

# THE SPACE TIME SEGMENTATION TECHNIQUE (ST<sup>2</sup>): A NEW APPROACH TO MARKET ANALYSIS

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It has recently been stated that basic real estate skills are in need of scientific management processes,<sup>1</sup> perhaps best exemplified in the real estate development and feasibility process. Today's real estate environment requires the use of the latest management, engineering, and financial techniques to ensure survival. The size of developments coupled with current financing terms and rising costs due to inflation demand more sophisticated economic planning than ever before. The purpose of this paper is to develop a new technique of market analysis for identifying development and merchandising opportunities.

## The Real Estate Marketplace

Marketing forces influence the demand, supply, value and/or price that is paid for any particular land use. The basic purpose of the real estate market is to allocate space, determine development rates and land use.<sup>2</sup>

Market analysis is an attempt to make projections of demand and supply. In analyzing demand and supply, the forces of competition in the allocation of space, land

use, and development rates aid the analyst in arriving at the information needed for decision making. Market analysis is a process of assimilating data in aggregate form and then reducing it to the explicit variables relevant to a particular site or land-use type. Therefore, the determination of use is important in understanding real estate markets. The analysis of use and use alternatives provides for a direct link between the real estate market and market theory.

## The Theory

Alfred Marshall, in his neo-classical synthesis of the classical school of economics with the Austrian (marginal utilist) school, illustrated the concept of market equilibrium. He showed that the market for a specific commodity is comprised of the demand for that commodity in relation to the available supply. The demand curve is comprised of the aggregation of individual diminishing marginal utility curves. The Austrian school was composed of Carl Menger, Friedrich Von Wieser, and Eugen Von Bohm-Bawerk—the University of Vienna triumvirate—who are generally credited with the development of marginal utility economics. Simply stated, diminishing marginal utility relates to the additional satisfaction derived from one additional unit of a specific product. This satisfaction will decline with successive units of a given product.

The supply schedule is the aggregation of the intersection of the marginal and average cost curves of various quantities of products from all producing units. This theory stems from the classical schools' theory of value developed by Adam Smith, David Ricardo, and T. R. Malthus. The classical triumvirate's observations evolved out of the industrial revolution of Great Britain. The classical theory states that value is based on the cost of production.

The Neo-Classical School combined these two schools of economic thought. The result of the Marshallian syn-

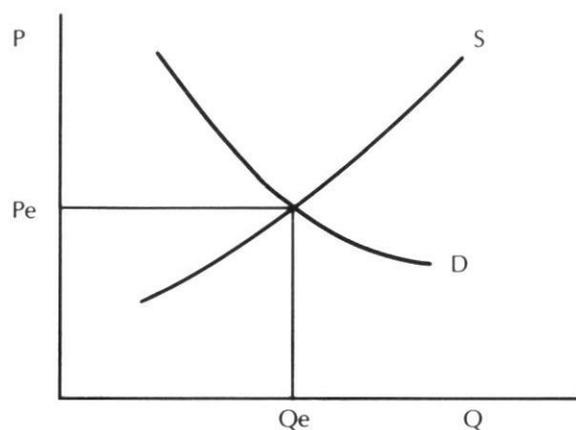
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thesis is the familiar market equilibrium model illustrated in Figure 1.

**FIGURE 1**  
Marshallian Synthesis



D = Demand schedule: based on marginal utility curves  
 S = Supply schedule: based on cost curves  
 Pe = Equilibrium price  
 Qe = Equilibrium quantity

The Austrian group stated that value or price was chiefly determined by demand for the goods (the D curve). The classical group stated that value-price was determined by the cost of production, the S curve. Marshall addressed this debate through the synthesis and the concept of equilibrium.

