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THE ECONOMICS OF ARCHITECTURE AND URBAN DESIGN: SOME PRELIMINARY FINDINGS

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The Economics of Architecture and Urban Design:

Some Preliminary Findings

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ABSTRACT

This paper makes a preliminary attempt to evaluate empirically the nature of the contribution of architectural quality to the value of buildings. An economic model is postulated which predicts equilibrium rent and vacancy behavior as a function of both design and non-design characteristics. Vacancies are created in equilibrium as a result of search and information costs and tenant heterogeneity and are observed by the landlord as price inelastic demand behavior. Design quality is seen to influence both rent and vacancy behavior. Its effect, however, is dependent on characteristics both of the production and operating cost functions and of tenant demand for the design vs. non-design amenity. An important characteristic of the design amenity is that it is not, in general, independent of the production function for non-design amenities. The model is tested using disaggregate cross-sectional and longitudinal operating performance and amenity data from a set of 102 class A office buildings in Boston and Cambridge. Data on design quality for the set of buildings were provided by a detailed evaluation of each structure by a panel of architects. Results confirm a strong influence of design on rents; structures rated in the top 20 percent for design quality were predicted to extract almost 22 percent higher rents than those rated in the bottom 20 percent. In contrast, the data showed a weak relationship between vacancy behavior and design quality. Finally, good design was shown to cost more to produce on average, but not necessarily in every case. The magnitude of the point estimates of the rent, vacancy, and construction cost effects suggest that good design may not in fact be more profitable on average, but as with a lottery, may provide a small probability of a high return to the developer.

The Economics of Architecture and Urban Design: Some Preliminary Findings

INTRODUCTION AND PROBLEM STATEMENT

A substantial body of urban economic research deals with hedonic estimation of the contributions of various amenities to property value.[1] Theoretical and empirical evidence about the nature of amenity influences are important, not only for their contributions to value theory, but also for the insight they provide into appropriate public policies affecting urban development.[2]

This paper makes a preliminary attempt to evaluate "design." "Design" is an amenity which has been studied very little but is potentially important, both as a control variable by developers and as a policy variable by government in affecting quality of life in the city. An understanding of the relationship between the quality of design and value can aid governmental agencies in the development of public policies toward design -- from zoning, building codes, and subdivision regulations to design review committees and urban design development guidelines. Furthermore, it could be even more important to the development community. Evidence on the nature of this relationship could enhance communication between developers and designers, who frequently bring to the table preconceptions about the relationships among design, cost, and return, without a clear or commonly shared notion of their nature.

Design as an amenity is difficult to define, as it embraces an overall attitude towards the making of objects which is manifest throughout the building process. Design can embrace the functionalism of the structure as well as its aesthetics, sometimes considered more ethereal, intangible, and subjective. It can also refer to the micro-level amenity of the architecture of the building as well as the macro-level response of the structure to the urban design environment in which it is located. The siting of a structure, the shaping of its volume, the articulation of its surfaces, the configuration of its lobby and the selection of its hardware are all acts which involve "design" and which, cumulatively with many other such decisions, define the "quality" of the final product.[3]

While it is true that lack of consensus on the definition of design could hinder its measurement, this problem can be overcome through the creation of an acceptable operational definition. The term "design" shall be operationally defined in this study as "aesthetics," and "functionalism" will be defined to be a distinctly separate amenity (although often interactive with design). Furthermore, a distinction shall be made between two components of design -- "architecture" as an <u>intrinsic</u> characteristic of the structure itself, and "urban design" as those <u>extrinsic</u> attributes of developments which affect the environment or neighborhood within which the structure is situated. After a brief review of the literature, a formal economic definition of design as an amenity and theory about its behavior in the marketplace will be presented. The succeeding section will present our empirical methodology. Final sections will report our empirical results on the primary questions of interest: What is good design? Does good design cost more? Does it produce higher rents? Does it result in faster least-up? And finally, is it more profitable?

PAST STUDIES

There exists a relatively complete literature, primarily in the engineering tradition, on the <u>supply</u> or cost side of the provision of certain intrinsic amenities, including design features. The value- or cost-engineering literature is replete with analyses of the relationship between certain design amenities, or building configurations, and construction costs (<u>e.g.</u> Canastero [1981], National Association of Home Builders [1982], O'Brien [1977], Grimm [1976]). Rules of thumb arising from these studies speak of 10 to 30 percent premiums for "superior" quality materials and finish and specialized structural configurations.

The value-engineering literature, however, has not provided much insight into the demand side of the market for design amenities. It is quite likely that tastes for design features and demand for high-quality design are variable across demand groups; in fact tenant and corporate-owner sophistication is frequently cited as a source for design quality differences. Furthermore, design tastes are expected to be variable across structure and market types. The class A office space and institutional markets have always seemed significantly more responsive to design considerations than the industrial space market. There have been some attempts in the environmental design literature to get a better feel for the utility associated with variations in architectural and urban design features (for example, see Im [1984], Lyons [1983]), but, by and large, we know very little about the demand side of the picture.

There is one existing study in the economics tradition which deals with the pricing of "good architecture" in a hedonic framework. Hough and Kratz [1983] made use of a sample of 139 office structures in Chicago to develop a rental hedonic which included as explanatory variables "good architecture" variables, as proxied by whether older structures were recognized as historic landmarks or whether new structures were awarded the Chicago American Institute of Architects jury award. The authors found a significant rent premium associated with good architecture for the newer structures (though not for the old) -- approaching $1.85 per square foot on an average annual rental rate of $8.27 per sq. ft., a 22 percent premium. This was unexpectedly large, hinting at a strong relationship between design quality and economic performance. However, the study leaves numerous unanswered questions. The data measured gross rental premiums alone without considering any additional costs of construction or operation which may be associated with architecturally significant structures. Thus, the cost of providing good design was undefined. A more subtle concern is that the rental premium in the Chicago study may represent a payoff to successful attempts at providing quality architecture. It is commonly accepted among architects and developers that the provision of out-of-the-ordinary architectural amenities increases the risk associated with market acceptance, hence return. In this view, architecture represents a gamble -- a lottery in some sense in which the expected return may be low or non-existent, but provides a small possibility of a very high return if the project is successful (see also Baumol [1986]). A final problem is the fact that although their criteria delineate the clear upper ranges of design quality, they do not provide a continuum of design gradations which can clarify the incremental value of increased design quality at both ends of the spectrum. Nor do they provide any indication of the numerous dimensions of design quality which typically underlie overall design opinions.

THE MODEL

"Design" Defined

An appropriate operational definition of "design" is essential to the usefulness of this study. We assume that the design amenity provides "aesthetic" utility in the sense that the user (or observer) derives pleasure from the visual environment created by the structure. This benefit is considered separate from the "functional "utility which directly facilitates the activities housed by the structure (for example shelter, heat, light, space, noise insulation, and specialized amenities such as electrical outlets).

This aesthetic pleasure may come from the outside looking at the exterior of the structure (architecture), from the inside looking out (view), or from the inside looking in (interior design). It may be valued purely for its own sake, as is art consumption (see Singer [1978]) or it may contribute indirectly to the productivity of the enterprise housed in the structure. For example, certain colors, shades, or configurations of interior space have been found to enhance employee morale, which in turn is related to productivity.

The firm and individuals may also derive "status" from occupying a design landmark. Such a landmark could be symbolic of a firm's progressiveness and stability and even serve a marketing function, as in the case of the Transamerica Pyramid and the Citicorp Tower. The important determinant in separating "aesthetics" from "functionalism" is whether the enhanced productivity comes via a physical response or an aesthetic response.[4]

We will concern ourselves in this paper only with "architecture," i.e., the effect of the external building appearance on those who look upon it, and to a limited extent with "interior design," or at least its public facilities component (see Pollard [1980] for an examination of view). Variations in architectural and interior design quality could be associated with any of the following four dimensions:

1. "decorativeness" or embellishment of the facade
2. color and texture of surface materials
3. quality of surface materials
4. differences in configuration or shape of the building, massing, and fenestration, often referred to by designers as "volumetrics," including the presence or absence of site amenities.

These are the objective characteristics of the structure associated with design judgments. Of course there are an infinite number of variations possible within each of these dimensions, each of which would elicit a specific judgment of design quality. To the extent that divergences exist in tastes, of course, these judgments may differ.

We assume that every structure possesses a vector of non-design (i.e. functional) attributes A and a vector of design attributes D. For every given set of functional attributes A_j there exists a least-cost production technology. This results in a certain base level of design D_{mj} associated with the purely functional structure. Controlling for A_j, then, there are an infinite array of possible design configurations D_{ij}, each with a specific cost of production and operation under the most efficient production technology. By definition the cost of any of these design configurations given A_j, C_{ij}, must be greater than the cost of the base design configuration C_{mj} (otherwise it would become the base design configuration).

