Designing and Testing Policies to Prevent Office Building Oversupply Cycles.

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Abstract
Long supply lags and delayed information feedback generate office market cycles resulting in billions of dollars of losses to investors and contributing significantly to macroeconomic cycles from the Depression of the 1930s to current Asian financial crises. This paper uses a simulation model to explore outcomes when alternative policies are applied to improve office market efficiency. A supply queuing circuit breaker about once every decade during the "euphoria" stage of a property cycle might reduce the severity of oversupply incidents and prevent costly market collapses. But policy interventions could also reduce market efficiency if not properly designed and implemented. The model demonstrates that shortening supply lags through use of forecasts, reducing incentives to overbuild, and smoothing supply responses could each reduce cycle amplitude. Whether policy interventions and forecasting would increase allocative efficiency depends upon the specifics of implementation, the distribution of forecast errors, and the rationality of supply behaviour.

Ubiquitous office oversupply cycles

Office market cycles are surprisingly widespread and repetitive. Barras (1994) maintains that investment property oversupply occurs in every other macroeconomic cycle--about once every ten years. Hendershott and Kane (1992) estimated economic losses from the U.S. 1980s' office oversupply at U.S.$130 billion, chiefly present value of lost rents from excess vacant space. London, Stockholm, Singapore, Tokyo, Johannesburg, Toronto, and many other cities have experienced office oversupply cycles. In Australia, 1993 central business district office vacancy rates peaked at 32% in Perth, 27% in Melbourne, and 22% in Sydney (BOMA, 1993). Reducing the amplitude of office market cycles (ie risk) would lower the cost of capital for projects, provide a steadier flow of new projects over time, reduce the costs of accommodation for office tenants, and benefit the macroeconomy by addressing a major source of instability.

Office markets may be even more volatile than in the past due to international institutional capital flows and advances in information technology. Hong Kong, Bangkok, Jakarta, Kuala Lumpur, Shanghai, Seoul, and other Asian centers currently face major office space oversupply. Solvency problems stemming from non-performing commercial property contributed to a spreading financial crisis in the Asian tiger economies and Japan.

Too little supply constrains economic growth by imposing high costs on tenants and making it more difficult to add office workers. Too much new supply leads to land and construction cost inflation, followed by excess vacancy, price collapses, and negative net present values. Non-performing properties contribute to financial intermediary liquidity and balance sheet crises, marketwide price drops, and recessions. Too much or too little office investment misallocates capital, increases risk, and reduces social returns to capital.

Explanations for Office Oversupply Cycles

University of Wisconsin real estate professor James Graaskamp remarked that every expense item in a project budget is a profit center for somebody (Graaskamp, 1988). Land assembly profits, construction profits, lending institution staff bonuses, consulting fees, project management fees, and securitization fees reward decision makers even where projects eventually fail. As one agent put it, “A lot of people don’t get paid unless a deal happens.” But, more deals means less likelihood all projects can perform as projected. "Principal/agent conflict" is therefore a convincing explanation for office market failures, (Cole and Eisenbeis, 1996).

A second explanation for office market failure can be found in Game Theory. Each developer faces a decision under strategic uncertainty: "If my project goes ahead and others' projects do not, rents will be high and my project profitable. If we all build, market rents will fall and we will all lose money." Interviews with developers of four major Perth projects (Kummerow, 1997) revealed that it was impossible to know during early stages which projects would go to completion, nor which would be completed first, given uncertain delays at each stage during a 7-8 year development process. This strategic uncertainty is analogous to the much-studied Prisoner's Dilemma game--absent cooperation or regulation, individually rational behaviour leads to a collectively irrational outcome.

A third office oversupply story emphasises system dynamics: Market decisionmakers may prefer to respond to current prices, thinking this a "conservative" policy that avoids forecasting errors. But a "respond to current prices" policy ensures a backlog due to supply lags and probably increases risk. With supply delays and backlogs, deliveries (office completions) must at some point exceed current demand growth for supply to “catch up.” Overshooting of supply is likely, especially if demand growth subsequently falls off due to a macroeconomic cycle.

Some would argue that, contrary to the preceding arguments, office markets are information efficient and that apparent cycles are the result of random shocks, and therefore unavoidable. Whether or not office markets are *ex ante* information efficient in some sense, they are sometimes allocatively inefficient, *ex post*. Excess spaces stands empty and net present values are negative at times, while at other points in the cycle there are shortages of space constraining economic activity and excess profits. These *ex post* market failures may be partly correctable by redesigning the information structure and policies of the system. Information is not a given, but rather a commodity that can be increased at a cost and applied in more sophisticated ways. Information efficiency in markets must always be defined assuming a particular level of information technology.

