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Office Market Indexes Development Using System Dynamics Models

Rogerio Fonseca Santovito [1], Max Kummerow [2], Claudio Tavares de Alencar [3]

[1] author: M.Sc. researcher, Real Estate Research Group, Polytechnic School of University of São Paulo, Brazil.

[2] co-author: Ph.D. Professor, Curtin University, Perth, Australia

[3] co-author: Ph.D. Professor, Polytechnic School of University of São Paulo, Brazil.

Rua Abílio Ramos, 291 – Macedo, Guarulhos, São Paulo, Brasil – CEP 07113-090

Phone: +55 11 2088306

santovito@hotmail.com or rogerio.santovito@poli.usp.br

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Abstract:

This paper presents the basis of a Real Estate Office Market indexes development, with its theoretical framework validation been made through the use of a System Dynamics model. The well recognized cyclicality of office markets, along with overbuild as a widespread problem, suggests a fundamental causal mechanism in the office market process itself. Being perceived that information lag is a major variable of the system, the use of System Dynamics models allows a better understanding of the function of each piece of information in the process. The structure and characteristics of each type of necessary information are analyzed. Database completeness and definition problems of the indexes already produced by developers are addressed in the discussion. Results indicate that information should be produced in a way to reflect the true current state of the system. Furthermore, an attempt to expand the model and the construction of a widespread database are proposed.

Introduction:

The main objective of this research is to support the development of Office Market Indexes that have a theoretical validation, and that might have a better adherence with reality. The location discussed in the paper is the city of São Paulo, but the index is intended to be valid for all other commercial areas in Brazil, with adjustments made based on local parameters. In fact, some São Paulo Office Market Indexes already exist, produced by developers. However, as will be exposed further on, these indexes diverge from each other, so much for the use of different criteria in the construction of each indicator, as for the comprehensiveness of the database used. This fact, if not invalidates their use in academic works, at least reflects the existence of a structural problem that deserves to be formally studied.

A proposed solution, although implying organizational changes, may contribute to improvement of the system. Since there is no reliable historical data about the São Paulo office market, we choose to discard those indexes already produced, and focus the work on the recognition of the office market dynamics, and its intrinsic characteristics, through a System Dynamics model, developed by Dr. Max Kummerow, and identify the types of information that would be necessary for the maintenance of a supply/demand balance in the system. Data base completeness and availability, along with characteristics of office markets and indexes applications are also discussed.

Office Market Dynamics:

Office market dynamics is a widely discussed issue on the literature. According to Block, (1998) the value of commercial properties, among them office properties, depends basically on factors denominated micro, such as location, maintenance, or lease, and macro factors, such as general performance of the economy, rates of interest, employment levels and inflation. Wheaton *et al.* (1996) adds that macroeconomics factors as growth of the economy, affect the balance of market forces, increasing office demand and supply, while a recessive economy reduces these variables. Another idea is that properties are subject to three influence levels: **[i]** national/regional/world economy, **[ii]** property types or market sector, and **[iii]** individual building.

Although the ways of discussing this idea may vary, it is clear that office market dynamics is associated to the movement of the economy. In general, it can be verified that during recession periods, the amount of non-occupied space tends to increase, and the construction levels fall, while the opposite happens in recovery periods. However, time lags, particularly in construction, may result in completion of properties too late in the business cycle, unbalancing the demand/supply relationship.

The nature of the office market is cyclical, and these cycles are identified through the variation in certain market indicators. Usually, these cycles are identifiable regarding type, but not always with relationship to the duration and intensity. In fact, effective investing in real estate depends to a large degree on understanding real estate market cycles.

In McGough *et al.* (1999), it is made a description of the forces that interact in this cycle, in Great Britain. In US, statistical work has identified a number of economic and other variables that are important in explaining the flow of new office construction. Pyhrr *et al.* (1999) does a synthesis of the most important works on real estate cycles, presenting eight cycle models, with their on analytical definition of cycles.

Although the denominations may vary, it is generally acknowledged that the office market cycle is basically composed by the phases of Recession, Recovery, Expansion and Contraction. Meuller (1995) establishes terminology for real estate's physical and financial market cycles, noting that the financial performance of real estate is closely tied to the sector's physical building cycle. (Gallager *et al,* 1999)

Kummerow, (1999) points out that overbuilding cycles are widespread, and that "the diversity of locations, times, economic systems and political regimes where oversupply have occurred suggests a fundamental causal mechanism in the office market process itself".

