156	3633
Charlotte	1286	476	188	62	56	13	53	7	24	3	0	43	2211
Chicago	4076	1342	85	248	31	41	347	19	136	2	10	207	6544
Dallas	3119	1588	258	393	112	49	250	54	54	2	11	76	5966
Fort Worth	1334	561	227	63	37	32	82	6	26	6	0	62	2436
Gary, IN	549	101	160	6	29	11	25	2	11	1	2	34	931
Joliet, IL	185	57	25	7	7	8	20	1	7	1	0	8	326
New York City	1099	702	38	72	24	14	160	17	56	2	12	82	2278
Northern New Jersey	971	765	134	29	23	16	112	6	30	3	2	108	2199
Oakland	940	206	597	56	12	53	273	11	6	11	3	335	2503
Raleigh-Durham	644	495	171	50	28	19	72	9	33	6	0	21	1548
San Francisco	414	236	324	57	6	40	288	14	3	7	2	256	1647
San Jose	887	163	490	53	6	57	287	10	7	15	4	204	2183
Washington DC	1891	1404	183	663	66	50	211	41	98	14	8	75	4704
Frame Type Total	21354	10635	3935	2236	603	506	2521	251	642	98	60	1753	44594
	47.9%	23.8%	8.8%	5.0%	1.4%	1.1%	5.7%	0.6%	1.4%	0.2%	0.1%	3.9%	100.0%
Source: F.W. Dodge													

MSA	FRAME CODE PERCENTAGE DISTRIBUTION PER MSA											
	A	B	C	D	E	F	G	H	I	J	K	L
Aurora	57.9%	22.9%	3.0%	1.5%	0.7%	0.2%	5.2%	0.5%	3.0%	0.2%	0.0%	4.7%
Atlanta	44.3%	26.2%	12.4%	7.6%	2.4%	1.2%	1.5%	0.6%	2.0%	0.3%	0.1%	1.3%
Boston	40.6%	30.7%	11.3%	2.3%	1.1%	1.1%	6.7%	0.6%	1.1%	0.2%	0.0%	4.3%
Charlotte	58.2%	21.5%	8.5%	2.8%	2.5%	0.6%	2.4%	0.3%	1.1%	0.1%	0.0%	1.9%
Chicago	62.3%	20.5%	1.3%	3.8%	0.5%	0.6%	5.3%	0.3%	2.1%	0.0%	0.2%	3.2%
Dallas	52.3%	26.6%	4.3%	6.6%	1.9%	0.8%	4.2%	0.9%	0.9%	0.0%	0.2%	1.3%
Fort Worth	54.8%	23.0%	9.3%	2.6%	1.5%	1.3%	3.4%	0.2%	1.1%	0.2%	0.0%	2.5%
Gary, IN	59.0%	10.8%	17.2%	0.6%	3.1%	1.2%	2.7%	0.2%	1.2%	0.1%	0.2%	3.7%
Joliet, IL	56.7%	17.5%	7.7%	2.1%	2.1%	2.5%	6.1%	0.3%	2.1%	0.3%	0.0%	2.5%
New York City	48.2%	30.8%	1.7%	3.2%	1.1%	0.6%	7.0%	0.7%	2.5%	0.1%	0.5%	3.6%
Northern New Jersey	44.2%	34.8%	6.1%	1.3%	1.0%	0.7%	5.1%	0.3%	1.4%	0.1%	0.1%	4.9%
Oakland	37.6%	8.2%	23.9%	2.2%	0.5%	2.1%	10.9%	0.4%	0.2%	0.4%	0.1%	13.4%
Raleigh-Durham	41.6%	32.0%	11.0%	3.2%	1.8%	1.2%	4.7%	0.6%	2.1%	0.4%	0.0%	1.4%
San Francisco	25.1%	14.3%	19.7%	3.5%	0.4%	2.4%	17.5%	0.9%	0.2%	0.4%	0.1%	15.5%
San Jose	40.6%	7.5%	22.4%	2.4%	0.3%	2.6%	13.1%	0.5%	0.3%	0.7%	0.2%	9.3%
Washington DC	40.2%	29.8%	3.9%	14.1%	1.4%	1.1%	4.5%	0.9%	2.1%	0.3%	0.2%	1.6%
Source: F.W. Dodge												

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