System Dynamics Modelling

System dynamics (SD) models offer two advantages as a representation of office markets: First, it is relatively easy to incorporate qualitative "mental" and written information as well as quantitative data. Second, simulations can be used where data is inadequate to support statistical methods or where change in processes makes historical data misleading.

Insights from system dynamic models often have to do with delayed and counterintuitive effects of feedbacks. Delays mean current information may provide misleading signals. Coyle (1996) identifies three types of delays crucial to system dynamics: 1) Time to find out, 2) Time to decide what to do, and 3) Time to remedy discrepancies from desired states. The time it takes before the system reacts to discrepancies from desired states (information flows), and the size of responses (physical adjustments) determine the dynamic behavior of the system.

Paich and Sterman (1993, P&S) cite several studies showing "decision making is poor where decisions have delayed, indirect, non-linear, and multiple feedback effects." Their results confirmed that "In situations of high dynamic complexity, peoples' mental models are grossly simplified compared to reality." (P&S, 1993:1440,1456) In their experiment, P&S presented MIT MBA students a simple two feedback loop model posing pricing, production, and inventory control problems similar to those faced by office market decision-makers. Subjects showed a tendency towards "conservative demand forecasts which ensure actual capacity will be grossly inadequate during the boom phase, causing high backlogs, long delivery delays and market share erosion." (P&S, 1993:1452) Subjects then failed to cut capacity fast enough in the ensuing bust. In repeated trials, although some learning took place, subjects never succeeded in matching the performance of a simple decision rule.

A System Dynamics Model of an Office Market

Coyle advises modelers to "think physics." (Coyle, 1996:20) Physical processes--such as constructing office buildings--may involve unavoidable time delays. Clapp (1993), Hendershott (1997), and other authors use the equilibrium vacancy rate concept as the state towards which office markets adjust. A simple office market model can be driven by the discrepancy from an equilibrium state where supply, S, equals demand, D, plus an equilibrium vacancy, V*.

In markets, rents and asset values (prices), transmit signals of the discrepancy to suppliers since rents and values respond inversely to vacancy rates. The model proposed here omits prices, allowing supply to respond directly to demand. In the model, when vacancy equals equilibrium vacancy, the supply-demand discrepancy will be zero and no supply adjustment will occur. If there is excess supply, the supply change called for is zero. In real systems, small amounts of office supply are removed by demolition or conversion. These adjustments are omitted for simplicity. Once a space shortage occurs in the model, due to exogenously generated demand growth, the system adjusts to eliminate the discrepancy, constrained by production capacity and supply lags.

Model supply adjustment is a function of four parameters, which give rise to system behaviour:

1. *Equilibrium vacancy rate (V*).* V* is an exogenous constant. The system seeks to eliminate S-(D+V*)= Excess Vacancy (XV), the discrepancy between equilibrium and the actual state of the system.
2. *Oversupply (OS).* New supply orders = OS * XV. For example, if OS, is 1, developers seek to build exactly the amount of space needed, while if OS is 2, they order twice the discrepancy.
3. *Adjustment time (A).* When XV*OS amount of space is ordered, (XV/A)*OS will be commenced in that year. For example, if there is a need for 300,000 ft². of new space, and the adjustment parameter is 3, the market will commence 100,000 ft². The remaining 200,000 ft². becomes a backlog.
4. *Supply lag (SL).* Physically, construction may require 2-3 years for major projects. However, the supply lag could be 0 or even negative if projects are commenced earlier in anticipation of future demand.

Taking the discrepancy XV = (D+V*)-S as the system error or deviation from the most efficient equilibrium state, statistics such as root mean square error or mean absolute percentage error summarize system allocative efficiency over time.

A previous paper (Kummerow, 1998) demonstrated that when the model includes supply lags longer than about 15 months, cyclical behaviour occurs under a wide variety of exogenous demand input assumptions including steady growth, random shocks, historical demand patterns, or demand spikes. Cycle amplitude increases with the tendency towards oversupply (OS), but are smoothed by increasing adjustment time (A) to an optimum level proportional to the supply lag.