To the extent that one can obtain objective measures of the four dimensions of design quality, design can be measured directly. One may use style descriptors, indicators of the presence of absence of certain colors or textures, or other amenities associated with design. However, the problem with this from a practical standpoint is that the array of all design dimensions is exceedingly large, some of the dimensions may not be operationally measurable, and some may in fact rely more upon the symbolism created by the overall design rather than individual components. Furthermore, as we shall see below, to paraphrase Philip Johnson, "more may be less," in that excessively ornate design statements may prove less aesthetically pleasing.

This suggests that a preferred proxy for design quality may be opinions of design quality, either by experts (such as a panel of architects), market participants (such as landlords or tenants), or the public at large. Market participants would perhaps provide the most direct proxy measure, though they may rely upon designer's opinions as the arbiters of design tastes.

We modify our above discussion, then, to replace the vector of objective design characteristics D_{kj} with a single -- or vector of -- design preference ratings, D'_{kj}. Note that the relationship

$$D'_{kj} = d(D_{kj}) \tag{1}$$

is important. One primary objective of developers and architects is to know what is good design, or what types of investments in design tend to be rewarded. Strong positive relationships and high explanatory power in (1) suggest we have good objective measures of design quality and a relatively complete set of attributes. However, more ambiguous relationships and low explanatory power suggest either an inadequate set of measures or possibly the presence of "overinvestment" in design.

With this new proxy for design quality we may again define a "base" level of design D'_{mj} associated with a minimum-cost A_j configuration. Controlling for A_j, there are an infinite array of design preference ratings D'_{kj}, each with a specific cost of production and operation C'_{kj}. These C'_{kj} must be greater than C'_{mj} by definition, but it is not necessarily true that $D'_{kj} > D'_{mj}$. This implies that good design does not necessarily cost more, or conversely inferior design does not necessarily cost less. In fact, in unique circumstances the minimum-cost functional configuration may actually prove the best design option. This would be the case in which $D'_{kj} < D'_{mj}$ for all possible k. Such a situation would be more nearly reflected in preferences which support the "minimalist" architecture of the International style.

However, in the case in which the point of "overinvestment" in design has not yet been reached (i.e., marginal utility is still positive or zero with increases in physical investment supporting design), it is true that the minimum cost C'_{kj} necessary to produce a given level of D'_{kj} must increase as D'_{kj} increases. One would expect in this case that, given an array of structures of similar functional characteristics but varying levels of design preferences, the relationship between design quality and cost, or

$$C'_{kj} = c(A_j, D'_{kj}) \tag{2}$$

would be positive. However, this relationship would be much more muddled if "overinvestment" is common or we have some measurement error in our preference rankings.[5]

Vacancies, Rents, and Design

Let us complicate this discussion further by considering the relationship between vacancy rates, rents, and design. Vacancies in the real estate market can be created by a number of factors (see Rosen and Smith [1983]), including the cost of holding inventory, search costs, information costs, tenant heterogeneity, rigidities in lease structure, lease timing, and "building ahead" under conditions of lumpy supply and variable demand. Intuitively we may postulate that these factors affect the vacancy rate faced by an individual landlord in the following way: the vacancy he experiences is dependent upon his rent level relative to "market," and "market" rent is determined by a number of demand and supply variables, including such structural amenities as design.[6] Better design would be expected to reduce vacancy from the demand side to the extent that demand is unambiguously increased. From the supply side, too, better design would be expected to reduce vacancy to the extent that production and operating costs are unambiguously increased with investment in design, hence reducing supply.[7]

The important point is that vacancies, as well as rents, are expected to be influenced by the design amenity, and furthermore, both rents and vacancies are simultaneously determined. This suggests that not only must the rental hedonic include design as an amenity (possibly interactively with certain other amenities), it must include the vacancy rate, or

$$R = r(A_1, D_1', X_1, (D_1'A_1, D_1'X_1), V) \qquad (3)$$

where R = rent per unit of service

A_1 = vector of functional structural amenities

D_1' = vector of design ratings

X_1 = vector of locational and site amenities

V = vacancy rate

Furthermore, the vacancy relationship must also include both design and the rental rate:

$$V = v(A_2, D_2', X_2, (D_2'A_2, D_2'X_2), R) \qquad (4)$$

Simultaneous estimation of (3) and (4) will require use of instrumental variables and replacement of the explanatory variables V and R by their predicted values from the first stage regression. The next sections of the paper will estimate equations (1) - (4) for a particular real estate market and use the results to draw conclusions about the behavior of the design amenity in affecting rents and values.

EMPIRICAL RESULTS

Data Sources

In order to test whether or not the design amenity affects costs, rents, vacancies, and profitability as predicted above, we gathered the following disaggregate, operating conditions and amenity information on a sample of 102 class A office buildings of over 100,000 sq. ft. in Boston and Cambridge:[8]

1. Quarterly quoted rent (RENT) and vacancy (VAC) information from Spaulding and Slye Office Reports 1:1979 to 4:1986.[9]

2. Descriptive attributes of sites and structures from Spaulding and Slye and the Codman Company data and surveys, including
   - Distance to the city center (CENTER)
   - Availability of parking on-site (ONPARK)
   - Number of parking places within 800 feet of the structure (PARKING)
   - Age of the building (AGE)
   - Gross square footage of the building (TOTAREA)
   - Number of floors (TOTLFLRS)
   - Whether or not the building has been rehabilitated
   - Date of rehabilitation

3. Ratings of design quality, which included eight dimensions of design quality plus an overall design rating (DESIGN) for buildings which have not been rehabilitated and three dimensions of design quality plus an overall design rating (REHAB) for rehabilitated buildings.[10] Data was gathered from a population of 80 architects, each of whom had served on an awards panel in the Boston area and were familiar with the

structures in question.[11] Twenty-eight completed surveys were returned, a 35 percent response rate.[12]

In addition, an attempt was made to gather construction and operating cost information through surveys made by the Boston Redevelopment Authority and reports by the Codman Companies and Spaulding and Slye. However, only limited hard construction cost information (HCRATIO) was available, and virtually none of the operating cost information was usable because of data reliability problems. The summary statistics for the amenity variables are shown in Figure 1.

We present below our empirical results for the various relationships of interest. First we observe simple correlations among the variables, focusing on the relationships between design quality and rents, vacancies, etc. Then we observe correlates of design quality, attempting to determine in particular whether such variables as structure age, gross area, or locational attributes tend to result in a higher quality design. Then we attempt to make use of whatever construction cost information was usable to evaluate the relationship of design and construction costs. Next we return to the primary variables of interest: the influence of design on rents and vacancies, estimating a rental hedonic and a vacancy relationship which, in addition to evaluating the impact of design on equilibrium vacancy rates, attempts to examine the extent to which design quality allows faster lease-up. Finally, we attempt to make some preliminary judgments about the profitability of good design, drawing upon our empirical results.

Simple Correlations

The Pearson correlation coefficients between all pairs of variables are displayed in Figure 2. These are quite consistent with many hypothesized relationships. For example note that the natural logarithm of the rental rate (LNRENT) is most highly correlated (and in expected directions) with structure area (TOTAREA), number of floors (TOTLFLRS), parking availability nearby (PARKING), and distance from the city center (CENTER). However, the negative relationship with the availability of on-site parking (ONPARK) is counterintuitive. Possibly the existence of on-site parking is proxying for a lower-density location. The correlation of LNRENT with design quality (DESIGN) is moderately positive at .405. Note that the correlations of rent with age of the structure (AGE) and vacancy rate (VAC) are small. One encouraging result is that the correlation of DESIGN with LNRENT is the highest of any DESIGN partial correlation. This suggests that a rental hedonic would be less likely to obscure the DESIGN effect through multicollinearity. Note also that DESIGN tends to have a negative correlation with AGE (though small), a positive correlation with TOTLFLRS, and a correlation close to zero with vacancy.

What is Good Design?

