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RESEARCH PROGRAM: IMPACT OF THE PUBLIC SECTOR ON LOCAL ECONOMIES

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Abstract

The subdivision development process is reviewed and an assessment made of the factors which affect the rate at which vacant single-family detached lots come onto the market. A one-equation behavioral model of this flow is then formulated and estimated. The empirical results indicate that, in addition to seasonal and structural factors which affect the flow of lots, the rate of interest and the wage component of servicing costs have an inverse effect on this flow, and the selling price of serviced lots a positive effect.

DETERMINANTS OF THE RATE OF SUBDIVISION DEVELOPMENT*

1. Introduction

Inflation in house prices and rents has been an important concern in most North American cities in the last several years, but the role of land supply and lot prices in the dynamics of this process has been given very little attention in the academic literature. The supply of vacant lots in the short run will be entirely predetermined, so that lot values are derived from the demand for housing.[1] Although the quantity of vacant lots will be predetermined in the short run, the number of lots which come onto the market via the subdivision development process will depend in the long run on economic and institutional factors. This flow is important insofar as an increase in the quantity of lots available to builders will inversely affect the prices at which these lots, and the houses built on them, eventually transact. The purpose of this paper is to examine the determinants of the rate at which serviced, subdivided lots for single-family detached units are brought onto the market. The empirical work is necessarily in the nature of a case study, but the intention is to develop a general specification and to generate some ideas which may be useful elsewhere. We first survey the relevant literature.

In a recent study, Markusen and Scheffman [7] develop an abstract, theoretical model of the timing of land development. They construct a two-period, profit-maximizing model which takes the total supply of developable land as fixed and given, and they determine an optimal distribution of development between the two periods given (i) a fixed, inter-period rate of interest, (ii) returns to agriculture, or non-developed, land (which are fixed in each period but different between periods), and (iii) constant costs of development per unit of land (which are identical in the two periods). The model provides qualitative predictions, but there is no attempt at calibration or empirical estimation.

There are only a few studies which examine the process of subdivision development, particularly concerning the supply side, and which provide quantitative estimates of the effects of the independent variables in the process. Until recently, virtually all residential behavioral research of this type has been conducted by the Department of City and Regional Planning at the University of North Carolina. Examples of their work are Kaiser and Weiss [7] and Weiss et al. [10]. They focus on the developer's location decision process, rather than the rate of subdivision development and their studies examine cross-sectional rather than temporal factors. Hence they view "cost considerations [as] secondary to the developer" since these "are not as uncertain to the developer nor do they tend to vary as much from site to site" (Kaiser and Weiss [7], 33-34). They also emphasize the central importance of the developer's land purchase decision, claiming that it "represents the speculative commitment to location that is crucial in the conversion of open land.... When the developer decides to purchase land, he often commits himself...to the much larger investment in residential development" (Weiss et al. [10], 36-37).

A similar, but more technical, approach is taken by Bourne [1] who first identifies and measures aggregate land use changes in 62 zones in Metropolitan Toronto. Results of interviews with developers of high-rise units are then described. The firms were questioned on their methods for allocating financial resources (presumably fixed) among alternative types of investments, and on the specific criteria or factors determining the choice of sites for development. Financing considerations, zoning constraints, land availability, and other factors were found to be more important determinants of location decisions in the short run than the price of developable land. The determinants of individual developer site selection are then related to the various determinants of land use change at an aggregate level.

The interview approach is also taken by Goldberg [5] and Goldberg and Ulinder [6] who surveyed developers in Vancouver, British Columbia to determine factors which influence their behavior, as well as the nature of that behavior. The developers were reportedly most concerned with proper zoning, access to trunk sewers, price of land, and availability of developable land. The authors point out that "'shopping' for land appears to be one of the developers' prime areas of cost minimization, and as such they ascribe a high level of importance to the price of land" (Goldberg and Ulinder [6], 365). Further, they observe that "developers are not engaging in land hoarding, generally holding land sufficient for the normal course of their development activities" (Goldberg and Ulinder [6], 364). Sources of financing were also determined, with banks being the most common source. Carrying charges, consisting of interest on acquisition debt, and property taxes are of increasing significance as government intervention results in "longer and longer lead times in planning projects....In parts of Ontario, up to four years are required from conception to completion of a residential development" (Goldberg [5], 88).