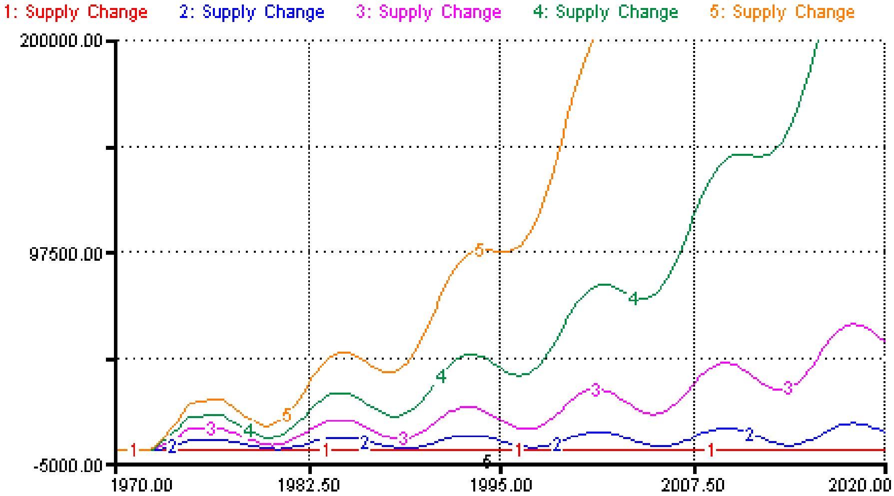
System Behaviour under Various Parameter Assumptions

Even with this simple model, there are in many possible combinations of the parameter settings for demand trend, demand errors, equilibrium vacancy rate, oversupply tendency, adjustment time, and supply lag. To present a succinct overview of model behaviour, parameters are fixed at plausible "base run" values and then each varied in sequence. In each case, the model is run across five values of the sensitivity analysis variable, presenting comparative graphs showing the results. The "base run" or reference parameters are set arbitrarily (but at levels similar to Sydney data) at V*= .09, D trend = 0.03, D error = .0, SL= 1.5, OS= 1.5, and A=1.6. Random shocks are added in subsequent simulations. With these settings, the model generates an explosive cycle with a period and amplitude similar to that observed in the three Sydney office market cycles of the past 25 years.

Demand growth rate (Exogenous growth)

If there is no demand growth, the system does not cycle, so no deviations from equilibrium occur. But a constant trend growth rate generates cycles (Figure 1).

Figure 1 Supply change as demand growth varies from 0 to 6% p.a.



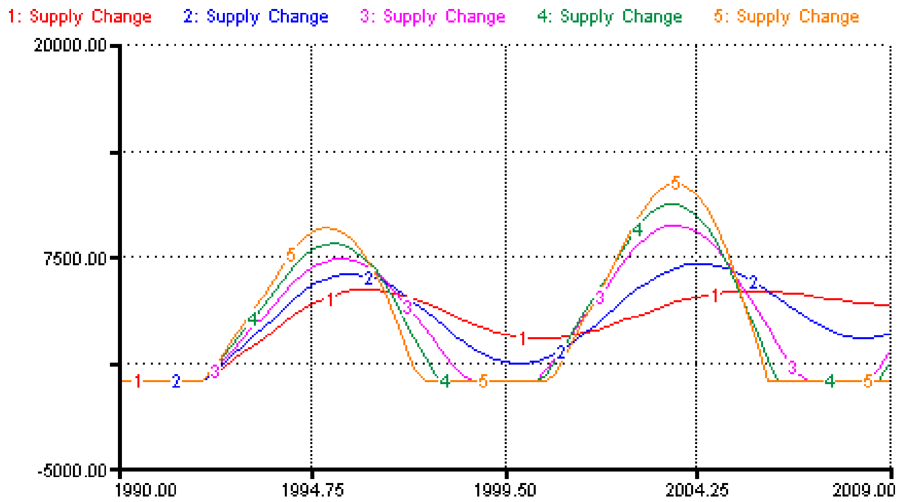
Equilibrium vacancy rate (Desired inventory holdings)

Increasing the equilibrium vacancy rate has little effect on cycles generated by the base case settings, until the equilibrium rate gets above 9%. At 12%, equilibrium vacancy moderates the cycle, but this is at the cost of higher vacancy. A higher equilibrium vacancy rate also lengthens the cycle. Regardless of cycles, it would seem desirable to reduce V* to a minimum level required for smooth functioning of the market--that is, only enough vacancy to serve as inventory for sale or rent, for transitions from one premises to another, and for renovations.