As described above, the designers' survey evaluated the panel of architects' ratings on eight dimensions of design quality plus an overall design rating for new (i.e., unrehabilitated) buildings and on three dimensions of design quality plus an overall design rating for rehabilitated buildings. The design ratings were all on a 1 to 5 basis, which represents the respondent's opinion of whether the particular design dimension placed the building in the lowest 20 percent of buildings, the next 20 percent, etc.[13] Note that the highest correlation with overall design quality for new buildings included the macro-shape factors of fenestration, massing, and view on skyline, while the lowest included public interior space, quality of materials, public amenities, and public exterior space. Highest ratings for new buildings were in quality of materials, the lowest in responsiveness to the neighborhood and public amenities.[14]

Rehabilitated buildings tended to score higher as a group in the overall quality ratings than newer buildings. Furthermore, the overall design rating for rehabilitated buildings seemed to be more related to the quality of the rehabilitation rather than the design quality of the original structure. Attempts to relate the design quality ratings of rehabilitated buildings to other measures of performance, such as rents and vacancies and other amenities such as age failed, suggesting the market for rehabilitations operates differently than that for new structures. This corresponds to the results of Hough & Kratz [1983]. We therefore confine all the following results to the sample of unrehabilitated new buildings and furthermore only to the sample of 63 unrehabilitated structures in Boston, since amenity information on many of the others was unavailable.

Figure 3 displays the highest- and lowest-rated buildings, along with their design ratings (and the standard deviations in these ratings), dates built, and design firms. No patterns are evident in design firms. There is clear evidence of older buildings ranking lower, although the lowest-ranking structure, One Exeter Plaza, was built in 1984. Note that the fourth-lowest ranking building, 125 High Street (The Travelers Building), was razed after the survey was taken. Buildings ranking highest seemed to fall into two distinct stylistic groups: (1) buildings which are designed as modern, high technology objects having an intrinsic fascination by their technology, material quality, and composition (e.g. - the John Hancock Building, a reflective glass-clad tower rated as the best overall office structure, or the Federal Reserve Building, an aluminum-clad tower with stark volumetric relationships at the street level) or structures which are largely context driven and responsive to the scale and design characteristics of their surroundings. In the latter group are included Rowes' Wharf and 855 Boylston Street, both highly detailed structures incorporating brick, detailed fenestration, and varied bulk and scale reminiscent of older Boston architecture, as well as Center Plaza abutting Government Center, a curved building following the edge of Cambridge Street defining one edge of Government Center Plaza.

The buildings rated lowest seemed to be characterized by a general insensitivity to their surroundings, combined with a heavy-handed use of materials and approach to detailing. Many of these structures were examples of the "International-Style" so prevalent in the 1960's, which produced large, relatively undifferentiated towers which were unresponsive and incognizant of their site and context, often without redeeming attention to scale or detail in their construction. This raises a question of some import, beyond the scope of the current effort; that is, the effect of changing public aesthetics and architectural tastes on opinions of quality and the chilling possibility that some of today's "signature" towers may be perceived as passe or inappropriate in a different milieu twenty years in the future. Of some interest is the lowest-rated office structure, One Exeter Plaza, a dark glass and brick structure in Boston's Back Bay known to local architects as the "Darth Vader" building for its gloomy, hooded appearance. It is interesting to note that the structure, in a sensitive and well-recognized architectural setting, suffered a slow rent up and still carries a high vacancy rate, even while more highly rated and recent neighbors move toward full occupancy.[15]

Several alternative specifications of the relationship DESIGN = f (other amenities) were tested using OLS, with seven of those reported in Figure 4. The explanatory power of all equations was relatively low, with adjusted R^2's only between 2.5 and 12.1 percent. The only variables consistently significant at the 5 percent level were AGE and TOTLFLRS, suggesting (1) a definite "fad" effect in which design quality depreciates as the structure ages, becoming design obsolescent, and (2) a tendency for the higher-rise structures to be favored. The magnitude of the AGE coefficient, averaging about -.0225, suggests a new building would be expected to be rated at 2.95. Each year of age would reduce this rating by .0225. At this rate, it would be expected to take 44 years to drop the structure into the next lowest design quintile (i.e., to a rating of 1.95). The scattergram of design quality and structure age in Figure 5 confirms this strong relationship, but suggests some irregularities which may represent the emergence of various styles.

Similarly, the magnitude of the TOTLFLRS coefficient, averaging about .0120 suggests an increase of 10 floors would increase the design rating by .120, to 2.871. Looked at another way, a 3-story structure would be rated lower by 0.200 at 2.551. This is not a large effect, but is significant.

Equally as important as the strong "fad" and "high rise" relationships is the apparent insignificant relationship of design quality with various locational amenities such as distance to the city center (CENTER), size (TOTAREA), floorplate size (ARPERFLR), or the presence of on-site parking (ONPARK).

Does Good Design Cost More to Build?

As indicated earlier, data problems limited our ability to evaluate fully the influence of design quality on construction costs. However, using a small, usable sample size of 12 we were able to estimate several simple models, regressing hard construction costs per square foot adjusted for construction cost differences over time (AJHCRATI or its logarithm LNAJCRA) on DESIGN, TOTAREA, TOTLFLRS, and AGE. We expect a priori the construction cost level to be positively related to DESIGN and TOTLFLRS. The relationship with TOTAREA is expected to be negative to the extent that economies of scale in production are present. The relationship with AGE is expected to be zero to the extent that the cost index is successful in adjusting for inflation.

The results are shown in Figure 6. The log specification clearly dominates. The coefficients for TOTAREA and TOTLFLRS are both in the expected direction and significant. The AGE coefficient is also insignificant, as expected. Evaluated at the mean adjusted construction cost of \$105.84/sq. ft. (logarithmic mean), and the mean gross area of 469,532 sq. ft., an increase in rentable area of 1 percent (4695 sq. ft.) reduces hard costs by 61.5 cents per square foot or 0.581 percent, an elasticity of -.581. Further, an increase of one floor increases HCRATIO by \$3.80 per square foot, or 3.6 percent, an elasticity of .554. Both are reasonable adjustment ranges.

The coefficient for DESIGN, although positive, is not significant. This is consistent with the notion cited above that design does not necessarily have to cost more to the extent that "overinvestment" may contribute to negative marginal returns to design. The magnitude of the point estimate, however, is large. Movement to the next highest quintile of design quality is predicted on average to cost $30.23/sq. ft., a 26.2 percent premium. This magnitude, however, is in the 10 - 30 percent premium range cited by developers for the highest quality structures.

More analysis clearly needs to be carried out on the construction cost variable with a large cost sample. Future efforts will be directed toward this end.

Do Well-Designed Buildings Rent for More?

Several specifications of the rental hedonic were tested to evaluate the relationship between contract rents and design. In each case, rents and other conditions for the most recent reporting period, 4:86, were selected using the 63-structure Boston sample.[16] Results of the OLS and 2SLS estimates are shown in Figures 7a and b. Given the cross-sectional nature of the database, the explanatory power of between 58 and 65 percent is considered quite good, and coefficients for several variables were consistently significant and in the expected direction. By and large, coefficients were of a similar magnitude for both the OLS and 2SLS models.

The AGE coefficient proved to be significantly negative, as expected, reflecting economic depreciation. The magnitude of the coefficient was in the -.00616 to -.00943 range, and -.00771 in the preferred 2SLS Specification Three, suggesting each year of age would reduce rents 21.1 cents per square foot or 0.77 percent. This suggests a new building which would rent for $29.52 per square foot would lower that rent to $23.43 per square foot, or by 20.6 percent if it were 30 years old.

The relationship with floor height was also positive, as expected, and non-linear. The coefficient for LNTOFLRS ranged from .1863 down to .0889 as TOTAREA and other variables were added. In the preferred 2SLS Specification Three the coefficient of .0890 implied that an average structure of one story would rent for $21.62/sq. ft., one of five stories for $24.95/sq. ft, one of 10 stories for $26.54/sq. ft., and one of 40 stories for $30.02/sq. ft. The premium for view is evident for heights up to 20 stories or so. This relationship is clear in the scattergram shown in Figure 8.[17]

The relationship with distance to the city center (CENTER) also displayed significance, at least at the 10 percent level (although not in all equations due to collinearity) and was negative as expected, with magnitudes ranging from -.00539 per thousand feet in OLS specification three to -.00628 per thousand feet in 2SLS specification three. This represents a 0.62 percent drop per thousand feet. For example, this would mean a drop from $28.68 per square foot at the city center to $27.75 one mile away and to $20.59 ten miles away.[18]

The existence of on-site parking (ONPARK) tended to lower rents (though not significantly in 2SLS Specification Three), again possibly proxying for locational characteristics. Surprisingly, increased distance to a transit stop (TSTOP) tended to increase rents. A satisfactory explanation for this has proven elusive, unless possibly it is proxying for a negative congestion externality effect.

Gross floor area of the structure (TOTAREA) is also a significant positive influence when included in the rental hedonic, though small in magnitude. The coefficient for the preferred specification was 1.105×10^{-7}. This implies for an average structure of 435,888 sq. ft., an increase in size of 100,000 sq. ft. would increase rents from $27.58/sq. ft. to $27.88/sq. ft., an increase of only 1.1 percent.