Gallager *et al.* (1999) presents three techniques that provide a useful function, signaling which markets are at most risk from overbuilding, at MSA level. Although these models provide a high degree of explanatory power, some limitation exists as, for example, the fact that some factors that may be important in determining overbuild such as rent growth, land availability and zoning, were not directly accounted for in the specifications.

Therefore, it evidence that the recognition of the causal mechanism of the overbuild cycle is fundamental for the development of the market, and market indexes built in a validated theoretical framework can be very useful for the several players of the market.

Methodology:

During the accomplishment of the research, we identified two major topics, one related to the database used for construction of the index, the other relative to the structuring of the index. The methodology for each one is described as follows.

Data base definition and aggregation:

The first aspect to be observed in this research is the database that has been used for the construction of the indexes. The São Paulo Office Market Indexes already produced by developers diverge from each other. It is observed that each developer or company possesses their own research department, which collects market data, and transforms it into information, in the form of market indexes. On behalf of commercial secrecy, the companies close their research departments, therefore the data base on which leans the construction of these market indexes doesn't reflect the market as a whole, but the portion of the market that could be perceived by each research department. And so doing, they end up with distorted indexes.

One solution for this problem resides, then, in the creation of an independent organization, external to the developers, that serves to promote cooperation and regulation among the companies. This organization would have access to the databases of each company, under confidentiality terms protecting privacy. Such a combined entity could build the indicators with more quality, at least from the database completeness aspect.

The other problem is related to data definition, due the use of different criteria in the construction of each indicator. Each company possesses it's own methodological criteria to define the data, and the problem resides in the fact that great part of these definitions is empiric, and they lack of theoretical validation.

Shilton *et al.*(1993) also discussed the problem of having information variance (vacancy rates, more specifically), and suggests that the creation of a single office index is not feasible. Regardless of this, one can verify that this is a problem of strategic behavior - prisoner's dilemma game-, where due the lack of cooperation, the rational behavior of each developer leads to a collectively irrational outcome.

The collection of comprehensive and theoretical validated data could help address this problem by increasing the ability to make decisions based on timely competitive supply information. In effect, if developers had more information on competitive supply, they could make decisions that would effectively "queue up" projects. It is not rational to proceed if one knows others have already gone ahead.

As Coyle, 1996 says, the 'politics' is usually the hardest part of changing a system because there are always vested interests in the status quo that feel threatened by change. So, the effort to aggregate the data from several agencies and developers must be carefully studied.

But the problem of the scarcity of theoretically validated criteria for the construction of the indexes remains. Although implying in organizational changes, this is supposed to be resolved with the use of System Dynamics models.

Index Structuring:

As previously commented, a reliable historical series of indexes doesn't exist to allow, through econometrics analysis, recognition of the variables and the inherent dynamics of the offices market cycles in the city of São Paulo. Thus, the development of the indexes will proceed independently of the existent indexes.

The office market can be understood as a complex, higher order, non-linear system and so, it is subjected to instabilities. When treating the fundamentals of Real Estate cycles, Wheaton, (1987), conducts most of his analysis using "a version of stock-flow model with specific functional forms, and even parameters". His explanation of doing so is that, without this specificity, the dynamic properties of higher order difference equations are very difficult to determine. Although we agree with him, and consider this a valid concession, we think that an attempt to use System Dynamics models to enlighten some conclusions about the system's dynamic behavior is worthwhile.

Pyhrr *et al.* (1999) synthesizes relevant research and commentary on real estate cycles, and it could be verified that the use of System Dynamics models as a tool for recognition of cycles and their behavior is not pointed out. The system dynamics model of cyclical office oversupply described in Kummerow, (1999) was the first on this issue and, although simplified, makes possible a good understanding of the dynamics of the offices market.

As Forrester, (1961) put it, when using a model, we should look less for prediction of specific actions in the future and more for enhancing our understanding of the inherent characteristics of the system. It is believed that indicators based in system dynamics models are valuable for these allow a better understanding of the inherent characteristics of the system. This way, it will be used to validate the theoretical framework that sustains the construction of the indexes.

