Modeling Location Choices of Housing Builders in the Greater Toronto, Canada, Area

Murtaza Haider and Eric J. Miller

An analysis of the spatial choice of housing builders in the greater Toronto area (GTA), Canada, is presented. A spatially disaggregate database of 126,462 new housing units built by 445 builders is used to analyze the determinants of the intrametropolitan location of new housing. Housing starts are classified into four types: single-family detached (SFD), semidetached, condominiums, and row–link housing. An accessibility analysis shows that the GTA remains a monocentric region where accessibility for most activities declines with distance from the central business district. The location choice of homebuilders differs by housing type. For instance, the construction of new condominiums is more likely to be in high-density areas with high accessibility to jobs. Similarly, the likelihood of construction of low-rise (SFD or semidetached) housing is higher in low-density areas with low accessibility to work and other activities. Neighborhood attributes help determine the type of housing likely to be built in the vicinity. Also, the location of low-rise residential units and planned residential construction is influenced by proximity to major transport corridors in the GTA. The location of condominiums is influenced by proximity to the subway system. Builders are attracted to zones with higher dwelling values, where they can obtain higher values for their products. Spatial inertia in housing markets is presented, which implies that the presence of a certain type of housing attracts more housing of that type to the vicinity.

Transportation planners and engineers are interested in the impact of residential construction on urban form. The location of new housing influences travel behavior, particularly trip length, and the choice of travel mode. Construction in the city core tends to create high-density neighborhoods that are easily served by public transit. Low-density construction at the urban fringe creates automobile-dependent communities that cannot be served efficiently by public transit.

The greater Toronto area (GTA) enjoys a pivotal position in Canada, given the strong concentration of housing activity in the region. The largest housing market in Canada, the GTA represents 55% of new home sales in the province of Ontario and 25% of new home sales nationwide. The residential construction industry in the GTA is a $12 billion enterprise that supports 250,000 jobs (O'Hanlon, P. What Did We Do before Smart Growth? We Built Smarter. Toronto. 2001.).

A spatially disaggregate database, compiled from many sources, is used to estimate spatial models of builders' location choice. This paper presents an analysis of new housing in the GTA constructed from January 1997 to April 2001. The study includes rental and nonrental housing starts in the GTA, comprised of the Toronto and Oshawa Census Metropolitan Areas (CMAs) as well as the municipality of Burlington, which falls under the Hamilton CMA.

M. Haider, School of Urban Planning and Department of Civil Engineering, McGill University, 815 Sherbrooke St. West, Suite 400, Montreal, Quebec H3A 2K6. E. J. Miller, Department of Civil Engineering, University of Toronto, 35 St. George Street, Toronto, Ontario, Canada M5S 1A4.

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LITERATURE REVIEW

Research in housing supply is scarce (*1*). Even scarcer is research that uses spatially and temporally disaggregate data to study new housing construction. Aggregate data (e.g., data collected at the state level) on housing supply has helped explain the linkages between macroeconomic indicators and housing supply. However, such data are not sufficient to explain the intrametropolitan location dynamics of new housing construction. The basic question of when and where the producers of housing space (builders) provide new housing cannot be answered with aggregate data collected at the state or province level. To answer such questions, construction data at the street or neighborhood level are required.

More often than not, research in housing supply relies on nonspatial data based on quarterly or annually reported housing starts regressed on macroeconomic indicators and average demographic attributes. Thus, research in housing supply has explored the effects of land use restrictions (*2*), jobs growth in the suburban fringe (*3*), "credit crunches (*4*)," and infrastructure availability (*5*) on new housing construction. In the long run, an increase in demand for housing does not increase real house prices (*6, 7*). Short-term changes in housing supply and demand deserve more attention because these changes play an important role in builders' decision making. For example, an excess supply of single-family detached (SFD) housing was found to exert downward pressure on rental income for multiunit residential property (*8*). Weber and Devaney (*8*) also discovered that in the short term, new housing construction might also increase the value of neighboring houses above their "equilibrium" prices.

Housing Starts

It has been argued in the housing literature that housing starts should be modeled as a function of change in prices rather than the price levels (*9*). Mayer and Somerville (*9*) also argue that change in construction costs, rather than the level of construction costs, should be used to estimate housing starts. In addition, they are of the view that housing supply analysis should account for the factor market of land, which is often excluded from the traditional econometric models of housing starts.