Let us now turn to the principal variable of interest, the design amenity. A simple scattergram of RENT vs. DESIGN (Figure 9) suggests a positive relationship. Those buildings outside of the trend line tend to be the very large structures in the heart of downtown, or in the case of one structure (One Exeter Plaza) a building rated very low on design quality and also displaying a relatively high vacancy rate. These results suggest the value designers place on design may correlate with any values attached by tenants and reflected in the market. As additional variables collinear with DESIGN are added to the specification, the significance of the

DESIGN variable tends to drop. However, in most equations, including the preferred 2SLS Specification Three, the DESIGN coefficient is significant at least at the 10 percent level, with magnitudes ranging from .0666 in OLS Specification One to .0456 in OLS Specification Five. In 2SLS Specification Three, the coefficient of .0488 implies a 5.0 percent increase in rents with every increase of one in the design rating (i.e., moving to the next quintile in design quality). This implies a movement into the next higher quintile will increase rents from $27.58/sq. ft. to $28.96/sq. ft. Furthermore it implies an increase from the lowest quintile (DESIGN = 1) to the highest quintile (DESIGN = 5) is predicted to increase rents on average from $25.34/sq. ft. to $30.81/sq. ft., a 21.6 percent increase.

Figure 10 displays the beta coefficients for the significant variables in the rental hedonic equations. Note that the LNTOFLRS and AGE variables seem responsible for most of the variation in rents. The DESIGN variable is about half as influential as these variables.

Does Good Design Result in Lower Vacancies?

According to our earlier discussion, it must be the case that, holding quality adjusted rents constant, better design quality unambiguously leads to lower vacancy rates. To examine this relationship, we ran two sets of regressions: (1) OLS and 2SLS vacancy models using 1986:4 cross-sectional data to examine vacancy behavior at a snapshot in time, and (2) vacancy models using 1979:1 - 1986:4 pooled longitudinal-cross-sectional data to examine the lease-up effect for individual buildings over time.[19] The AGE variable in these models is expected to pick up the rate of lease-up as the structure is absorbed into the marketplace. Results for the cross-sectional regressions are shown in Figures 11a (for OLS) and 11b (for 2SLS). Both sets of results were similar.

The cross-sectional equations performed reasonably well, with adjusted R^2's in the 14 to 22 percent range. The AGE variable, entered as LN(AGE + .005), was clearly influential, reinforcing the importance of lease-up. The AGE coefficient ranged from -.5998 to -.6857 and in preferred 2SLS Specification Two was -.6220.

This magnitude suggests a rapid lease-up for the average structure, from close to 100 percent vacancy when new to 3.8 percent vacancy within one year, 1.4 percent after 5 years, and 1.0 percent after 10 years. Part of the reason for this rapid lease-up is the fact that several structures were essentially leased up at the time they opened, thus moving the average vacancy rate downward. In future work it may prove fruitful to evaluate separately the characteristics of those structures which opened fully occupied and exclude them from estimation of the vacancy relationship. The vacancy relationship with age is shown in Figure 12.

None of the other amenity coefficients were significant in any of the OLS or 2SLS specifications. The following results are of particular interest:

- Neither TOTAREA nor LNTOFLRS were significant, although the coefficient for TOTAREA was positive, weakly suggesting possible oversizing for the market, and the coefficient for LNTOFLRS was negative, suggesting market segmentation and tenant movement to higher-rise structures.
- LNRENT and LNRENTP were insignificant. Thus we were not able to confirm a predicted direct relationship between rents and vacancies.
- Finally, the DESIGN coefficient was insignificant, though consistently negative as expected and always within the narrow range -.4003 to -.5127.

The DESIGN coefficient point estimate of -.4923 in preferred 2SLS Specification Two suggests that, at the mean, an increase of one quintile in design quality would decrease the vacancy rate from 1.7 to 1.0 percent. For a structure exposed to the marketplace for 3 months an increase of one quintile in design quality would decrease the vacancy rate from 8.9 to 5.4 percent. The lack of significance of the DESIGN effect may be partly due to the fact that in 1986 the average vacancy rate in Boston among our building sample had dropped to 10.2 percent due to significant increases in absorptions, and the market was no longer considered soft. Possibly only during softer market periods would the DESIGN effect be significant.

Additional cross-sectional, longitudinal pooled regressions (not shown) were run to examine possible variations in the DESIGN effect on vacancies over time. Similar results to those reported above were forthcoming: only the AGE lease-up variable was consistently significant. Although the DESIGN effect on vacancies was negative, the coefficient was insignificant. Again, the biases present in estimation due to the fact that DESIGN was not observed over time may affect this result. Attempts to examine interactions of the DESIGN effect with market vacancy conditions over time also found no effect. Thus we do not as yet have clear proof of the hypothesis that flight to design quality occurs during soft market conditions. However, there is some suggestion that more rapid lease-up that has been attributed to DESIGN may in fact be partly due to other correlates of design quality such as AGE and TOTLFLRS.

Are Well-Designed Buildings More Profitable?

The ultimate question of interest, of course, is whether well-designed buildings are more profitable. Theory tells us they would be expected to be in the long-run only if increased risks of market acceptance and salability or unforeseen higher costs of production and operation are associated with structures with significant design investment. Otherwise, the increased costs associated with design would be expected to be just offset by the increased revenues in equilibrium. In fact, to the extent that developers treat design investment as a lottery, expected returns from design could even be negative, so long as there is some probability of deriving a substantial return in the event the design investment catches the fancy of the market.

To make preliminary estimates of profitability, we made use of predicted construction costs, rents, and vacancies from our preferred specifications as functions of given levels of design quality. We recognize the shortcomings associated with this, especially in view of the lack of significance of both the construction cost and vacancy rate coefficients. Nonetheless, point estimates derived from the data can provide at least preliminary evidence of the effects of design quality on project profitability.

We chose to use as the measure of profitability a modified return on total cost ratio defined as:

$$\text{Profitability Index} = \frac{\text{RENT } (1 - \text{VAC})}{\text{AJHCRATIO}} \qquad (5)$$

Note that this measure ignores possible effects of design on operating and maintenance costs, which were unavailable, and thus may be biased to some extent. To the extent that operating and maintenance costs are increased with design investment, our calculated profitability measures could tend to overstate the effects of design.

The results of the profitability calculations are shown in Figure 13. Profitability indices were calculated for structures rated 2, 3 and 4 in DESIGN quality, both as of month 3 after opening and after the lease-up period (AGE = 8.85 years). The preferred specifications were used in all calculations.[20] All other conditions beyond AGE and DESIGN were set at their average levels for our 55-structure sample.

The salient result of this exercise is that profitability is predicted actually to <u>decline</u> on average with increases in design quality. The primary reason is that the magnitudes of the predicted increase in rent and reduction in vacancy rates are insufficient to overcome the predicted considerable increase in construction costs. Taken at face value, this would suggest that higher levels of investment in design would have to be justified in a lottery framework, where the expected return is negative but there exists a small probability of a very high return. However, what these results really suggest is that we need to do considerably more analysis on a larger sample of cost data in order to draw more definitive conclusions about the relationship between design and profitability. A larger cost sample would make possible calculation of a profitability measure for each structure individually and direct estimation of profitability as a function of design, eliminating the effects of correlations among rents, vacancies, and costs.

SUMMARY AND CONCLUSIONS

We have examined in this paper numerous property performance measures as they relate to the quality of design of a structure. We found a definite "fad" relationship of perceived design quality with age, whereby such quality is perceived to depreciate in relative terms over time. This suggests that many property performance dynamics perceived to be associated with aging of the property may in fact be partially due to perceived design obsolescence and vice versa. Design quality opinions, too, tend to be affected by whether or not a structure is a high-rise, with taller structures receiving higher ratings. Although on average design quality is expected to be more costly, it is not definitively shown to be so when one controls for property age, size, and height. Additional work is needed on this relationship with a fuller sample of cost information.We obtained statistically significant evidence that perceived design quality affects rents. An increase in design quality of one quintile was predicted to increase rents about 5 percent at the mean, and an increase from the lowest quintile to the highest to increase rents almost 22 percent. The impact of design quality on vacancies, however, was less clear. Although suggested to be negative, as expected, the coefficient was not statistically significant. Thus, the hypothesis that a "flight to quality" (i.e., to well-designed structures) tends to occur during soft market periods, resulting in lower vacancies, could not be confirmed. It may well be that this observed behavior reflects the effects of certain correlates of design on vacancies, e.g., age and height, more than the effect of design itself. Finally, we must note that we found no evidence that well-designed buildings are expected to be more profitable either in the short or long run. In fact quite the opposite is predicted to be true, providing preliminary empirical support for the proposition that investment in design is a "lottery," providing a negative expected return but a small chance of a very high return.