Marshall illustrates "equilibrium analysis" through his familiar scissors analogy by stating:

"We might as reasonably dispute whether it is the upper or the under blade of a pair of scissors that cuts a piece of paper, as whether value is governed by utility or cost of production. It is true that when one blade is held still, and the cutting is effected by moving the other, we may say with careless brevity that the cutting is done by the second; but the statement is not strictly accurate, and it is to be excused only so long as it claims to be merely a popular and not a strictly scientific account of what happens."<sup>3</sup>

This analogy suggests that one blade cannot function without the other. The market only works when demand responds to supply or vice versa at any one time. Marshall further concludes that final value or price depends upon the net, marginal conditions, which reflect the final marginal supply price of all the factors used in production as well as the marginal demand price for the commodity. This marginal analysis model and its relevance to real

estate market analysis is based on the following assumptions:<sup>4</sup>

- 1) The model is an explanatory model, not a predictive one.
- 2) It is a stationary model which considers many time periods but collapses them all to a single time frame. The time frame is the long-run.
- 3) The model considers homogeneous goods. Marshall's model looks at the market for single commodities that can readily be substituted for one another. The goods are often fungible. The model considers newly-produced goods.
- 4) It is a deductive model. The logic format flows from the general to the specific.
- 5) It is a normative model. The analysis states how the market interaction of supply and demand should act, not necessarily how it works.
- 6) The model equates price (normal) to value. Value is a concept that occurs at the state of equilibrium ( $D = S$ ).
- 7) The model is tied to three valuation approaches that consider different time elements.
- 8) The model is concerned with a value conclusion reflecting a long-term equilibrium influence.
- 9) The model is tied to a set of explicit and implicit assumptions which consider a stationary state under conditions of certainty and perfect competition.

The Marshall equilibrium model does not apply directly to real estate. Since real estate is a heterogeneous product, it is difficult to identify the marginal contribution in the consumption of one additional unit. Real estate is often an older good and not a new product. The substitutability of alternatives is not perfect. Therefore, given the markets' perception of real estate, alternative properties are not interchangeable (fungible) or readily substitutable. This notion conflicts with Marshall's market theory. Real estate markets vary from Marshall's general market theory in the following ways:<sup>5</sup>

- 1) Real estate cannot be graded or bought and sold from samples. Deals take place as an assortment of legal rights which vary from case to case. The transfer of real estate involves legal formalities. Each parcel is unique, heterogeneous, and neither fungible in general nor readily substituted.
- 2) The real estate model does not fit the perfectly competitive scenario often depicted by Marshallian theory. In some real estate cases a single buyer or seller may exercise a significant effect on the total market, a factor characterizing the "thinness" of real estate markets.
- 3) Other than the legal packaging of the real estate product, real estate is subject to external public and private restrictions in the use and development of space. Legal procedure also governs the validity of

agreements, that is, oral agreements not binding, the nature of transactions, and the determination of title.

- 4) The free flow of the real estate market is also constrained by locational and environmental aspects. Real estate is physically fixed but economically dynamic. The effect is that the market for any particular parcel of real estate is highly subject to external forces and the public infrastructure.
- 5) The real estate product is also interwoven with subjective perceptions of value and strong sentimental attachments to property. The market mechanism is further distorted by absentee ownership, localized knowledge, an inequitable distribution of knowledge, and antiquated leases locking competitive property off the market within certain time frames.

Hence, general market theory is limited in real estate market analysis unless the following two alternatives are considered:

- 1) The theory must be altered to fit the real estate framework.
- 2) The definition of real estate must be altered to fit the market theory.

Further, while the practice of real estate is analyzed in the context of general market theory, the following problems arise:

- 1) The real estate market is viewed as a two-tiered market. One tier is the sales market for the fee simple estate in property or various partial interests in real estate, which is similar to the market for producers' durable goods. The second tier is the rental or leasehold market, which is the direct market for the rights of use and possession and is similar to the market for consumer goods. These markets are often inappropriately treated as a proxy for each other in the context of the general market theory.
- 2) In the context of appraisal and feasibility analysis, real estate market analysis often looks only at one blade in the scissors analogy—the supply side. Appraisers/analysts often look at the supply side to interpret or explain an estimation of market demand, resulting in the analyst making short and long-term projections about future markets on the basis of sold inventories. Hence, such parameters as changes in tastes and preferences as well as effective demand are excluded.
- 3) The traditional appraisal and feasibility processes that look only at the supply side do consider the use/value of a project at the margin. However, they often fail to consider the marginal unit in relation to the existing stock or planned units in terms of substitutability. It is the entire existing stock and additional inventory that become the consumer's alternative in the short and long-term marketplace.