The growth in housing stock renders developable land even scarcer and more expensive and thus increases the price of new dwelling units. Increase in the price of new dwellings encourages more construction. It has been argued that real estate markets take several years to clear (*10*). Given the resultant disequilibrium, DiPasquale and Wheaton (*10*) suggest that housing price is not a sufficient statistic and that vacancy rates, mortgage rates, and other macroeconomic factors should be included in the model. In equilibrium conditions, they believe, these factors are captured by price, which then becomes a sufficient statistic. DiPasquale and Wheaton also contend that new housing prices are better predictors of housing starts than are prices for the resale market. In addition, housing starts are cost elastic, which suggests that higher construction costs reduce residential construction (*11*).

Development taxes result in low densities, though development delays do not always affect densities (*12*). Ontario survey data, collected by Skaburskis and Tomalty (*12*), show that most builders in Toronto base their decisions about building type and lot size partly on development taxes, and they cite such taxes as their motive to build low-density residential projects in the suburbs. Builders have also argued that revenues from residential development depended mainly on lot frontage, larger lot frontages with resulting in areas with high development taxes. The marginal increases in revenue from a greater number of developable lots are outstripped by development taxes (*12*).

The role of land availability is crucial to housing starts. The rate of capitalization of fiscal variables and amenities is higher in cities or towns where developable land is scarce (Hilber, C. A., and C. J. Mayer. Land Supply and Capitalization, 1991.). Denser cities report higher capitalization of fiscal variables than do less-dense cities. Also, the coefficient for change in housing values is significantly higher for developed locations (i.e., cities with less developable land) than is the coefficient for undeveloped cities. Econometric studies have shown that the price elasticity of residential land often lies between 0 and −1 (Gyourko, J., and R. Voith. The Price Elasticity of the Demand for Residential Land, 2000.).

Integrated Transportation Land Use Models

The other stream of research in housing supply pursues integrated land use transportation models (integrated models, for short) such as MUSSA and UrbanSim, which account for new housing construction at a spatially disaggregate level, thus accounting for its intrametropolitan distribution. Comprehensive reviews of integrated models in the literature are available (*13–16*); here, only those features of UrbanSim and MUSSA that deal with housing supply are discussed.

Generally, modules for housing supply are often part of integrated models. A variety of modeling techniques have been applied in operational integrated models. Rule-based models provide new housing in response to the demand for residential space, subject to capacity constraints regarding land availability and zoning bylaws. Yet these models are not behavioral, and therefore real-life builders are not explicitly modeled in rule-based (deterministic) models. The other major category of integrated models applies discrete choice methods to model the spatial choices of agents, such as MUSSA and UrbanSim. Some integrated models, such as UrbanSim, use microsimulation in combination with discrete choice frameworks. UrbanSim assumes that households demand residential space and developers or builders supply space in response to the demand (*16*). Household behavior in UrbanSim is microsimulated using a synthetic sample drawn from a population of households. This simulates urban development as a "dynamic process over time and space as opposed to [a] cross-sectional or equilibrium approach" (Waddell, P. The Oregon Prototype Metropolitan Land Use Model. 1998, p. 3). MUSSA advances the bid–rent theory to a bid–choice theory in which agents choose the alternatives (e.g., location) that maximize their consumer surplus (*17*).

MUSSA and UrbanSim treat builders as profit maximizers. Building stock prices are endogenously determined for each zone. The land market is modeled as the interaction between demand for space by businesses and households, and the supply of land. Demand and supply components are modeled with the use of random utility theory. The developer's model converts vacant or already built land into structures through which a stream of housing services is generated. The ratio of demand to supply for each type of structure in each zone results in proportional price adjustments for each type of structure (Waddell, P. The Oregon Prototype Metropolitan Land Use Model, 1998.).

METHODOLOGY

In operational integrated models, the developer's behavior is not based on a sample of real builders or developers. A class of agents, defined as builders, responds to demand for residential space by constructing new housing. This treatment of supply preempts operational integrated models from exploring the behavior of builders, who consider factors beyond price signals to determine what and where to build.

Builders often focus on neighborhoods and municipalities in which they have built before, a phenomenon that is called "state dependency" in the discrete choice parlance. Earlier dealings with municipal authorities ease the project approval process for builders. Similarly, builders tend to specialize in housing types, for example, low-rise or high-rise. Land holdings often restrict the focus of builders to areas where they already own land, purchased speculatively with the intent to develop later. These behaviors are not accounted for in operational integrated models.