Oversupply tendency (Agency/Strategic behaviour market failure)

There are strong empirical and theoretical grounds for expecting a tendency to build more office buildings than would be sufficient to satisfy demand. Most of the property industry operates on the basis of fees, commissions, and profit centres proportional to the number of projects and amount of investment put in place. Moreover, a prisoner's dilemma-like strategic behaviour problem (Kummerow, 1999) tends to make independently rational behaviour turn out to be collectively irrational. Figure 2 shows that as the tendency to build grows from 100% to 200% of the discrepancy between V and V*, the amplitude of cycles increases. However, (see below), this would not be true in the absence of supply lags.

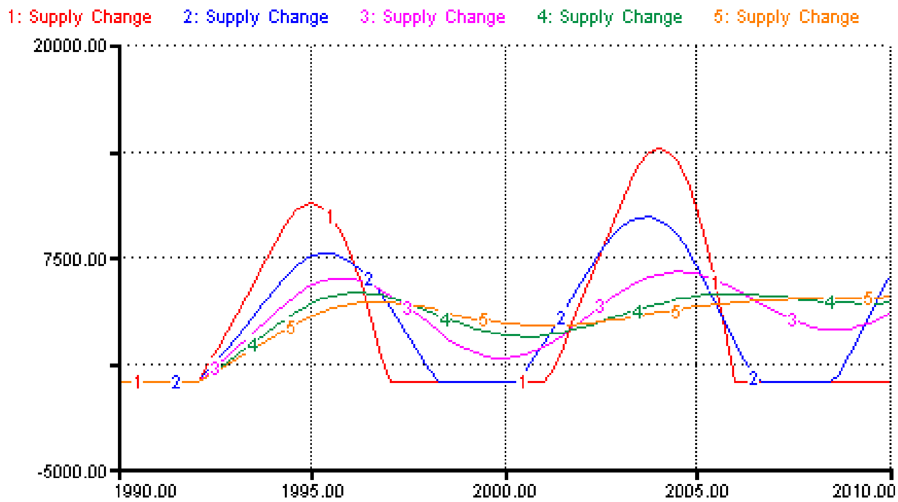
Figure 2 Increasing cycle amplitude with increasing supply response



Adjustment time (Smoothing of the supply response)

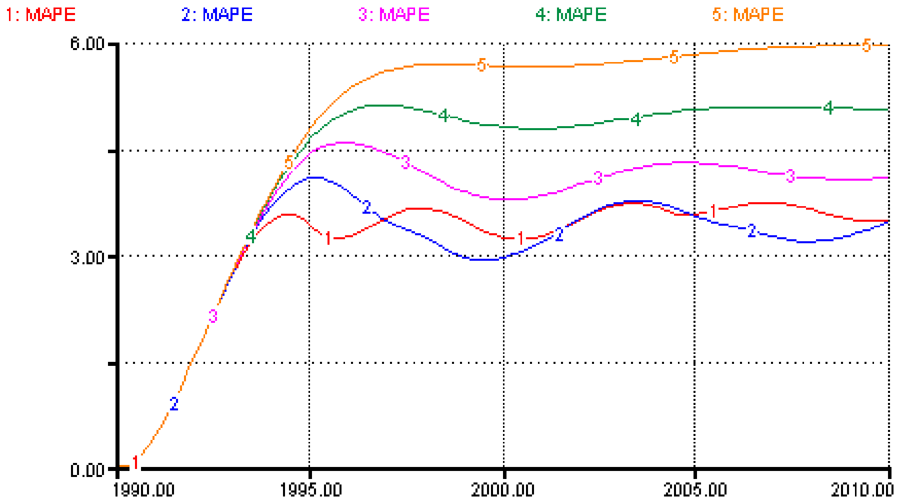
The supply cycle smooths out as adjustment time increases from one to 2.5 years. This means a smaller percentage of the discrepancy is begun each year (Figure 3).

Figure 3 Supply change as adjustment time increases



However, increasing adjustment time too much means that supply catches up with demand more slowly, increasing errors in the system (Figure 4).