While the above results are suggestive, especially with respect to the potential magnitude of importance of design on property performance, they are certainly not definitive, both because of data inadequacies and limitations in the analytic methodology. An expanded exploration of this topic would collect significantly more data and move beyond the confines of one geographic market. A broader effort would gather more detailed construction cost information on a larger sample of properties. Such data would be supplemented by detailed operating cost information to permit development of a better measure of profitability. Furthermore, we may question whether the designer survey results are the appropriate measure of design quality at all. It is certainly relevant if we are evaluating whether or not developers should pay heed to designers opinions, but ultimately we must be interested in whether these opinions correlate with tenants' attitudes. The correlation of these design opinions with objective characteristics of the structure itself (i.e., the presence or absence of certain amenities) also needs to be examined further. In addition, we have not sufficiently evaluated the lottery aspect of the design amenity. Using observed costs to proxy for the "intended" level of design investment and observing the volatility of design ratings and profitability measures with such costs would perhaps provide us with some notion of whether investment in design creates greater risk. Finally, the public good aspect of design quality has not been investigated, either theoretically or empirically. The spillover effects of non-tenants enjoying the consumption benefits of good architecture and urban design could result in underproduction, hence provide a justification for external imposition of design controls.

Figure 1

Summary Statistics

Variable	N	Mean Value	Standard Deviation
AGE	55	8.85	8.00
LNAGEA	55	1.293	2.120
TOTAREA	55	435,888	428,353
ONPARK	55	0.345	0.480
RENT	55	28.17	6.01
LNRENT	55	3.317	0.205
CENTER	55	6729	7726
TSTOP	55	907	696
DESIGN	55	2.732	0.633
STDDES	59	0.859	0.142
PARKING	55	1598	1397
VAC	55	14.26	23.38
LNVACA	55	0.5319	2.5766
TOTLFLRS	55	20.42	15.58
LNTOFLRS	55	2.735	0.772
ARPERFLR	55	22,661	16,727
RENTAREA	25	372,604	320,258
AJHCRATIO	12	115.20	36.88
LNAJHCRA	12	4.661	0.516

Note to undefined variables:

LNAGEA = LOG(AGE + .005)
LNRENT = LOG(RENT)
STDDES = Standard Deviation of DESIGN rating
LNVACA = LOG(VAC + .005)
LNTOFLRS = LOG(TOTLFLRS)
ARPERFLR = TOTAREA/TOTLFLRS
AJHCRATIO = Hard Costs ($/sq. ft.) inflated to 1986 cost levels
LNAJHCRA = LOG(AJHCRATIO)

Figure 2

Correlation Matrix
Rents, Vacancy Level, and Explanatory Variables

	AGE	TOTAREA	ONPARK	LNRENT	CENTER	TSTOP	DESIGN	STDDES	PARKING	VAC	TOTLFLRS	HCRATIO	RENT AREA
AGE	1.000												
TOTAREA	.172	1.000											
ONPARK	-.220	-.413	1.000										
LNRENT	-.162	.547	-.585	1.000									
CENTER	-.189	-.305	.683	-.512	1.000								
TSTOP	.013	-.218	.568	-.331	.574	1.000							
DESIGN	-.195	.163	-.147	.405	-.082	-.146	1.000						
STDDES	-.217	.103	.122	.160	.046	-.153	.412	1.000					
PARKING	.110	.356	-.721	.498	-.547	-.375	.088	-.019	1.000				
VAC	-.437	-.170	.097	.154	.109	-.071	.073	-.002	-.043	1.000			
TOTLFLRS	.104	.766	-.567	.648	-.465	-.369	.224	.135	.506	.047	1.000		
AJHCRATI	.143	-.397	.000	-.109	-.594	.147	.134	-.159	-.308	-.045	.198	1.000	
RENT AREA	.124	1.000	.370	.543	-.300	-.154	.061	.189	.124	-.104	.726	-.389	1.000

Figure 3

Highest- and Lowest-Rated Buildings: Date Built and Designers

HIGHEST-RATED

Rating	Standard Deviation of Rating	Name of Building	Date Built	Architectural Firm
4.462	0.947	200 Clarendon (Hancock Center)	1974	I. M. Pei
4.333	0.832	Rowes Wharf	1987	Skidmore-Owens-Merrill
4.074	0.958	Federal Reserve Plaza	1976	Hugh Stubbins
4.071	0.979	28 State Street (Bank of New Eng.)	1968	Edward Larrabbee Barnes
4.037	0.808	Charles Square	1984	Cambridge 7
3.821	0.819	1 Center Plaza	1966	Weltin Beckett & Assoc.
3.667	0.784	855 Boyleston St. (Ingalls Bldg.)	1986	The Architects Collaborative
3.667	0.761	10 Canal Office Park	1986	Tsoi Kobus

LOWEST-RATED

Rating	Standard Deviation of Rating	Name of Building	Date Built	Architectural Firm
1.240	0.436	1 Exeter Plaza	1984	Jung-Brannen
1.571	0.598	100 Charles River Place	1968	Victor Gruen
1.704	0.724	800 Boyleston Street (Prudential Center)	1965	Charles Luckman
1.727	0.631	125 High Street*	1965	Kahn & Jacobs
1.786	0.893	Constitution Plaza	1985	George E. Ross
1.818	0.665	101 Huntington Ave.	1971	Charles Luckman
2.000	0.949	545 Technology Square	1960	Eduardo Catalano

* Razed since survey was taken

Figure 4

Design Quality Correlates
Results of Alternative Specifications
Dependent Variable: Overall Design Rating (DESIGN)

	Specification Number						
Independent Variable	1	2	3	4	5	6	7
INTERCEPT	2.670**	2.733**	2.850**	2.808**	2.792**	2.797**	2.794**
	(0.152)	(0.244)	(0.286)	(0.302)	(0.316)	(0.321)	(0.346)
AGE	-.0221**	-.0229**	-.0233**	-.0233**	-.0231**	-.0228**	-.0227*
	(.0100)	(.0103)	(.0103)	(.0104)	(.0105)	(.0109)	(.0114)
TOTLFLRS	.0122**	.0108*	.0115*	.0117*	.0118*	.0118*	.0121
	(.0052)	(.0063)	(.0064)	(.0065)	(.0066)	(.0067)	(.0119)
ONPARK		-.0790	-.1845	-.2015	-.2271	-.2116	-.2124
		(.2055)	(.2611)	(.2658)	(.2962)	(.3138)	(.3184)
PARKING			-.0000562	-.0000615	-.0000596	-.0000580	-.0000585
			(.0000851)	(.0000866)	(.0000879)	(.0000893)	(.0000914)
ARPERFLR				.00000226	.00000219	.00000227	.00000242
				(.00000499)	(.00000505)	(.00000512)	(.00000725)
CENTER					.00000305	.00000389	.00000392
					(.00001490)	(.00001592)	(.00001612)
TSTOP						-.0000260	-.0000261
						(.0001586)	(.0001603)
TOTAREA							-.00000001
							(.00000043)
$\bar{R}^2$	.1205	.1062	.0964	.0821	.0642	.0452	.0249
N	56	56	56	56	56	56	56
DEP MEAN	2.732	2.732	2.732	2.732	2.732	2.732	2.732
F-VALUE	4.769**	3.178**	2.467*	1.984*	1.628*	1.372*	1.175