Furthermore, integrated models divide real estate markets into discrete zones. Often the choice of spatial scale is driven by the availability of data. UrbanSim imposes a 150-m grid on the urban space; MEPLAN, another integrated model, uses a similar grid system. This ad hoc spatial classification has serious implications for plottage and plattage; real builders do not evaluate parcels on a 150-m square grid. It can be argued that builders' behavior can best be modeled on a spatial scale at which builders operate instead of on an ad hoc grid-based system.

The new breed of integrated models relies on agent-based microsimulation, which is appropriate in cases where many agents are active in the market. It is argued that there are not enough active agents (builders) in a metropolitan housing market to generate a representative synthetic database. This renders the simulation process incapable of truly reproducing the behavior of participating agents. A few builders engaging in heterogeneous behavior could affect the validity of microsimulation models. For instance, once builders are classified by their size and the type of housing that they build, there will not be enough observations in each cell to offer reliable parameters from probability distributions.

In the traditional land use–transportation modeling framework, the causal relationship between land use and travel demand is well established. However, feedback from travel demand models into land use models is still in the experimental stage. Accessibility indices have been introduced into builders' utility functions to provide feedback from travel demand models into spatial choice frameworks.

The spatial choice set is based on the Transportation Tomorrow Survey (TTS) zone system. It is argued that builders evaluate locations based on neighborhoods and not parcels or grids. The TTS zone system approximates the neighborhood structure in the GTA and conforms to topological details such as ravines and freeways. Certain zones, such as those in close proximity to Pearson International Airport, are not valid locations for new housing and are therefore excluded from the choice set. A random sample of alternatives is drawn from the feasible choice set. This is consistent with earlier research that has proposed using a random sample to reduce alternatives in the choice set (*18*).

This paper does not restrict supply of new housing to the urban fringe. The explanatory data analysis shows that new housing construction in the GTA is not confined to the boundary of the built area and reveals unique locational patterns that vary by type of housing.

DATA ASSEMBLY

Data for spatial modeling of housing starts were obtained from Real-Net Canada Inc., which records and maintains data on housing starts and sales for construction projects involving more than 10 units. The data include details on the location of newly built residential projects with some attributes of builders, type of housing, units built, average lot size, and the like.

Land inventory data were obtained from the Ministry of Municipal Affairs and Housing in Ontario. Land inventory databases account for housing units that are in the pipeline, that is, going through various stages of planning approval.

Spatially disaggregate data on demographic attributes were derived from Statistics Canada's 1996 census geographical files. Similarly, travel behavior data were extracted from the 1996 TTS. The 1996 Traffic Analysis Zone (TAZ) system, devised by TTS, has been used as the basis for spatial analysis in this research. All spatial data were either aggregated or disaggregated to the 1996 TAZ level.

Accessibility profiles for each TAZ were created for activities such as work, school, green spaces and leisure centers, and retail. Activity profiles were based on gravity type measures for which the attractiveness of performing an activity in a different zone was discounted by the average travel time to that zone. Zone-to-zone travel times were derived from running an assignment module in the GTA model in EMME/2, which was maintained at the Joint Program in Transportation at the University of Toronto. The travel times were estimated for the automobile mode for the morning peak period only. Land use data were provided by DMTI Spatial, Inc. Spatially disaggregate data on retail enterprises were supplied by the Centre for the Study of Commercial Activity at Ryerson University. Similarly, accessibility to transportation infrastructure such as subways and highways from each zone was estimated by using GIS. In addition, distance from the central business district (CBD) to the centroid of the TAZ was also calculated by using GIS.

Developers' profit maximization function depends on some estimate of revenue from the sale of units. The underlying hypothesis is that builders will locate projects in zones where they can generate the maximum profit from the sale of new homes. Such disaggregate data by housing type, however, were not available, and thus resale values were used as a proxy for new home values. To control for various structural attributes, neighborhood characteristics, and accessibility premiums, hedonic models of housing values disaggregated by housing type were developed.

Accessibility is difficult to define and measure. Unlike population levels, which can be measured directly, accessibility remains rather abstract and cannot be quantified with simple solutions (such as a binary variable to account for proximity to a subway station). Also, measures of accessibility are often correlated with each other and therefore may not be used simultaneously in the models. For example, zones with high accessibility to retail might also have high accessibility to work; the two variables can thus introduce multicollinearity in the model.