These statements are supported in a 1975 study by Derkowski [4] of land development across Canada. He found that rising servicing standards, levies, and municipal subdivision requirements adding to costs in land development were major determinants of the large increases in serviced land prices. Table 1 reproduces his findings on the cost components of lot prices for Toronto and Ottawa, the two Ontario cities studied, and as such those most likely to have conditions similar to those experienced by developers in our study area (London, Ontario). The "profit" figures are actually a residual component, and thus should not be taken as accurate. It is also notable that

> in selecting a uniform length of time during which the developer was assumed to have held the land in its raw state prior to its subdivision, the relatively short period of two years was chosen in order to provide some measure of isolation of development profit from land ownership profit. (Derkowski [4], 17).

He claims that profit, carrying charges and land costs are "market-variable components" of land prices, whereas developer's overhead, municipal levies, consultants' fees and servicing costs are "cost-fixed components", the greatest inter-urban variation occurring in the market-variable components.

He also describes the pervasiveness of government intervention.

> Throughout the decade under study, Ontario has had a more highly developed and rigorously applied system of development planning controls at both the provincial and municipal levels than any other province. Provincial government exercises close control over all land development via direct control of subdivision approval, through controls of municipal official plans and zoning, [and] by rigorous water pollution control and environment protection policies....The total number of bodies which could be potentially involved in the approval of a subdivision has been estimated in 1972 as 90. (Derkowski [4], 111).

Anyone studying Ontario subdivision development must be careful not to underestimate the time required in the process.

Crawford [2], in describing the tax treatment of transactions

Table 1

Cost Components of Lot Prices (Per Cent)

	Toronto		Ottawa	
Raw land costs		28.65		10.91
Carrying charges		7.38		4.65
Municipal levies		8.41		5.75
Consultants		5.09		5.00
Planners	.44		.26	
Engineers	1.30		3.95	
Surveyors	2.70		.48	
Others	.65		.31	
Servicing Costs		33.70		48.16
Rough grading	2.17		2.10	
Sanitary sewers	3.48		6.32	
Storm sewers	6.52		12.37	
Watermains	3.48		6.05	
Roads and lanes	7.82		11.58	
Sidewalks	2.39		.79	
Electrical	4.35		3.95	
Off-site	.44		3.16	
Landscaping	1.74		1.05	
Miscellaneous	1.30		.79	
Overhead		3.48		3.68
Profit		13.30		21.85
Total		100.00		100.00

Source: Derkowski [4], 78, 110.

involving developers, outlines costs components which parallel those of Derkowski. There are also administrative and general planning expenses, not clearly identified with any particular property.

> Land development companies are constantly engaged in the search for new development opportunities and it is not unusual for a developer to incur significant costs before an acquisition is carried out. Examples of these are the cost of forfeited options to acquire real properties, fees paid for planning studies, architectural drawings for presentation at planning boards, planning fees payable to municipalities, the costs of attempts to obtain rezoning, and perhaps the cost of detailed working drawings. (Crawford [2], 191).

He points out that carrying charges incurred after physical development while seeking government approval are significant relative to other industries because of the size of the investment as well as the length of the business cycle in the industry. He describes servicing costs as including consulting engineers' fees, surveying costs, hydro installation charges, and the cost of installation of water mains, sewers, roads, sidewalks, bridges, and street lighting.