* Significant at 10 percent level
** Significant at 5 percent level

Figure 5

Design Quality vs. Structure Age: Newly-Constructed Buildings

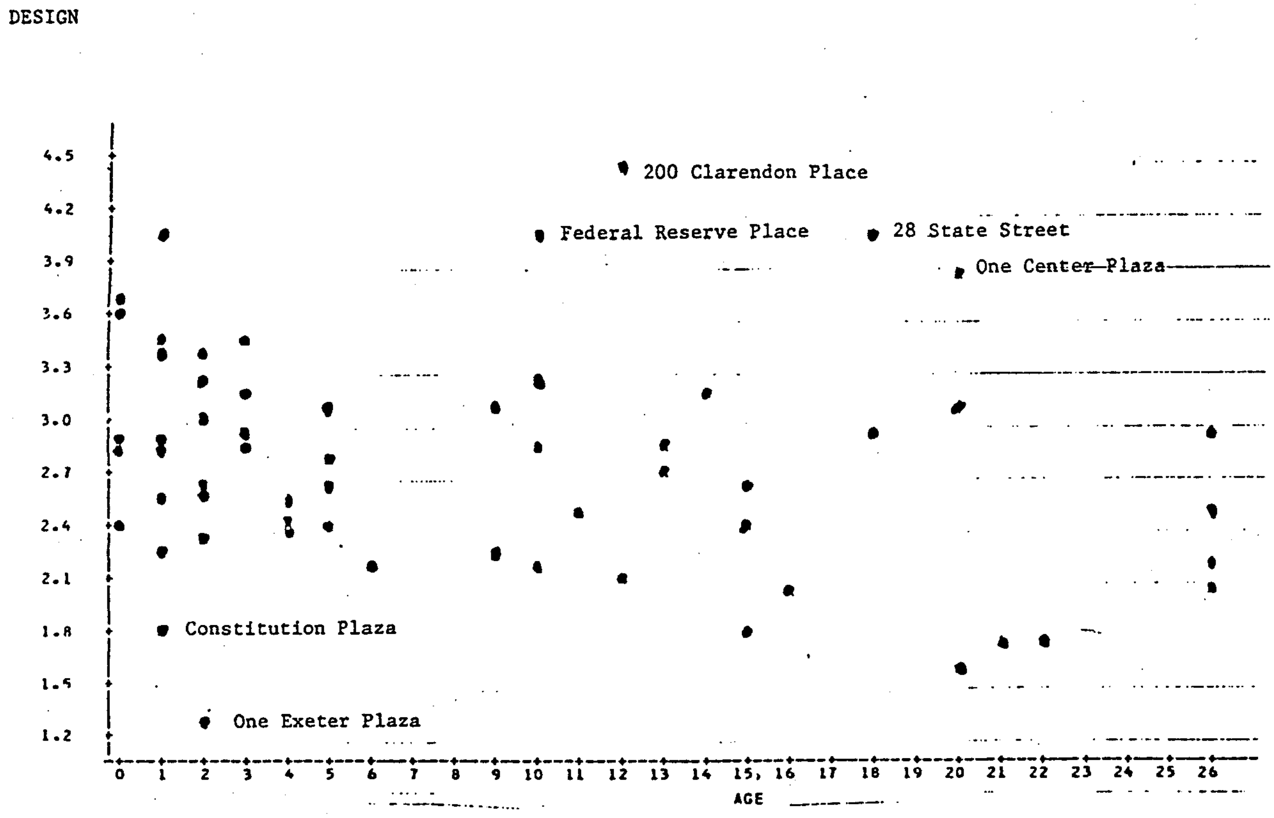

Figure 6

Determinants of Construction Costs

	Dependent Variable	
Explanatory Variable	AJHCRATIO[a]	LNAJHCRA[a]
INTERCEPT	40.613 (59.905)	3.614** (.691)
TOTAREA	-.0000812** (.0000338)	-.00000124** (.00000039)
DESIGN	20.93 (19.06)	0.233 (0.220)
TOTLFLRS	1.933 (1.079)	.0353** (.0124)
AGH.520	.0298 (2.715)	(.0313)
$\bar{R}^2$ .1985	.4545	
N 12	12	
DEP MEAN	115.20	4.662
F-VALUE	1.681	3.291*

[a]AJHCRATIO = Hard costs per sq. ft. inflated to 1986 cost levels by Marshall and Swift Construction Cost Index

LNAJHCRA = ln(AJHCRATIO)

* Significant at 10 percent level
** Significant at 5 percent level

Figure 7a

Determinants of Contract Rents
Results of Alternative OLS Specifications
Dependent Variable: Log (RENT)

Independent Variable	Specification Number 1	2	3	4	5	6
INTERCEPT	2.703** (.091)	2.704** (.093)	2.907** (.125)	2.904** (.128)	3.010** (.143)	3.006** (.145)
AGE	-.00606** (.00228)	-.00616** (.00245)	-.00896** (.00230)	-.00888** (.00242)	-.00943** (.00230)	-.00928** (.00242)
TOTAREA					1.022 E-7* (.565 E-7)	1.029 E-7* (.572 E-7)
LNTOFLRS	.1791** (.0232)	.1792** (.0235)	.1363** (.0317)	.1365** (.0321)	.0889** (.0406)	.0889** (.0410)
DESIGN	.0666** (.0277)	.0664** (.0280)	.0500* (.0287)	.0502* (.0291)	.0456 (.0285)	.0459 (.0288)
CENTER			-.00000539 (.00000325)	-.00000540 (.00000328)	-.00000600* (.00000325)	-.00000602* (.00000328)
TSTOP			.0000579* (.0000315)	.0000586* (.0000323)	.0000525 (.0000314)	.0000537 (.0000322)
PARKING					.00000401 (.00001747)	.00000404 (.00001766)
ONPARK			-.1056* (.0579)	-.1055* (.0585)	-.1035 (.0660)	-.1032 (.0667)
LNVACA[a]		-.000883 (.007376)		.000771 (.007066)		.00151 (.00698)
$\bar{R}^2$	.5831	.5734	.6377	.6300	.6476	.6401
N	58	58	55	55	55	55
DEP MEAN	3.314	3.314	3.317	3.317	3.317	3.317
F-VALUE	27.575**	20.308**	16.839**	14.138**	13.404**	11.673**

[a] LNVACA = Log(VAC + .005)

* Significant at 10 percent level
** Significant at 5 percent level

Figure 7b

Determinants of Contract Rents
Results of Alternative 2SLS Specifications
Dependent Variable: Log(RENT)

	Specification Number		
Independent Variable	1	2	3
INTERCEPT	2.726**	2.864**	2.960**
	(.102)	(.137)	(.150)
AGE	-.00658**	-.00765**	-.00771**
	(.00294)	(.00284)	(.00281)
TOTAREA			1.105 E-7*
			(.570 E-7)
LNTOFLRS	.1863**	.1393**	.0890**
	(.0247)	(.0320)	(.0405)
DESIGN	.0497	.0527*	.0488*
	(.0309)	(.0290)	(.0286)
CENTER		-.00000556*	-.00000628*
		(.00000327)	(.00000339)
TSTOP		.0000685*	
		(.0000344)	
PARKING			.00000441
			(.00001745)
ONPARK		-.1029*	-.0996
		(.0582)	(.0660)
LNVACAP[a]	.00803	.0132	.0178
	(.01618)	(.0169)	(.0167)
$\bar{R}^2$	.5836	.6347	.6486
N	55	55	55
DEP MEAN	3.317	3.317	3.317
F-VALUE	19.922**	14.406**	12.077**

[a] LNVACAP = Predicted Log (VAC + .005) from first stage
* Significant at 10 percent level
** Significant at 5 percent level