Factor analysis addresses the above-mentioned concerns. It creates proxies for an abstract phenomenon, originally quantified indirectly by many variables, by collapsing those variables into one or more factors. These factors act as a proxy for the underlying phenomenon. Another advantage is that the estimated factors are orthogonal to each other and therefore do not pose risk of multicollinearity. With the use of factor analysis, accessibility variables and indices were collapsed into seven factors.

DESCRIPTIVE ANALYSIS

Background

The housing starts market in the GTA has followed boom-and-bust cycles. Starts declined significantly during the last recession in the early 1990s. In the past few years, macroeconomic indicators have slowed down—yet housing starts have soared since 1995, perhaps because of low interest rates and stable new housing prices.

Condominiums or multiples dominate the new housing market in the high-density city of Toronto, whereas single-family housing dominates the market in low-density outer suburban regions. The new housing market consisted mainly of nonrental housing, with the exception of a brief period in the early 1990s when state-sponsored rental units were constructed en masse. There has been a slight recovery in rental starts witnessed only in 2001.

The database includes 445 builders constructing 1,384 unique housing projects containing 126,462 units from January 1997 to April 2001. About 116 builders undertook high-rise construction and 329 builders built single-family units. Each record in the data set contains information on an individual real estate project with details on housing type, sale price expectations, and name of the builder.

New housing construction is mainly concentrated in the central municipalities (Table 1). The old city of Toronto reports fewer projects (153) than other municipalities, but its total units supplied is the highest (20,171) because of the dominance of apartments in that market. Outer suburbs such as Mississauga, Vaughan, and Brampton also record a significant share of new housing construction.

Large builders dominate the real estate market in the GTA: 22 large builders were responsible for almost 400 housing projects containing 50,000 new units (Table 2). Not all builders were active during every year of the study period. For example, 94 builders reported new construction in 1997, whereas 189 builders started new housing projects in 2000. SFD housing is the dominant housing type with 39% of the market share followed by condominiums at 31% (Table 3). Detached projects, averaging 90 units per project, trail behind condominium projects, with 166 units for each project.

TABLE 1 Starts by Municipality in GTA

Municipality	Units	Projects	Units/Project
Toronto (Old City)	20171	153	132
Mississauga	16458	192	86
Vaughan	13785	155	89
Brampton	13276	121	110
North York	11351	67	169
Richmond Hill	8234	100	82
Markham	8051	103	78
Scarborough	4506	53	85
Oakville	4456	62	72
Whitby	4296	62	69
Burlington	3267	46	71
Etobicoke	3220	31	104
Milton	2499	20	125
Ajax	1900	20	95
Caledon	1863	27	69
Oshawa	1593	25	64
Clarington	1554	29	54
Halton Hills	1508	21	72
Aurora	1083	21	52
Newmarket	1056	21	50
Pickering	879	24	37
Georgina	675	15	45
Scugog	370	7	53
Uxbridge	213	6	36
King	131	2	66
Whitchurch-Stouffville	67	1	67
	126,462	**1,384**	91

Spatial Trends in New Housing Construction

Most housing starts during the study period are found in the old city of Toronto, Mississauga, Brampton, North York, and Vaughan (Figure 1)—northwest and southwest of the Toronto CBD. Whitby presents a unique example of leapfrogging: builders have bypassed Pickering and Ajax to build further away from the city center.

TABLE 2 List of Large Homebuilders in GTA

22 Large Developers	Units	Projects
Mattamy Homes	6945	34
Tridel	6126	27
Greenpark Homes	5815	51
Monarch	2673	18
Aspen Ridge Homes	2509	20
Great Gulf Homes	2410	20
Menkes	2379	18
Conservatory Group	2240	20
H & R Dev.	2073	17
Sundial Homes	1778	21
Pemberton Group	1743	10
Arista Homes	1616	12
Intracorp	1525	17
Fieldgate Homes	1402	14
Daniels Corporation	1344	17
National Homes	1292	14
Townwood Homes	1121	10
Touchstone Homes	1117	13
Regal Crest Homes	998	12
Baycliffe Homes	954	12
Ballantry Homes	884	11
Wycliffe Homes	436	9
	49,380	**397**

Condominiums are concentrated along the Yonge Street corridor because of its central location and accessible subway service. Apartment units have been constructed mainly in the central city, where land acquisition costs are high. Semidetached projects are mainly found in the outer suburbs, concentrated in Mississauga and Brampton along major transportation routes. Link-row housing is located in inner and outer suburbs. Residential projects are concentrated along east–west corridors (especially Highway 401) in the GTA. In Whitby, Brampton, Mississauga, Markham, and Vaughan, residential projects have also concentrated along highways and major arterial intersections.