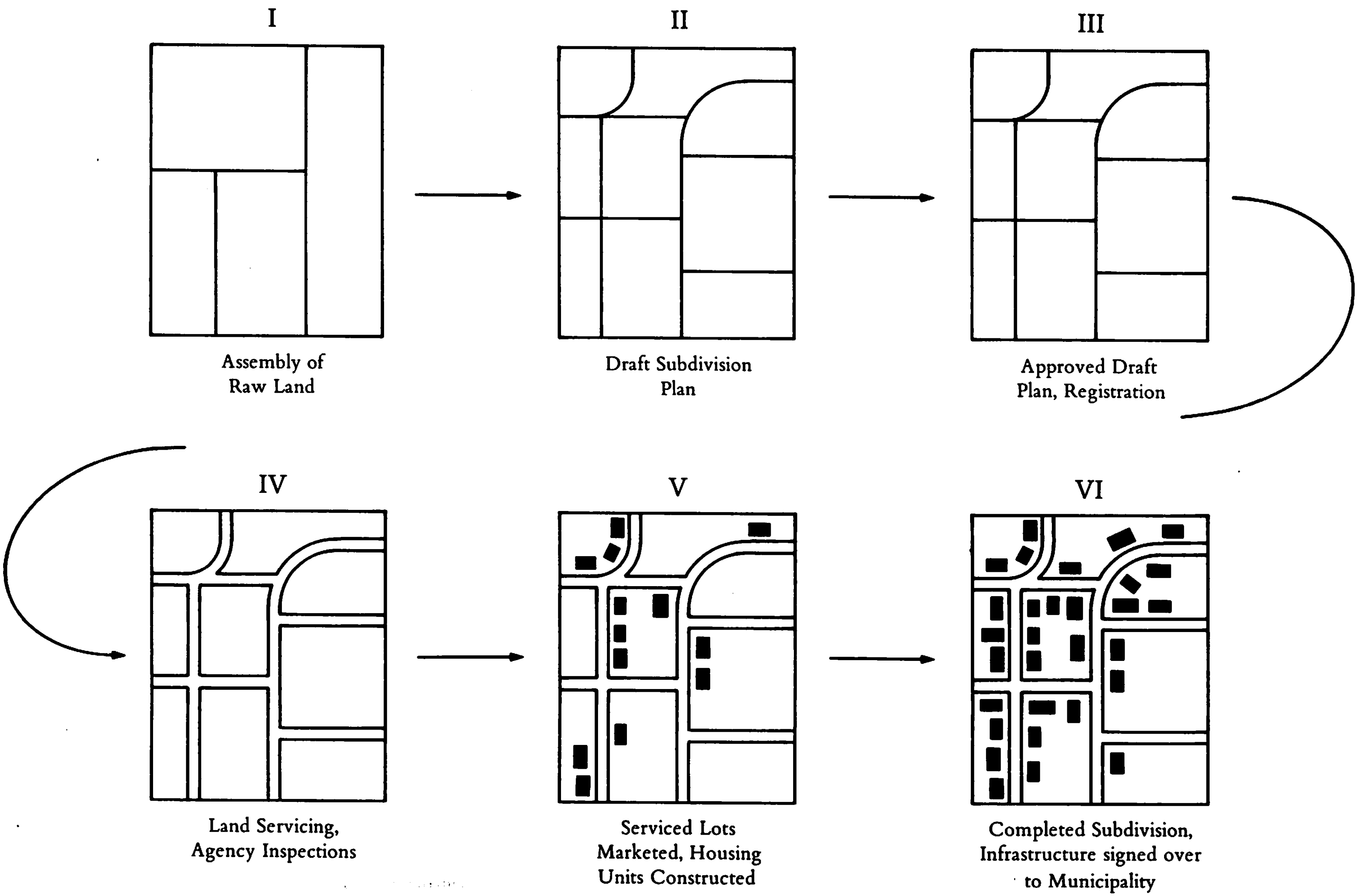
In short, these studies describe the revenues and costs faced by residential developers, but do not attempt to determine the importance of the effect of their variation on the rate of subdivision development. We proceed to develop a general specification for an equation to determine the rate of subdivision approval for urban single-family detached lots.