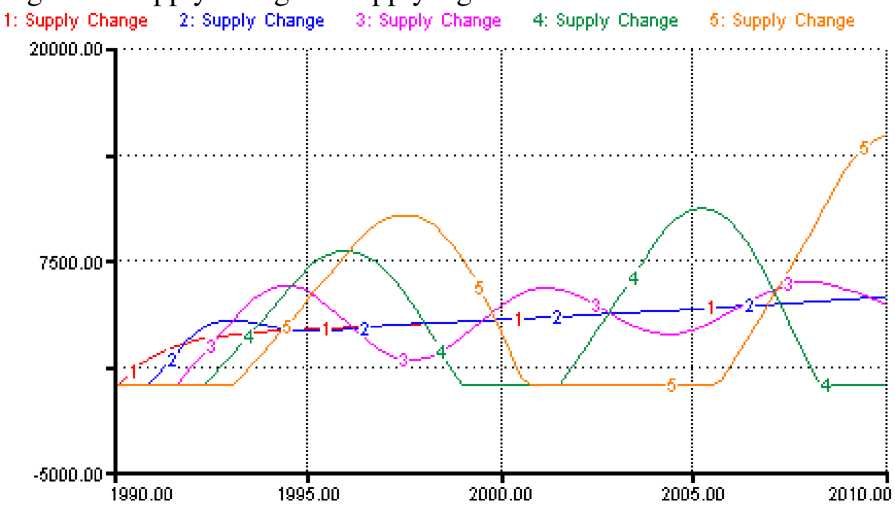
Figure 4 Mean absolute percentage errors as adjustment time increases.



Supply lags

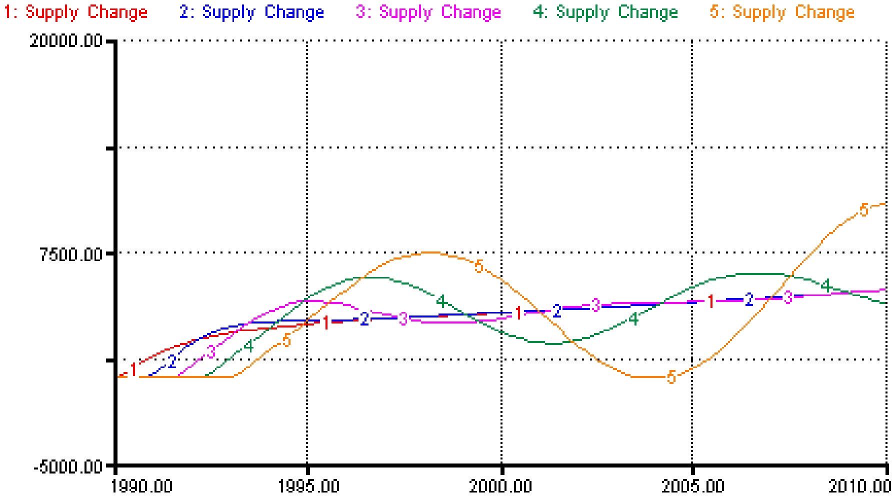
It will be no surprise to system dynamics modellers to see that the major generator of cycles in the model is the supply lag (Figure 5).

Figure 5 Supply change as supply lag increases



When the lag is zero, that is, with "just in time" inventory, there is no cycle. With a half-year supply lag (run 2) a small overshoot occurs, followed by convergence to equilibrium. As the delay in delivery of ordered new inventory increases from one year to 3 years, runs 3, 4, and 5 show a pattern of longer cycles with greater amplitude. The model produces larger discrepancies and the mean average percentage errors as the supply lag increases. Even with oversupply (tendency to build too much) set to 1 (ie the "correct" setting where new construction orders equals exactly the amount required to return to equilibrium), the model still produces cycles as the supply lag increases (Figure 6).

Figure 6 Cycles due to supply lag with no oversupply tendency in operation.