Market indexes are not replacements for monitoring individual projects, but they do provide a useful function in signaling which markets are at most risk from overbuilding. It can be inferred of the model that one of the causes of the overbuilding is the delay of necessary time to the recognition of a certain state of the system.

What is sought with the production of market indexes and forecasts, therefore, is an improvement by reducing this delay, contributing to the prevention of the overbuilding cycles. The indexes are supposed to serve as support to the decision, and once they reflect the state of a system. The model will identify, **[i]** the type of necessary information, **[ii]** which the characteristics of each type of information needed, and **[iii]** how each one should be interpreted.

Results:

Analyzing the model proposed by Kummerow, (1999), identified the following types of information as controllers of office market dynamics:

Vacancy Rate:

In the model, vacancy is used to control supply responses. This means that when a discrepancy exists between the vacancy rate verified in the system and the equilibrium vacancy rate, the system reacts to eliminate this discrepancy, acting on the supply side.

It was verified in São Paulo that developers have different criteria for determination of the vacancy rate. For instance, for a certain research department, the vacancy rate is calculated by considering every office space (m^2) indeed non-occupied, while another developer calculates it considering vacant the office spaces that do not hold long-term contracts. If we consider that the time to be considered a long-term contract also varies for each agency, we can perceive one of the origins of the discrepancies among the vacancy rates published by the developers.

The Property Council of Australia (PCA) in Sydney, that succeed BOMA, produces a vacancy report and they have struggled with these methodological issues. When does demand enter the statistics - when a tenant goes looking for space, when they sign a lease or when they move in? When does demand disappear - when a company decides to downsize, when nobody is in the space or when the lease expires? Different decisions on these issues lead to different vacancy even before we come to measurement errors and incomplete data. Also what space should be in the stock? The PCA decided arbitrarily to remove some buildings from the stock on grounds they were too old to be competitive. Probably this was reasonable, but again, a "how to measure" decision leads to a different vacancy figure.

Vacancy rate information is a major determinant of the amount of office space to be produced (supply side). In this way, the vacancy rate should reflect the amount of office space indeed non-occupied, otherwise new spaces will be produced that were not necessary, unbalancing the system.

Equilibrium Vacancy Rate:

As stated by Kummerow, (1999), this parameter was simplified as an exogenous constant. In the development of the index, however, this parameter should be constructed, through the models proposed in the literature.

Voith *et al.*, (1988), Shilton *et al. (1993)* and others have found that equilibrium rates vary between cities and over time, turning this into a dynamic parameter.

This could be a big modeling exercise in itself. One alternative may be the use of a "switching model" with one process during booms, another during busts, for example. Some simple assumption would be the way to go for simple simulations—make the V* proportional to the expected demand growth rate (time t and t+1) and leave it at that — a theory that if you are selling more of a product, you are willing to hold more inventory. Would be worth study the effects of city size, interest rates, rent levels, vacancy levels themselves, etc.

Demand:

Several factors that can alter the level of demand exist, among them demographic factors and employment level, and the reflection of these alterations should be measured in an indicator that can be, with reasonable safety, forecast. In the Kummerow paper cited above, the demand was considered with a steady growth, and also random demand shocks were modeled. An indicator that could reflect movements in demand is the *rate of absorption of the stock*, defined as the speed with which the stock is absorbed by the demand in meters squared per time period. The volume of this absorption - essentially new leases minus space vacated - is denominated *net absorption*.

Supply change:

In the model, supply change is function of four parameters: oversupply, adjustment time, supply lag and equilibrium vacancy rate. This last one was already commented on, therefore we pass to comment the other parameters.

Oversupply:

This parameter is the ratio of orders to discrepancy, and it could expected that with more public and reliable market information, the developer will look for the 'exact' attendance to demand, gauged by the vacancy equilibrium rate. That is, there would be no tendency to build more than is needed.