This existing stock also becomes the source of competition.

Another concern of competitive analysis is how to identify a valid substitute, given the heterogeneous real estate market.

The recognition of these three problem areas leads to the following suggestions:

- 1) A need to develop skills in demand analysis becomes especially important to appraisal which considers the estimation of value as one of its primary functions. Demand analysis can be improved in two ways. First of all, the analyst must develop primary research skills to obtain the most relevant and current information. Primary research is the marketing technique of direct sampling of the perceived target market for a specific commodity. Real estate types should develop sampling, surveying, and statistical skills. Secondly, the analyst must understand the quantitative techniques which allow for the complete analysis of the relationships within the primary data gathered.
- 2) An improved recognition of the essence of real estate is needed and can be enhanced by a better understanding of productivity analysis as applied to real estate. Improved recognition of productivity analysis allows for the identification of the common element of all real estate.<sup>6</sup> This element is the economic use of space over time. The space-time argument necessitates a new definition of real estate. The recognition of the common space-time unit to all real estate provides for a more logical acceptance of the general market theory assumptions of substitutability and homogeneity.
- 3) The need for improved supply side analysis. This could be accomplished through the recognition of the common space-time element which would allow for a better description of competitive space within the appropriate market or submarkets.

The need to redefine real estate in a space-time context is necessary in order to apply general market equilibrium analysis. Further, it is a logical extension to provide for the space-time concept in the traditional supply-side analysis. The result is a logical application of market theory to the problems of data availability in a quantitative context that supports the real estate analyst's decision making ability. The technique derived is termed the space time segmentation technique or ST<sup>2</sup>.

### Conceptual Premises Of ST<sup>2</sup>

James A. Graaskamp of the University of Wisconsin—Madison defines real estate as “artificially delineated space referenced to some point on the surface of the earth, with a fourth dimension time”<sup>7</sup>. He says that this artificially delineated space is created to house some economic activity, and is subject to the cultural preference and constraints of the public infrastructure.

Cultural preferences are concerned with the manner in which society views and enforces the concepts of rights in real property. The cultural preference is stated in terms of the legal enforcement of property rights and the market behavior that can be witnessed as a result of the trading of real property. An example would be the increasing preference for condominium ownership over straight fee ownership in the single-family market of some areas. The impact of cultural preference rests on the ability to create an economic value via contractual agreement in some market areas, while being denied this same ability in other areas.

The public infrastructure is apt to criticize the potential use, development, and ultimate value of any specific real estate site. The infrastructure represents the off-site capital improvements such as utilities, streets, and enforcement agencies, and is one of the primary contributors of differentials in the manufactured locational value of specific sites within a community.

By taking all of the attributes of real estate in sequence, one is able to develop a working definition of real estate that logically addresses current and future problems in this area. A synthesis of the above descriptions yields the following definition:

Real estate is artificially delineated space with a fourth dimension time, created to house some economic activity. The space time unit is referenced to some point on the surface of the earth and is subject to the cultural preference and constrained by the public infrastructure.<sup>8</sup>

This definition allows for the identification of the primal productive essence of all real estate—the space-time product. By acknowledging that the space-time product is the central issue of real estate, one is able to address real estate analysis on a more formal and logical basis. By properly recognizing the space-time element, the analyst is able to identify the space-time/money-time equation that underlies the real estate process. It is through this process that the legal, physical, and spatial nature of real estate is incorporated into the overall financial and economic framework.