2. Specification

Specification of an equation describing the rate of approval of single-family detached lots requires further examination of the dynamics of the entire subdivision development and approval process. This process is represented schematically in Figure 1. In Stage I the developer assembles land by acquiring adjacent parcels of "raw" land in an area

Figure 1

Subdivision Development Process



suitable for development. Stage II involves the creation of a draft subdivision plan, i.e., a plan showing lot boundaries, road allowances, grading, services, open space, etc. Between Stages II and III is a lengthy and involved process in which all relevant aspects of the plan are closely scrutinized by a large number of municipal and provincial agencies. Modifications to the plan are often made as a part of this step, which also includes detailed negotiations on the sharing of costs, between the developer and the municipality, imposed by additional infrastructure required because of the development, e.g. increased trunk sewer capacity, widened access roads, etc.

Once the subdivision plan and agreement are approved by the municipality, the plan and agreement are registered, a step which legally creates the lots and other parcels of land in the subdivision. In Stage IV the developer instals, or contracts for the instalment of, the required services. This process also involves detailed on-site inspections by public agencies concerned with the development, predominantly the municipal government. In Stage V the serviced lots are then marketed and the construction of dwelling units begins.[2] Most developers will sell off only a portion of the lots and retain the remainder for construction of his own units. The final Stage in the process occurs when the subdivision is complete, the developer is released from responsibility for the services, and the subdivision is "signed over" to the municipality.

Specification of an equation describing the flow of lots may proceed in a straight forward manner. We postulate simply that the flow of lots depends on the expected profitability from subdivision development. The expected gross return will be related directly to the market price of serviced lots and to some measure of the probability of selling these lots. The costs involved in this process have been identified in section 1. Adapting these costs for empirical purposes allows us to specify the flow of new lots as a function of the determinants of profit in subdivision development or

[1] $NL = n\ (PL, SS/KL, RP, W, MAT, PA)$

in which NL is the number of new lots created in the municipality by subdivision approval, PL is the price at which the vacant, approved, and serviced lots transact, SS/KL is the ratio of housing starts to the total stock of lots, RP is the prime rate of interest, W represents the real wage component of servicing and other development costs, MAT represents the real materials component of servicing costs, and PA is the price of raw or agricultural land deflated by the Consumer Price Index. The variable SS/KL is intended to measure the probability of selling a lot once it is to be marketed. The prime rate is intended to measure carrying costs. Although some developers may not be able to borrow at this rate, the rate at which they may borrow will certainly be related to the prime rate.

Further consideration of the variable PA is required. In an abstract, monocentric city, the boundary of the residential area is determined by the intersection of the residential rent gradient with the rent of land in non-urban use.[3] Non-urban rent is assumed to be exogenous in such a model, and determined implicitly by the marginal value product of the land in agricultural use. This assumption is certainly appropriate for a static model, but in an expanding urban area, the price of any land for which the potential use is residential will be determined by the expected profitability from converting its use from agricultural. The value of land in agricultural use will therefore only act as a lower bound on its potential value in residential use. PA will therefore be a derived demand and will depend on the same factors which determine NL (except for PA itself). Except for the recognition of the role of the other cost factors, the determination of PA has been recognized in the literature. For example, Derkowski states that

> The cost of raw land is in itself determined by total lot price--for the price of raw land sold for development is set on the basis of the anticipated market value of the lots to be produced. Theoretically, a cost floor is set under the price of raw land by its agricultural value; in practice this floor is always exceeded. Thus, the raw land element is itself determined by, rather than a determinant of, the price itself (Derkowski [4], 18).

We therefore have

[2] $PA = p\ (PL, SS/KL, RP, W, MAT).$

Substitution of [2] into [1] gives the equation to be estimated

[3] $NL = \ell\ (PL, SS/KL, RP, W, MAT).$

The next section deals with the lags involved in equation [3] above, discusses seasonal and structural factors affecting NL in our sample period, and analyses the results of various attempts to estimate the equation using monthly data.