Unfortunately, this is probably not true—developers have what the late Professor Graaskamp (University of Wisconsin) called "above the bottom line profit centers" in the development process that may motivate them to undertake projects that will lose money overall. What is rational for the developer may differ from what is rational for investors. For example, the developer may earn profits on land assembly, construction, leasing or management of a project, even if they project turn out to have negative net present value. These issues arise due to asymmetric information and contracts that allow developers to lay off risk onto investors or lenders. Graaskamp compared this to a developer in effect holding a put option to lenders in case the project fails to find tenants. There may also be that simply irrational motives are enough to send some developers towards building too much. This oversupply tendency may be difficult to remedy completely, given the structure of incentives facing industry participants.

Adjustment Time:

The inclusion of this parameter is justified by the commencements delays. When a supply shortage (below equilibrium vacancy) appears, projects may not immediately commence due to planning and regulatory delays.

Supply Lag:

It is understood as the difference of time from order to delivery. It is believed that, use of forecasts at a forecast horizon corresponding to the construction time lag could reduce this parameter to 0. This would mean just-in-time supply in response to forecast changes in demand.

It is believed that the movements of these three parameters described concisely can be observed through the indicators *New Stock*, relative to the new supply, and *Total Stock*, relative to the total stock of available office space available for absorption.

Variables not included in the model

Economic building size:

Effects of the 'economic building size', in the overbuilding cycle are not modeled and would tend to make supply responses more "lumpy" and less continuous. The index can, as a simplification, be expressed in square meters, and not in commercial units or buildings.

Rent level:

The model used in the present work doesn't contemplate rents because in markets, rents respond inversely to vacancy rates, being therefore, already contemplated. This simplification, although valid, deserves a more detailed study. Office rents are the most significant determinant force to cause the large swings in the supply side of new office space. An empirical analysis presented in McGough *et al.* (1999), provides supporting evidence for the significant influence of office rents on the rate of new office construction.

It is expected that a reliable indicator of rent can be built from the work developed by Webb *et al.* (1996) and from the work of Wheaton et al. (1994) that estimate hedonic office rent equations for 36 metropolitan areas, with a data span from 1979 to 1991, in constant dollars. An extension of the model would be to use rent to make the supply response lags clearer, but again, vacancy rates is perhaps a very logical proxy for the price signals of supply and demand conditions.

Conclusions:

Model results appear give evidence that one of the most important variables of the office market overbuilding cycle system is the lag of information, understood as the time that one takes to recognize a state of the system, plan responses and then carry out new construction. The system response depends on the speed with which the information arrives, and on the quality of this information. Indicators should be built in way to reflect the true current state of the system. The speed with which this information is produced, and physical processes, as, for instance, preparation of reports, it should be maximized, to reduce the lag of information. This suggests collection and dissemination of information through an Internet website for quick and universal access by market participants.

The indicators that could be perceived in the work are not new, nor ignored; however, what was intended with the use of System Dynamics was to promote a better visualization and a better understanding of the paper of each piece of information in the behavior of the system. It is believed that this procedure can contribute in a positive way for the performance of Real Estate developers companies, once it becomes well-known how costly is the lack of reliable information current in this market.

The companies act as in a *prisoners' dilemma game*, each one with its own rational thought, however producing an irrational collective result. To improve this situation, collaborative actions are necessary. As Kummerow, (1999) put it, "uncoordinated management, poor communication, lack of information and naïve decisions policies lead to unsatisfactory results". This is reflected in higher risk of losses in real estate investments, higher costs of capital and higher accommodation costs for tenants as well as negative effects on the stability of macro economies.

Collaborative actions, coordinated by an organization independent of the developers, although once thought of as non-feasible, plows the most appropriate alternative, and it will become more feasible as the established developers recognize the need for organizational change.

Organizational changes in the production of the indexes are necessary. The companies should also react to the environmental transformations that they are passing through, reconsidering their forecast methodologies, and studying the possibility of the use of system dynamics theory in these methodologies. The system dynamics model used in this work to recognize the necessary information, although simplified, allows a good image of the system's dynamic behavior over time.

A future project of research would be an attempt of expanding it, incorporating parameters of rent, of the equilibrium vacancy rate construction, and of demand shocks, as well as macroeconomics and regional influences, so that the model could be used in the future to support the development of more reliable forecasting methods.

We believe that System Dynamics should be considered a tool with which Real Estate developers improve their analyses and forecasts with direct benefits to financial results and long-term wealth.

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