A direct application of the space-time concept is observed in market analysis. Previous studies have correctly identified market analysis as the determination of supply and demand for specific property types. While much theoretical effort has been put into demand analysis, little in the way of applicable demand projection and formulation has been forthcoming. Further, only limited theoretical effort has been assigned to the identification of the supply element. In practice, a number of methods have been developed and used in dealing with the supply parameter. Supply represents the total stock of space (square footage) available at any one time. Supply analysis also considers the proposed space to be developed.

The typical model is identified by the following parameters:<sup>9</sup>

$$Q_s = S_b + V_{nb} + [(S_y + V_{ny}) - S_b + V_{nb}] - (V_s + C) + R_{b-y}$$

$S_b$  = Existing stock in base year

$V_{nb}$  = Allowance for a normal vacancy level

$S_y$  = Stock forecast in future year  $y$  (includes proposed units)

$V_s$  = Surplus vacant units

$C$  = Units currently under construction

$R_{b-y}$  = Anticipated demolitions during forecast period

All of the preceding parameters illustrate a limited perception of the real estate process by considering only the quantity of the space dimension of real estate and failing to consider the fourth dimension of time. The space-time element must be developed before the analyst can continue with the money-time consideration of the market and feasibility study.

By considering only the space dimension, the analyst bases his decision on incomplete information. Again, the analyst considers only one blade in the market. Real estate markets are highly differentiated because of the heterogeneity of the real estate product. This implies that the market is not one mass of activity for any one type of space but is composed of numerous stratifications. The identification of these stratifications (segments) is possible by application of the space-time concept in analyzing the available supply of competitive properties. The process of combining market segmentation with the space-time element enables formulation and application of the ST<sup>2</sup> model.

### The ST<sup>2</sup> Methodology

Market analysis and appraisal are applied fields of economics. Marshall's general theory is applicable to any one commodity market at a specific time. The ST<sup>2</sup> model is a logical extension of general market equilibrium theory and is illustrated in an application concerning office space. The existing market data for office space in regard to stratification of uses and lease terms are stated in Table 1. Segmentation of the office market from this table is achieved by grouping the existing stock of office tenants into broad use categories as illustrated in Table 2. The amount of office space used for medical, government, or certain businesses is first identified. Each group in Table 2 is then taken as a percentage of the total existing square footage.

The segmentation illustrated in Table 2 is no departure from the traditional analysis of the real estate supply. Table 2 shows that the traditional process stratifies on the basis of space. It fails, however, to incorporate the important element of time in market analysis. To better understand the potential supply within the existing stock of space, it is necessary to consider the term of the remaining lease on any particular space. The amount of

**TABLE 1**

Existing Market Information

Office Complex	Leaseable Area	% of Office User Type		Lease Terms
1	350,000	Medical	10%	All leases were originally signed for 3-year terms.
		Government	25%	
		Retail	20%	
		Wholesale	20%	
		Service	25%	
2	400,000	Medical	15%	All leases were originally signed for 5-year terms.
		Government	30%	
		Retail	15%	
		Wholesale	20%	
		Service	20%	
3	250,000	Medical	25%	All leases are for terms of 6 years. All leases have been signed.
		Government	40%	
		Service	35%	

**TABLE 2**

Segmentation of Office Space Square Footage into Use Categories

User Category	Building Number	Square Feet	% of Total
Medical	1	35,000	3.50
	2	60,000	6.00
	3	62,500	6.25
			15.75%
Government	1	87,500	8.75
	2	120,000	12.00
	3	100,000	10.00
			30.75%
Retail	1	70,000	7.00
	2	60,000	6.00
	3	0	0.00
			13.00%
Wholesale	1	70,000	7.00
	2	80,000	8.00
	3	0	0.00
			15.00%
Service	1	87,500	8.75
	2	80,000	8.00
	3	87,500	8.75
			25.50%
TOTALS		1,000,000	100.00%