3. Estimation

The subdivision development process, to the point of registration of the plan, encompasses Stages I through III inclusive in Figure 1. As mentioned in the introduction, Goldberg [5] gives an upper limit of four years from conception to completion, and Derkowski [4] a lower bound of two years. Thus each independent variable was lagged 24 through 47 months prior to sale of the serviced lot.

A log-linear equation was estimated for the sample period, which was March 1966 to December 1974 inclusive. Because serial correlation was indicated, the Cochrane-Orcutt iterative technique was used to transform the variables. The coefficients of the lagged values for each independent variable were constrained to satisfy a linear relationship with a zero coefficient in the 48th month preceding lot sale, i.e., we estimated

$$\log (NL + 1) = \alpha_0 + \alpha_1 LPL + \alpha_2 LSS/KL + \alpha_3 LRP + \alpha_4 LW + \alpha_5 LMAT$$

where, for each independent variable X,

$$LX = \sum_{t=0}^{23} \left(\frac{24-t}{256} \right) \log (X_{-24-t}).$$

The dependent variable is log(NL + 1) rather than log (NL) to avoid taking the logarithm of zero. Hence the α's cannot be interpreted as elasticity estimates.[4]

For the wage variable, WEW, average weekly earnings of engineers for highways, bridges, and streets was employed in order to capture the effects of changes in consultants' fees. Average weekly earnings of construction workers, WCW, was also used as a proxy for the labour component of servicing costs. Both were deflated by the Consumer Price Index, as was PL.

We experimented with two materials indices, using two different price indices for concrete. By definition,

$$MAT1 = 0.624 \cdot SPR + 0.320 \cdot ASP + 0.056 \cdot COR$$

and

$$MAT2 = 0.624 \cdot SPR + 0.320 \cdot ASP + 0.056 \cdot RMC,$$

where SPR, ASP and RMC are industry selling price indices for reinforced sewer pipe, asphalt and ready-mix concrete, respectively, and COR a price index for concrete used in residential construction. All were deflated by the Consumer Price Index. The weights were based on expenditure figures in Toronto and Ottawa given by Derkowski [4]. Assuming that these components capture the materials costs of sewers, watermains, roads, lanes and sidewalks, 74 per cent of total non-labour servicing costs have been accounted for by these indices. This construction of the indices implicitly assumes that the capital-labour ratios of the processes are similar.

NL appears to be affected by seasonal and structural factors as well. Because the colder winter months inhibit housing starts, and hence lot sales, a developer may time the subdivision registration to occur in other months. We define a seasonal binary variable as follows:

$$A = \begin{cases} 1 \text{ in November through March inclusive} \\ 0 \text{ otherwise.} \end{cases}$$

Further, there appear to have been structural changes in the housing and land markets in the study area in January 1969, presumably in anticipation of the city's Official Plan and the subsequent more restrictive land use policies.

> One important component of the Official Plan involved the introduction of staging, whereby large blocks of land were to be held off the market to control the city's growth. Although the Official Plan was not introduced until 1971, the staging and other policies were known and vigorously discussed well in advance of their introduction. (Davies [3], 397).

The evidence is that the Official Plan increased some of the costs of development and building, but increased activity in these areas because it reduced risk and uncertainty. Risk and uncertainty may have been reduced because the Plan specified precisely which areas could be developed for different uses, and the times at which the development might occur. The costs of development and building increased as a result of the Plan because of more stringent servicing requirements and tighter building controls. We therefore experimented with a binary variable, D, equal to zero before January 1969, and to unity otherwise.

The equation now reads

$$\log (NL + 1) = \alpha_0 + \alpha_1 LPL + \alpha_2 LSS/KL + \alpha_3 LRP + \alpha_4 LW + \alpha_5 LMAT + \alpha_6 A + \alpha_7 D$$

where the α's are to be estimated. The hypotheses are that α_1, α_2, α_7 > 0 and that α_3, α_4, α_5, $\alpha_6 < 0$.