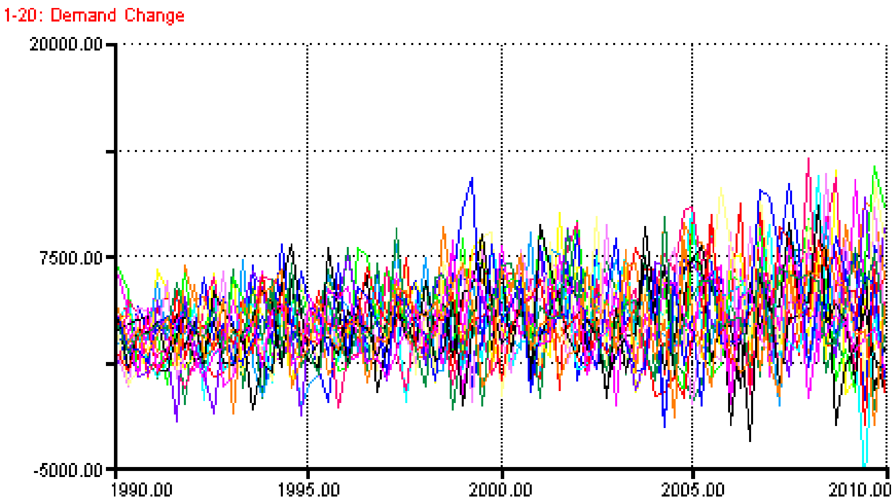


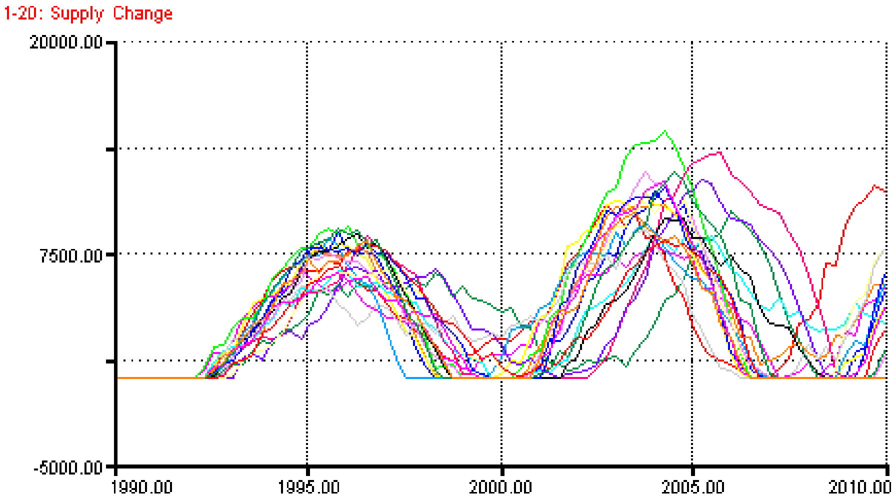
On the other hand, if the supply lag is set to zero, then even a pronounced oversupply tendency will not produce cycles. Supply will adjust quickly to demand so that backlogs do not develop, even where the industry wants to build too much space.

Supply lags with forecast errors

The preceding "story" neglects demand shocks. With random errors, the analysis is complicated by variation so that several runs must be performed to reveal the distribution of results.

Figure 7 Plots of twenty runs with demand standard deviation .02 and supply lag 2 years.