**TABLE 3**

Calculation of Space-Time Units Available in the Market

User Category	Building Number	Square Feet	Lease Term	Space-Time Product	TOTALS
Medical	1	35,000	$\times [1/3(1 \text{ yr}) + 1/3(2 \text{ yr}) + 1/3(3 \text{ yr})]$	= 70,000	625,000
	2	60,000	$\times [1/2(2 \text{ yr}) + 1/4(3 \text{ yr}) + 1/4(5 \text{ yr})]$	= 180,000	
	3	62,500	$\times 6$	= 375,000	
Government	1	87,500	$\times [1/3(1 \text{ yr}) + 1/3(2 \text{ yr}) + 1/3(3 \text{ yr})]$	= 175,000	1,135,000
	2	120,000	$\times [1/2(2 \text{ yr}) + 1/4(3 \text{ yr}) + 1/4(5 \text{ yr})]$	= 360,000	
	3	100,000	$\times 6$	= 600,000	
Retail	1	70,000	$\times [1/3(1 \text{ yr}) + 1/2(2 \text{ yr}) + 1/3(3 \text{ yr})]$	= 140,000	320,000
	2	60,000	$\times [1/2(2 \text{ yr}) + 1/4(3 \text{ yr}) + 1/4(5 \text{ yr})]$	= 180,000	
	3	0	$\times 6$	= 0	
Wholesale	1	70,000	$\times [1/3(1 \text{ yr}) + 1/3(2 \text{ yr}) + 1/3(3 \text{ yr})]$	= 140,000	380,000
	2	80,000	$\times [1/2(2 \text{ yr}) + 1/4(3 \text{ yr}) + 1/4(5 \text{ yr})]$	= 240,000	
	3	0	$\times 6$	= 0	
Service	1	87,500	$\times [1/3(1 \text{ yr}) + 1/3(2 \text{ yr}) + 1/3(3 \text{ yr})]$	= 175,000	940,000
	2	80,000	$\times [1/2(2 \text{ yr}) + 1/4(3 \text{ yr}) + 1/4(5 \text{ yr})]$	= 240,000	
	3	87,500	$\times 6$	= 525,000	

space (square footage) weighted by the remaining lease term defines the total stock of existing space-time units available in the market. The calculation of the total space-time units is illustrated in Table 3. The space-time units per user type are then calculated as a percentage of the aggregate space-time unit estimate. The percentages appear in column four of Table 4.

**TABLE 4**  
Percentage Breakdown of Aggregate Space-Time Product

User Category	Building Number	Space-Time Product	% of Total Space-Time Product
Medical	1	70,000	2.0
	2	180,000	5.3
	3	375,000	11.0
		625,000	18.3%
Government	1	175,000	5.1
	2	360,000	10.6
	3	600,000	17.6
		1,135,000	33.3%
Retail	1	140,000	4.1
	2	180,000	5.3
		320,000	9.4%
Wholesale	1	140,000	4.1
	2	240,000	7.1
		380,000	11.2%
Service	1	175,000	5.1
	2	240,000	7.1
	3	525,000	15.6
		940,000	27.8%
TOTALS		3,400,000	100.0%

The significance of the space-time unit in market analysis is illustrated in Table 5. Table 5 is a comparison of the square footage per user group to the space-time units per user group. The comparison enables the recognition of the significant difference in product identification due to the introduction of the time element. The recognition of this difference enables the formulation of an analytical tool for market analysis. This tool is illustrated in Table 6.