Our empirical results, summarized in Table 2, are promising, but hardly conclusive. T-statistics are given in parentheses below the coefficients. Because of the extreme "lumpiness" of the NL series,[5] relatively low R^2 values were anticipated. However, the F-statistic, which tests the hypothesis that all coefficients except the constant are jointly zero, is such that the null hypothesis is accepted at approximately a 90 per cent confidence level for equations 1 through 6.

In the first six equations, all variables have coefficients with the expected signs, at least at the 75 per cent confidence level, with the exception of the materials indices, the stock variable, and, in equation 1, serviced land prices. The estimated coefficients of the seasonal dummy, engineers' wages, the prime rate of interest, and serviced land prices are generally satisfactory. There is little difference

Table 2

Estimated Equations

Eqn. No.	Independent Variables										R^2	ρ	F	
	C	A	D	LWEW	LWCW	LRP	LSS/KL	LPL	LMAT1	LMAT2			DF	=
1	- 2.933	-1.612				- 1.612		0.9086			0.15	-0.194	3,54	3.20
	(-0.15)	(-2.95)				(-0.71)		(0.46)				(-1.51)		
2	-18.09	-1.649		-20.13		-10.72		16.20			0.18	-0.208	4,53	2.95
	(-0.84)	(-3.07)		(-1.42)		(-1.58)		(1.48)				(-1.62)		
3	- 7.132	-1.654		-20.61		-11.15		16.62	-2.116		0.18	-0.208	5,52	2.31
	(-0.03)	(-2.98)		(-1.14)		(-0.95)		(1.14)	(-0.04)			(-1.62)		
4	- 1.404	-1.657		-20.88		-11.37		16.85		-3.218	0.18	-0.208	5,52	2.31
	(-0.01)	(-2.98)		(-1.15)		(-0.96)		(1.15)		(-0.07)		(-1.62)		
5	-20.55	-1.654		-23.35		-11.52	0.4851	18.70			0.18	-0.209	5,52	2.33
	(-0.87)	(-3.05)		(-1.24)		(-1.54)	(0.26)	(1.28)				(-1.62)		
6	19.82	-1.756	2.284	-32.83		-18.38		21.40			0.23	-0.259	5,52	3.18
	(0.70)	(-3.43)	(1.93)	(-2.20)		(-2.43)		(2.01)				(-2.04)		
7	-287.6	-1.549		-22.96	-0.7197	-4.449	2.221	17.97	49.30		0.19	-0.211	7,50	1.63
	(-0.47)	(-2.57)		(-0.72)	(0.02)	(-0.22)	(0.48)	(1.03)	(0.43)			(-1.64)		

between the estimates using alternative materials indices.

Equation 7 is indicative of attempts at complete specification, and typical in that only the seasonal dummy, engineers' wages, and serviced lot prices enter significantly. The F-statistic is not significant in this equation. In the cases of complete specification, it is quite possible that the inclusion of too many independent variables has biased both t- and F-statistics downwards.

Finally, it is worth noting that, if the model is to be used predictively, the R^2 statistic is biased downward, although by at most only 10 per cent. Actual values of the dependent variable are bounded below by zero, whereas estimated values are in some cases negative, so that residuals are in these case overestimated. Thus the accuracy of prediction should be somewhat better than that of estimation.

4. Summary

These results must be taken only as a preliminary attempt to assess empirically the factors which affect the rate of subdivision development. The costs and returns of the process have not been difficult to identify but the estimation is hampered by the fact that the available data do not perfectly measure these variables. Also, the lags involved in the process are very long (presumably they are also quite variable over a long time span) and changes in institutional constraints, only some of which we were able to account for, may reduce the explanatory power of a behavioral economic model. Finally, the use of monthly data facilitates identifying seasonal factors, but carries with it the disadvantage that the series describing the flow of lots is quite "lumpy": approvals of lots in many months of a given year are zero, and very large in the months in which they are positive. Further research into the subdivision development process might usefully attempt to deal with some of these difficulties.