Figure 8

Contract Rent vs. Total Floors:
Newly-Constructed Buildings

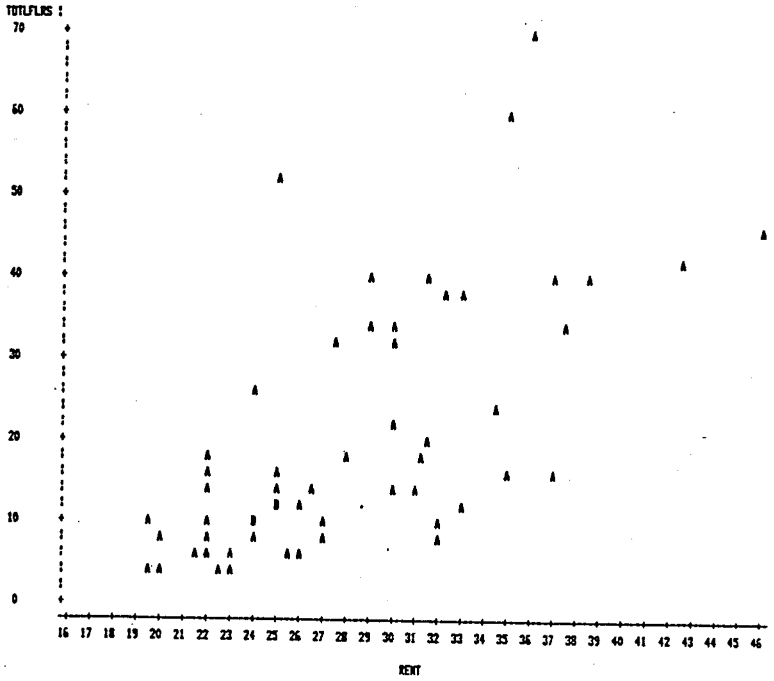

Figure 9

Contract Rent vs. Mean Design Quality:
Newly-Constructed Buildings

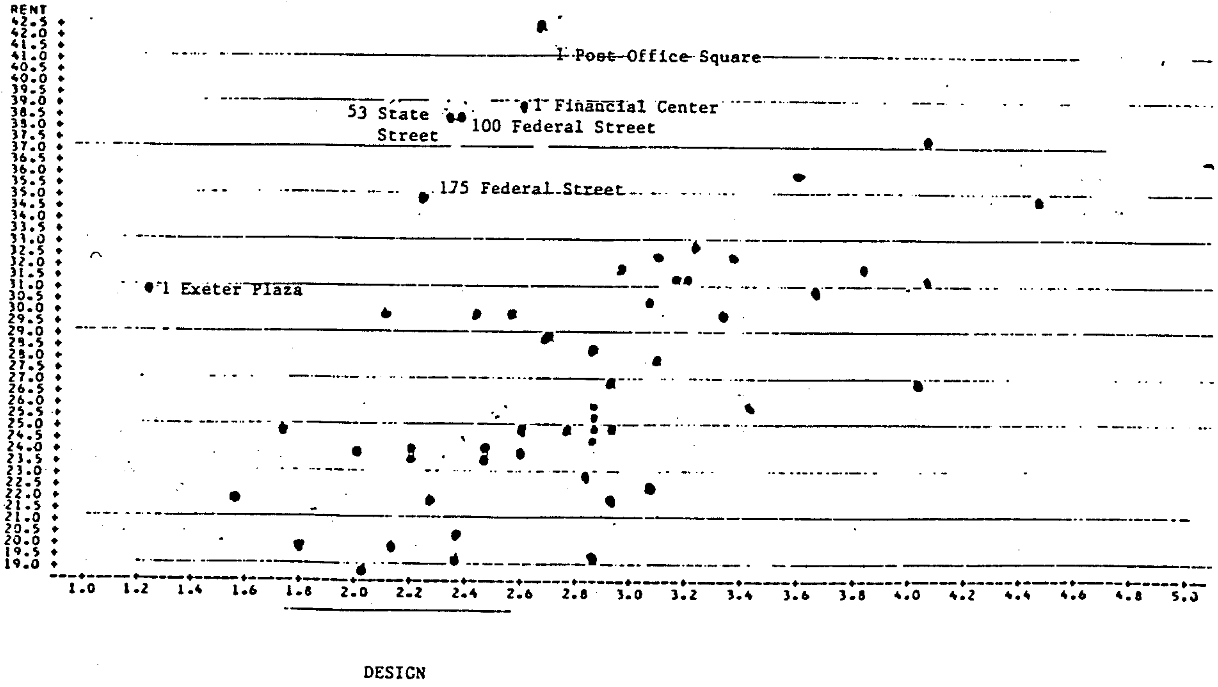

Figure 10

Beta Coefficients
Selected Explanatory Variables
Rental Hedonic

	Coefficient	Std. Dev.	Beta Coefficient
AGE	-.00771	8.00	-.0617
TOTAREA	1.105×10^{-7}	428,353	.0473
LNTOFLRS	.0890	0.772	.0687
DESIGN	.0488	0.633	.0309
CENTER	-.00000628	7726	.0485
TSTOP	.0000663	696	.0461

Figure 11a

Determinants of Vacancy Rates
Results of Alternative OLS Specifications
Dependent Variable: Log (VAC + .005)

Independent Variable	Specification Number 1	2	3	4
INTERCEPT	1.119 (4.987)	4.301 (5.622)	5.304 (7.381)	7.496 (8.726)
LNAGEA[a]	-0.6224** (0.1484)	-.6238** (.1532)	-.6376** (.1716)	-.6857** (.1964)
TOTAREA				5.264 E-7 (11.992 E-7)
LNTOFLRS			-.1946 (.6791)	-.3746 (.8292)
DESIGN	-.4003 (.5045)	-.4650 (.5485)	-.4465 (.5597)	-.4739 (.5812)
CENTER				-.0000219 (.0000671)
TSTOP		-.000780 (.000474)	-.000702 (.000569)	-.000632 (.000626)
PARKING				-.000139 (.000345)
ONPARK			-.5014 (1.0685)	-.7661 (1.3301)
LNRENT	.3974 (1.6087)	-.2943 (1.7285)	-.4178 (2.4823)	-.8382 (2.7407)
$\bar{R}^2$	.2060	.2161	.1876	.1405
N	58	55	55	55
DEP MEAN	.5367	.5319	.5319	.5319
F-VALUE	5.930**	4.722**	3.078**	1.981*

[a] LNAGEA = Log (AGE + .005)

* Significant at 10 percent level
** Significant at 5 percent level

Figure 11b

Determinants of Vacancy Rates
Results of Alternative 2SLS Specifications
Dependent Variable: Log (VAC + .005)

Independent Variable	Specification Number			
	1	2	3	4
INTERCEPT	-1.504 (6.365)	3.495 (7.033)	2.676 (14.452)	10.065 (23.367)
LNAGEA[a]	-.5998** (.1551)	-.6220** (.1535)	-.6161** (.1995)	-.7119** (.2955)
TOTAREA				6.351 E-7 (15.102 E-7)
LNTOFLRS			-.3241 (.9143)	-.3145 (.9721)
DESIGN	-.5127 (.5750)	-.4923 (.5670)	-.4993 (.6127)	-.4317 (.6818)
CENTER				-.0000275 (.0000822)
TSTOP		-.000767 (.000488)	-.000734 (.000589)	-.000594 (.000706)
PARKING				-.000137 (.000346)
ONPARK			-.3780 (1.2173)	-.8519 (1.5150)
LNRENTP[a]	1.270 (2.064)	-.0357 (2.1975)	-.5122 (5.0486)	-1.693 (7.712)
$\bar{R}^2$	.1930	.2157	.1873	.1397
N	55	55	55	55
DEP MEAN	.5319	.5319	.5319	.5319
F-VALUE	5.305**	4.713**	3.074**	1.974*

[a] LNAGEA = Log (AGE + .005)
LNRENTP = Predicted Log (RENT) from first stage

* Significant at 10 percent level
** Significant at 5 percent level

Figure 12

Vacancy Rate vs. Age of Structure
1986:4

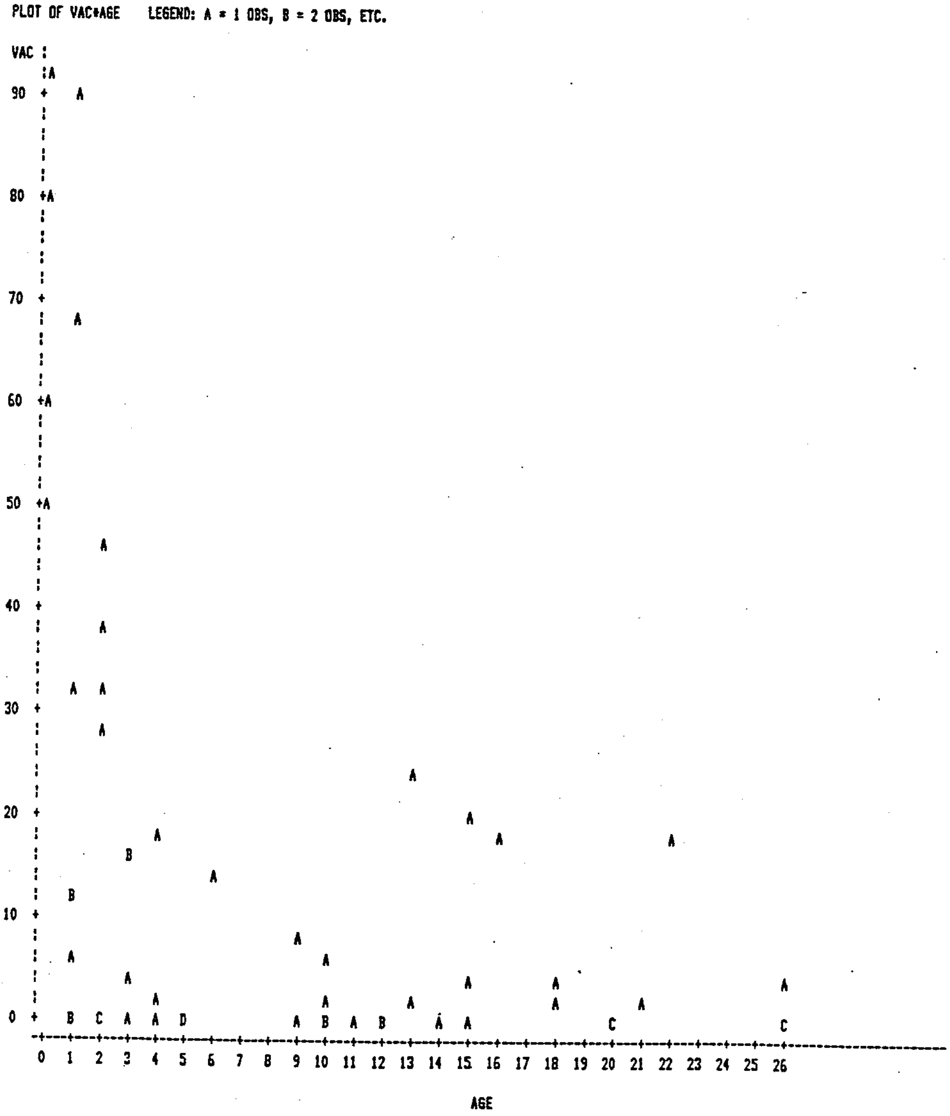

Figure 13

Point Estimates of Structure Profitability
as a Function of DESIGN Quality Rating