In Table 6 the square footage as a percentage of the aggregate spatial area in the market is compared to the percentage of space-time units in the same market area. If the percentage difference declines or has a positive difference, one of two factors occurs:

- 1) If the percentage declines (a positive difference), potential sources of competitive space are indicated. It is potentially competitive space if the tenant intends to renew or not renew the lease. Since these situations are never for sure, probabilities of lease renewal might be considered by

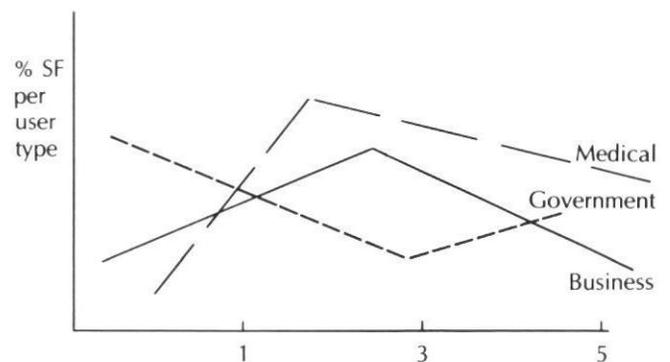
weighting each lease to project a potential short-term competitive position of existing stock.

The negative percentages indicate existing space that is locked in by lease and is off the current and intermediate market. Depending on demand, this may be the area of greatest potential development. The negative differences may be considered markets of possible development because the existing stock will not offer any competition.

- 2) If the tenants do not renew, they represent potential users for proposed space. An additional advantage generated from the data in Table 3 is that the comparison between the space amount and the space-time units can be used to group the existing space into a "time-frame" as illustrated in Figure 2.

**FIGURE 2**

Time Frame for Expected Use Competition



The time structuring illustrated in Figure 2 enables the analyst to recognize the competition from the existing stock (expected) in the intermediate term as well as in the short run. This figure shows that the existing office space for government and business use is tied in from year 1 to year 3, but many of the leases will be terminating in year 5. Thus, one might want to offer space in the market in year 3 if adequate demand is identified, and avoid competing in the market in year 5 when much of the existing space may be available. Depending upon projected demand, one might establish a marketing program that will endeavor to capture many of the tenants of the existing space since their leases will be terminating.

### ST<sup>2</sup> As A Merchandising Technique

The ST<sup>2</sup> model can be used to develop a merchandising strategy and to inform the potential developer, leasing agent, etc., where the potential markets might be. For example, suppose the ST<sup>2</sup> model shows a decline in the medical tenant's space-time as compared to space units but shows an increase in business and government space-time over existing space. Further, suppose the demographics supporting the demand analysis indicate an increase in medical and business activities, but a decline

**TABLE 5**

Comparison of Square Footage to Space-Time Units per User Group

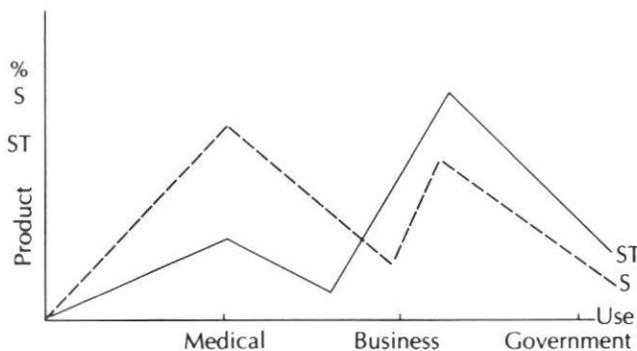
(1) User Category	(2) Building Number	(3) Square Feet	(4) Space-Time Product	Difference (4-3)
Medical	1	35,000	70,000	35,000
	2	60,000	180,000	120,000
	3	62,500	375,000	312,500
		157,500	625,000	467,500
Government	1	87,500	175,000	87,500
	2	120,000	360,000	240,000
	3	100,000	600,000	500,000
		307,500	1,135,000	827,500
Retail	1	70,000	140,000	70,000
	2	60,000	180,000	120,000
		130,000	320,000	190,000
Wholesale	1	70,000	140,000	70,000
	2	80,000	240,000	160,000
		150,000	380,000	230,000
Service	1	87,500	175,000	87,500
	2	80,000	240,000	160,000
	3	87,500	525,000	437,500
		255,000	940,000	685,000
TOTALS		1,000,000	3,400,000	2,400,000

in government demand in the market. This type of analysis would indicate a potential construction or development opportunity.