APPENDIX I

Sources of Data

ASP: industry selling price index for asphalt in Canada

This variable was taken from CANSIM (Matrix No. 671.18.365.1.10)

COR: price index for concrete in residential construction in Canada

The source is CANSIM (Matrix No. 185.1.1). The series was deflated by 130.4, its 1971 annual level, so that the base year would be 1971, rather than 1961.

KL: number of vacant lots zoned and approved for the construction of single-family detached units

This series was calculated using the equation

$$KL_t = KL_{t-1} - SS_{t-1} + NL_{t-1},$$

given the value of the stock for February 1974 (from the City Planning Department) and the monthly series on NL and SS.

MAT1, MAT2: price indices for materials used in lot servicing

These indices were constructed using the equations cited in the paper. The weights used were based on Derkowski's [4] figures for Toronto and Ottawa, calculated from dollar expenditures. The individual component indices were deflated by the consumer price index.

NL: number of new single-family detached lots created by subdivision approval

To obtain this series, the approved use for each plot of land in each subdivision registered over the period was determined by referring to the actual subdivision plan and agreement and, when there was some doubt, by referring to city land use maps which show the type of dwelling constructed on each parcel of land in the city. In cases where registered plans modified parts of earlier plans, the lots affected were considered part of the newer plan and were excluded from the count of lots in the previous plan.

PL: median sale price of vacant lots zoned and approved for the construction of single-family detached units

One possible source for the price of lots is title searches of registered deeds. A more convenient source for this study was Teela Digest (1965-1973), a monthly publication giving information on real estate transactions in the city. The median rather than the mean value was used in order to avoid the effects of unusually large or small observations in any month.

RMC: industry selling price index for ready-mix concrete in Canada

The source is CANSIM (Matrix No. 670.17.355.17)

RP: prime rate of interest

The prime rate for the area was assumed to be the same as the national prime rate, the source for which is CANSIM (Matrix No. 2560.2)

SPR: industry selling price index for reinforced sewer pipe in Canada

This index was taken from CANSIM (Matrix No. 670.17.354.1.12)

SS: starts of single-family detached housing units

A monthly series was obtained in unpublished form for the years 1963-

1974 from Housing and Building Permits Section, Construction Division, Statistics Canada.

WCW: average weekly earnings in construction in London

The source is CANSIM (Matrix No. 1673.1.4)

WEW: average weekly earnings of engineers for highways, bridges and streets in Canada

The source is CANSIM (Matrix No. 1468.1.4.2.1)

FOOTNOTES

*This research was funded by a grant from the Canada Council. The authors also wish to thank Wayne Whitney for providing some of the data.

[1] See Davies [3] for an estimated equation determining lot prices as a derived demand, given a predetermined supply of lots.

[2] Technically, sales of lots may occur as soon as the plan and agreement are registered, but before the services are fully installed, because the agreement will state that the services are to be provided within a specified, minimum time period. The distribution of lot sales in our sample area, relative to the date of registration of the plan, indicates that most lots are sold from one-half to 2 years from the date of registration, with the peak in the distribution occurring between one and 2 years from registration.

[3] See, for example, Mills [9], 81.

[4] The coefficients are divided by 256 so that in the steady state, when $X_{-24} = X_{-25} = \ldots = X_{-47}$, $LX = \log X_{-24}$.

[5] NL has a mean of 79 and standard deviation of 153.

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02 G.P. Schaefer, "The Urban Area Production Function and the Urban Hierarchy: The Case of Saskatchewan" (October 1975).

** 03 C.L. Poon, "A Cost-Benefit Study of Urban Railway Relocation" (November 1976).

* 04 M.W. Frankena, "Urban Transportation Economics and Canadian Public Policy" (February 1977). [85 pp. - $4.25]

05 T.J. Courchene and H.R. Sims, "Migration and Income Patterns: Quebec, 1966-69" (August 1977).

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