	DESIGN Quality Rating					
	2		3		4	
Age =	3 mo.	Average[a]	3 mo.	Average[a]	3 mo.	Average[a]
Hard Construction Costs ($/sq. ft.)	71.36	92.20	90.09	116.40	113.73	146.94
Rent ($/sq. ft./yr.)	28.45	25.61	29.61	26.75	30.82	27.73
Vacancy Rate (%)	12.7	1.4	7.8	1.1	4.7	0.5
Profitability Index[b]	.3481	.2739	.3030	.2273	.2583	.1878

[a] Mean Age = 8.85 years

[b] Profitability Index = $\frac{\text{RENT (1 - VAC)}}{\text{AJHCRATIO}}$

FOOTNOTES

[1] Recent studies include those for highways (Li and Brown [1979]), view amenities (Pollard [1980]), recreational amenities (Grimes [1974]), school quality and busing (Jud and Watts [1981], Vandell and Zerbst [1984]), housing quality (Kain and Quigley [1970]), air pollution (Ridker and Henning [1967]), and racial composition of the neighborhood (Smith [1982]).

[2] For example, Ridker and Henning's study of air pollution helped establish criteria for setting air quality guidelines, and estimates of the value of recreational amenities are useful for planning parkland acquisition programs.

[3] Despite the difficulty of firmly grasping design as an amenity, other amenities that are similarly problematic <u>have</u> been studied extensively. For example, the social characteristics of a neighborhood are intangible and subjectively felt. Likewise, they have both structure-specific and neighborhood-wide effects. However, numerous theoretical and empirical studies have addressed the influence of social characteristics on value.

[4] For example, better lighting and appropriate temperatures render one physically better able to carry out his assigned tasks, but a rich-appearing marble lobby may be preferred to one surrounded by concrete, even though both may serve their physical purposes equally well. Note that whether color is functional or aesthetic is truly ambiguous. Here aesthetic pleasure is very difficult to distinguish from physical need. This ambiguity may well extend to other design elements, such as the marble lobby, though to a lesser extent.

[5] Note that it is not true in general that the production of design is independent of the production of functionalism, hence that the cost functions are independent. This can be seen by a simple example in which design is represented by the shape of the floorplate of a structure and functionalism is represented by floor area. The minimum-cost "functional" structure is a square, since it would minimize total surface area, which we assume is proportional to cost. To move to a different shape, yet control for area, would require added surface area, hence added cost. This added cost would be greater for larger buildings, implying an interaction between area and the marginal cost of production of design. Conversely, controlling for shape, the incremental cost necessary to add a given amount of space becomes greater at more extreme deviations from a square building, implying an interaction between design (i.e. shape) and the marginal cost of production of space. These same arguments would hold true generally for design as represented by increased embellishment and higher quality materials. The implication of this jointness of production is that the hedonic pricing model which has design and space as arguments may not only not be linear it may contain interaction terms among design and space. Such interactions would not be a problem for traditionally non-jointly produced amenities such as, say, number of fireplaces and the presence or absence of a swimming pool. But it is a problem when considering any quality variable. Furthermore, joint production occurs in the case of other amenities, for example between floor area and the presence of a brick facade, suggesting common mis-specifications in hedonic models which ignore this interaction.

[6] In other words, demand is not totally elastic at the market rate for some of the same reasons that equilibrium vacancies exist.

[7] Note that this assumes no "overinvestment" and ignores the effects of possible interactions of the production of design with functional amenities such as square footage. In the event that such interactions are significant, they could result in possible anomalies in the relationship of design with vacancy.

[8] The Boston/Cambridge area was selected both because of the availability of operating and amenity data and the apparent importance of design reputation in marketing and public discussion.

[9] Quoted asking rents and reported vacancy rates were obtained. Asking rents tended to correlate highly with effective rents during the study period because concessions were not extreme and tended to be consistent across buildings. Of course, asking rents for new space do not represent average contracted rents. Reported vacancies may not properly account for space leased but unoccupied, but this was not a major element of the Boston office market during the study period. Furthermore, some buildings were 100 percent occupied; thus it was unclear in these cases whether asking rents reflected market conditions.

[10] For the purposes of this initial exploration, the focus was placed on the aesthetic and formal, rather than the functional or quantitative attributes of design. Therefore, the questions asked in the survey focused on those aspects of the buildings which are most apparent to the public -- exterior forms and materials, as well as major public spaces and amenities. In further research, it would be useful to assess the contribution of objective measures of office amenities (e.g., glass area, number of corner offices, amount of column-free space, floor-to-ceiling height, etc.) which are of presumed high interest to tenants, to design judgments.

Design judgments were asked on the following aesthetic aspects of the newly constructed buildings:

1. Quality of materials used in the exterior skin
2. Fenestration: composition and scale of the facade
3. Massing: compositional bulk and volumetrics of the building
4. Design of interior public space: design of lobby plus other interior public space
5. View on skyline: as seen from a distance
6. Design of exterior public spaces
7. Responsiveness to neighborhood: relationship to abutting uses
8. Provision of public amenities

For rehabilitated buildings, the questions were necessarily different, as the structure and site were in place prior to the developer's involvement. They included:

1. Design quality of the original building (prior to renovation)
2. Quality of the rehabilitation
3. Appropriateness of the renovation to the original structure

[11] Note that we are relying on "expert" opinions, rather than objective design characteristics to measure the design amenity. This was suggested earlier as possibly being preferable. Such ratings of amenity quality by an expert panel have been employed in the past (e.g., see Kain and Quigley [1970]). They necessarily rely, of course, on objectivity by the respondents and consistency with the opinions of market participants. A sample of designers' opinions should hypothetically be closely correlated with the opinions generated during the architectural design process, when the developer and architect are establishing the overall image and quality of the product. Hence we would be measuring the question of most interest to developers: whether such opinions pay off in the marketplace.

[12] All panel members were asked to rate all buildings. A median of 3 respondents failed to rate overall design quality for each building (with a minimum of zero and a maximum of 14). As expected, those with the fewest nonresponses were the largest structures and those with the most nonresponses were the smallest. (The mean size of structures with 0-3 nonresponses was 601,000 sq. ft. while that for structures with 7 or more nonresponses was 160,000 sq. ft.)

[13] The use of quintiles as grading criteria was based upon a desire to "normalize" responses, as well as to control for differing intensities of preferences.

[14] All correlations with overall design rating were high however, suggesting that most respondents had an overall view of design quality which was modified little for specific dimensions. Potentially, this could create a problem to the extent that one's rating may depend less on individual and objective criteria than on the general reputation of the building and the reputation of the developer or architect, or even on the building's perceived success in the marketplace. Since architects tend typically to be opinionated and independent, as well as generally ignorant about how well a building is doing in the marketplace, this is unlikely to be a problem, but it does suggest that the search for more objective design evaluation criteria should continue.

[15] Comparing the mean design rating for newly-constructed buildings vs. the standard deviation in that rating found an increasing consensus among designers at the low end of the design spectrum and the greatest range of opinions within the middle ranges. Future research separately evaluating "consensus" vs. "controversial" structures would be instructive.

[16] Using only cross-sectional rather than pooled longitudinal cross-sectional data was considered appropriate because we did not have past ratings of design quality or other amenity information such as parking availability. Thus, estimates of the design effect based upon such data would be biased.

[17] It is important to remember that rent is average asking rent for the entire building and not rent for the topmost floor.

[18] Entering CENTER in its logarithmic form did not prove to enhance the explanatory power of the model or result in higher coefficient significance.

[19] Of course, the lack of multi-period observations for such variables as DESIGN and PARKING result in the latter coefficients being biased, as discussed earlier.

[20] The preferred specifications: for constructions costs, dependent variable LNAJHCRA; for rents, 2SLS Specification Three; for vacancies, 2SLS Specification Two.

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