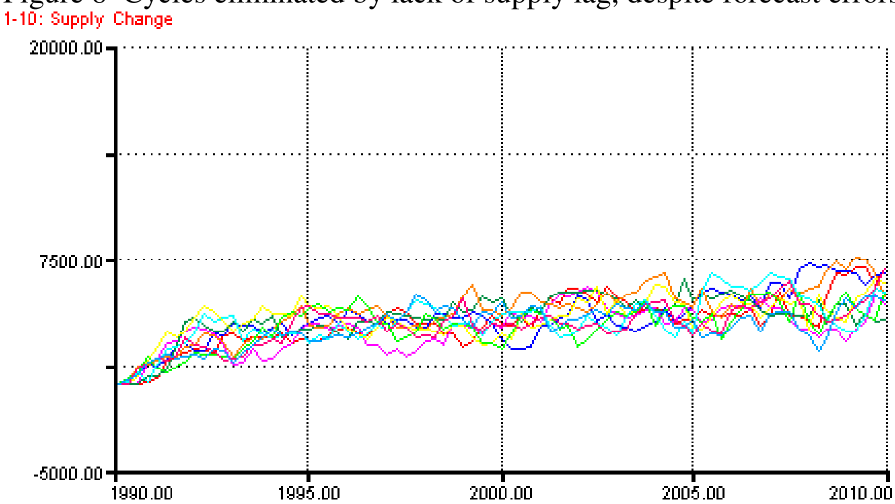


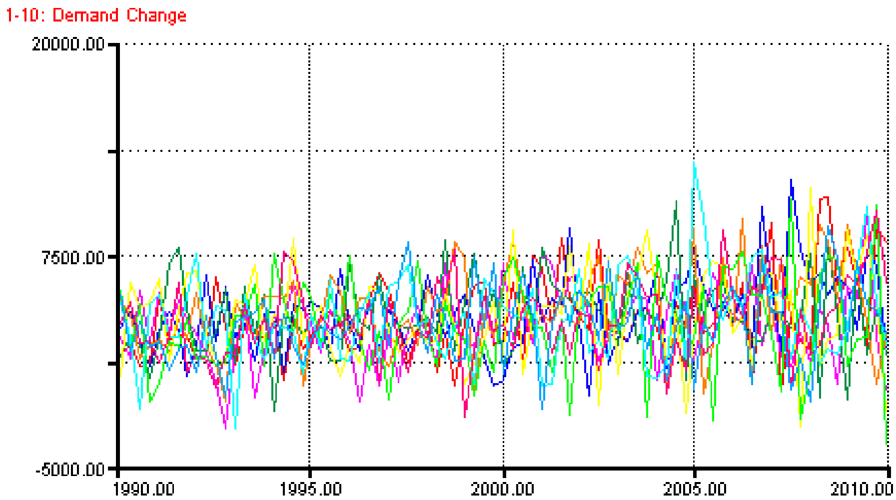


Notice that even with demand a summation of a trend plus random shocks, the supply lag generates an explosive cycle. The real driver of the cycle is trend growth, plus system dynamics (the supply lag) rather than random errors.

This is shown by the fact that even with the standard deviation of demand errors set to 0.04, the supply response is not cyclical when the supply lag is zero. Note that the supply change is less variable than the demand change in this model due to the smoothing effect of an adjustment time >1 period. (Figure 8)

Figure 8 Cycles eliminated by lack of supply lag, despite forecast errors.

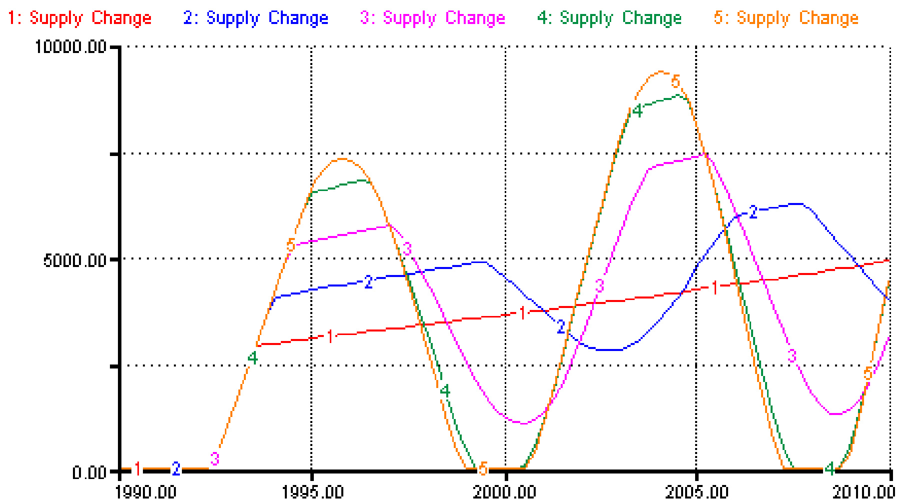




System Behaviour under a Public Policy Constraint

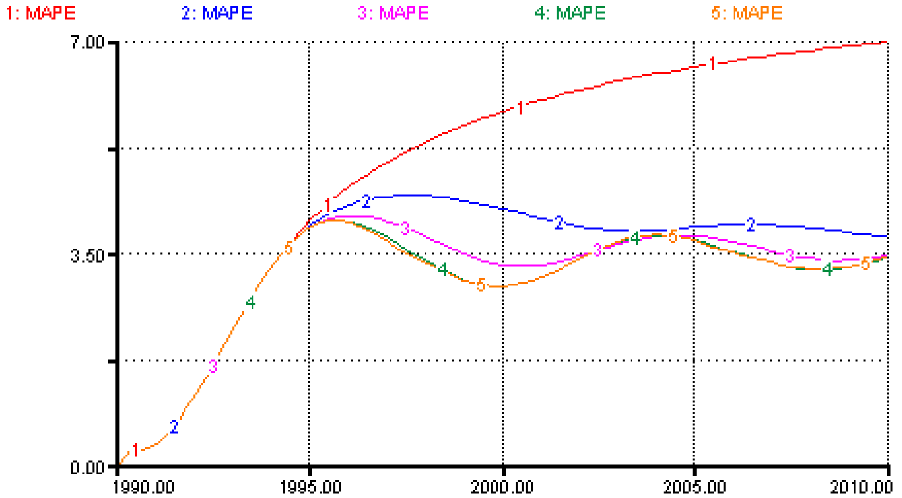
We have seen that forecasting (ie zero supply lag) eliminates cycles and reduces error even with random demand shocks. Another tempting way to reduce system errors or inefficiency would be to add a circuit breaker policy through the municipal building permitting process. Figure 9 shows a run with a "ceiling" imposed on supply responses. In the five runs shown the ceiling increases from 1 x forecast demand to 2.5 time forecast demand. The former constrains supply dramatically, the latter not at all.