The supply side analysis of the medical, business, and government target market is depicted in Figure 3.

**FIGURE 3**

Comparison of Square Footage Percentage to Space-Time Percentage



where:

ST = Space-time

S = Space

**TABLE 6**

The Tool for Analysis: Direction and Percentage of Difference Between the Square Footage and Space-Time Units

User Category	Building Number	Square Feet (%)	Space-Time Product (%)	Direction of Difference (%)
Medical	1	3.50%	2.00%	1.50%
	2	6.00%	5.30%	.70%
	3	6.25%	11.00%	-4.75%
Government	1	8.75%	5.10%	3.65%
	2	12.00%	10.60%	1.40%
	3	10.00%	17.60%	-7.60%
Retail	1	7.00%	4.10%	2.90%
	2	6.00%	5.30%	.70%
Wholesale	1	7.00%	4.10%	2.90%
	2	8.00%	7.10%	.90%
Service	1	8.75%	5.10%	3.65%
	2	8.00%	7.10%	.90%
	3	8.75%	15.60%	-6.85%

As illustrated in Figure 3, it is probable that most of the existing medical leased space will be on the market in the short run while the government and business space is tied in for the intermediate period. Since government activity is not expected to increase locally in the foreseeable future, at least not in this example, this particular target market might best be avoided.

At the same time, however, business activity and the demand for space are increasing. The existing facilities are legally tied up and off the market. This might be the target to pursue if space can be bought on the market in appropriate time. The medical demand is also increasing, but existing space will be available in the short run. The decision to develop and merchandise medical space will depend on the projected demand and the risk parameters of the decision makers.

**ST<sup>2</sup> Applied To Projects Proposed And Under Construction**

The ST<sup>2</sup> model can also be applied to projects that are proposed and under construction. The analyst needs to determine the number of building permits granted and pending and to identify the building types represented by those permits. The ratio of issued permits to those applied for is useful in projecting the percentage of proposed projects. This ratio can be used as a risk or probability adjustment for the supply forecast.

Another useful ratio is the number of projects that are under construction or were recently completed in relation to the number of permits issued. This ratio allows for a comparison of planned or proposed projects to a projection of probable competitive units in the near future.

Viewing the proposed projects within a time frame leads to an estimate of possible competitive supply units in the short, intermediate, and long run. The competitive supply is comprised of existing units and those under construction as well as proposed space-time units. In addition, a lag of current competition as it relates to forecasted demand will result because of the time it takes for construction. The extension of the competitive horizon can now be projected if one determines the projected lease terms used in the newly constructed buildings.

### Summary And Conclusions

This paper has addressed only the supply side of the market. Three reasons for this are:

- 1) Many appraisers, market analysts, and feasibility analysts frequently use supply data to interpret demand. They analyze and explain demand activity by looking at the variances (differences) between the physical, economic, legal, and financial attributes of properties that have been sold in the market.
- 2) Behavioral dimensions of demand have been ignored in a major portion of market appraisal and feasibility analysis. Demand is usually analyzed on a macro level using secondary information. Improvement in demand analysis will require the development of quantitative techniques and the awareness of data sources that are beyond the scope of this paper.
- 3) Considering the two factors above, the authors feel that an immediate development in market interpretation can be achieved through improved supply analysis. The  $ST^2$  model is a suggestion towards achieving this goal.

The  $ST^2$  model allows for the segmentation of market supply and hence competition. It defines real estate supply in units of comparison (space-time) that more appropriately fit the needs and behavior of the market. It also provides for the time framing of the competitive supply, which allows for the projection of short-term, intermediate, and long-term competition. Finally,  $ST^2$  may be a method of directing the merchandising of space.

The  $ST^2$  model is only one of many "tools" available to the analyst. Market analysis cannot rely on supply analysis alone and can only be improved if both supply and demand potential are appropriately estimated. It is felt that the  $ST^2$  model is a step in this direction.

### NOTES

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