Figure 9 Supply response with a regulatory ceiling



However, this smoother pattern of supply response does not necessarily mean less error in the system. The constrained supply could be more out of balance with demand than the unconstrained supply. This naïve extrapolation of demand does not include feedback to keep supply and demand in balance, so once the constraint takes over, the system performs worse than without the constraint. This perhaps mimics experience in London, San Francisco, and Singapore, cited as places where planning constraints created artificial shortages. The naïve constraint increases system error.

Figure 10 System mean absolute percent errors with a naïve planning constraint

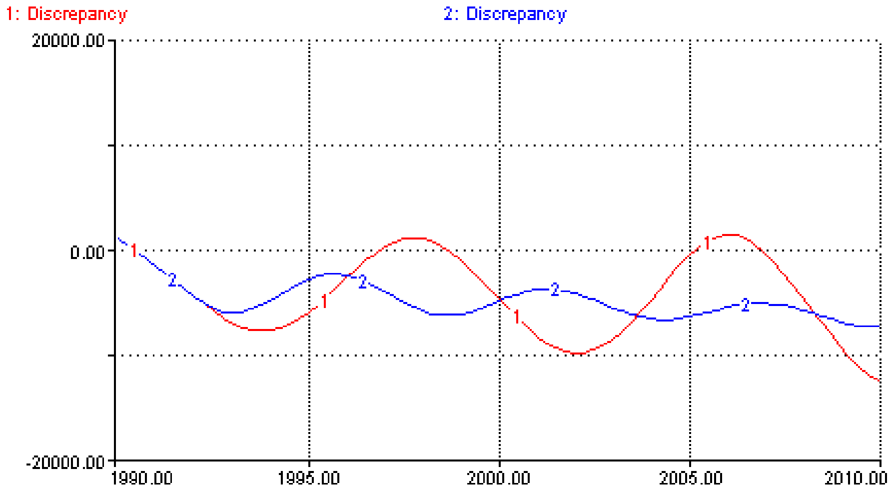


The forecast error, forecast horizon trade-off

In a 1970-1996 sample of Sydney, Australia data, for example, the mean and standard deviation of the office space demand growth (leased space) series were approximately 2% and 3% respectively. The trend in historical demand growth can be used to generate a "trend growth" demand forecast.

Setting the construction time and therefore the forecast horizon at two years, allows us to use construction already commenced as a supply forecast at the two-year horizon. Recall that no matter which forecast horizon we choose, the property industry faces a two year (or perhaps 3 year for large projects) construction lag for major office buildings. The question we are trying to answer with the simulation is whether it is better to build based on the known current discrepancy between supply and demand, or to forecast market conditions at the time when the project is completed. If we rely on current market conditions, we are "wrong" by changes during the construction period but at least we have fairly precise current supply/demand figures. If we rely on forecasts, we will be "wrong" by the amount of forecast error, but at least we are focussing on the relevant time period when the new project will be completed.

Figure 11 System errors (excess vacancy) without (1) and with (2) forecasting



In this case the use of a model structure relying on a naïve trend extrapolation of demand as the basis for construction commencement decisions outperformed a structure using current conditions as the basis for decisions.

Conclusions and Directions for Further Research on Office Market Systems

The model results seem straightforward, pointing chiefly to supply lags as the cause of office market cycles, while amplitude is increased by tendencies to build too much and to bunch project commencements rather than spreading projects over time. The latter is probably a better strategy given uncertainty about future demand shocks. Further application of the model to design and test policies to counteract cycles will require attention to forecast errors and to designing policy rules to take better account of delayed feedbacks. Methods to forecast demand are a key to reducing supply lags.

Further research should be undertaken using system dynamics models to explore likely outcomes of various "circuit breaker" policies in the building permitting process to try to a) prevent shortfalls of office supply through too much delay in commencements, and b) excessive oversupply of space that is costly to investors and the economy. It is likely that such policies should emphasise encouraging earlier commencements of projects to create "just in time" inventory more than "caps" or "queues" to limit oversupply.

One problem in attempting to model office markets is that those making decisions to build are not necessarily always acting rationally and in the best interests of investors. And even "good" decisions to build based on rational criteria, may be transformed into financial debacles by subsequent irrational decisions or recessions (negative demand shocks) which often lead to oversupply. Because the Prisoner's Dilemma problem creates strategic uncertainty about competitive supply, project feasibility decisions cannot be made rationally without coordination with others in the market.

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