The spatial choice of a builder is influenced by the cost of land. Land rents are considerably higher in the city of Toronto when compared with rents in the outer suburbs. High-rise construction requires less land per unit developed. This should explain, to an extent, builders' decisions to build condominiums in the city of Toronto and low-rise units in the suburbs, where land prices are low.

The predominant trend in the GTA is to build new housing on smaller lots. This trend is an outcome of the goods and services tax (introduced in 1991), which increased new housing values. Traditional suburban development accommodated three to four residential units per acre; the new trend for smaller lots has resulted in 7 to 11 UPA. Most low-rise construction in the GTA is being carried on lots with street frontage of 40 feet or less, and promotes higher average residential densities.

A spatial analysis of the residential land inventory in the GTA was undertaken to explain future residential development patterns.

TABLE 3 Breakdown of New Housing Construction by Type of Housing

Type	Units	Projects	Percent (%)	Units per Project
Townhouse	18703	312	14.80	60
Single-family detached	49130	546	38.80	90
Semi detached	16797	241	13.30	70
Link	2384	48	1.90	50
Condominium	39448	237	31.20	166
Total	126,462	1,384		91

Land inventory data show the intentions of future construction and spatial choice preferences of builders. Most development applications are for residential projects in the outer suburbs (Figure 2). Development applications to the north of the city are along major arterials or highways. The analysis of residential inventory by housing type shows that developable land for low-rise projects in the pipeline is found in low-density outer suburbs. Applications for most new high-rise residential developments have been made in the central city.

Although accessibility premiums influence the utility of households, it is argued that builders cannot afford to be oblivious to the accessibility of possible development sites. It is further argued that the proposed location of a new residential project, in a developer's decision making, must meet a certain implicit threshold of accessibility. Recent starts and future planned construction projects have evolved along major transportation corridors, which serve as a proxy for accessibility. With the interzonal travel times estimated from the EMME/2 assignment algorithms, gravity-type indices are estimated for accessibility to work, school, shopping, and nature (parks and other green space). The accessibility surface for work shows that zones in the CBD enjoy the highest accessibility to work (Figure 3). Accessibility to nature is higher for zones in the outer suburbs and the lowest for zones in the central areas. The spatial distribution of accessibility to shopping and school is similar to that of work.

MODELING RESULTS

The data set consists of 150 variables and 1,384 observations. Each decision maker's choice set includes nine randomly simulated alternatives from the reduced choice set of 706 zones and the chosen alternative, which is the zone where housing was built. Explanatory variables are attributes of choice (zones). The characteristics of the individual decision maker have not been used as regressors because of data constraints. Discrete choice models, also known as McFadden's logit, have been used to estimate the utility functions. A detailed descriptive analysis of the entire database is presented in Haider (*19*).

The SFD housing model in Table 4 shows a reasonable model fit with $\rho^2 = 0.202$ where ρ^2 is a measure of goodness-of-fit and is expressed as

$$\rho^2 = 1 - \frac{L(\hat{\beta})}{L(0)}$$

where $L(\hat{\beta})$ is the maximized value of the log-likelihood and $L(0)$ is the log-likelihood value evaluated with only sample shares in the model.

Variables in the model meet a priori expectations. However, the coefficient for percentage of open space in a zone is statistically insignificant. This result might be due to multicollinearity. It was earlier hypothesized that the likelihood of SFD construction increased with the increase in open (buildable) space in a zone. The model suggests that housing units in the approval process in a zone increase the likelihood of SFD housing development in that zone. However, variables showing physical development in the zone (e.g., intersection density, length of roads) have returned negative coefficients, suggesting that SFD housing is less likely to be built in built-up areas. The likelihood of SFD housing construction increases for zones with a high inventory of SFD housing units. Furthermore, zones with high accessibility to green space are more likely to be chosen for new detached projects.

The percentage of housing stock of some type will attract more housing of that type in a zone. This phenomenon is called spatial inertia. In SFD housing models, the percentage of freehold proper-

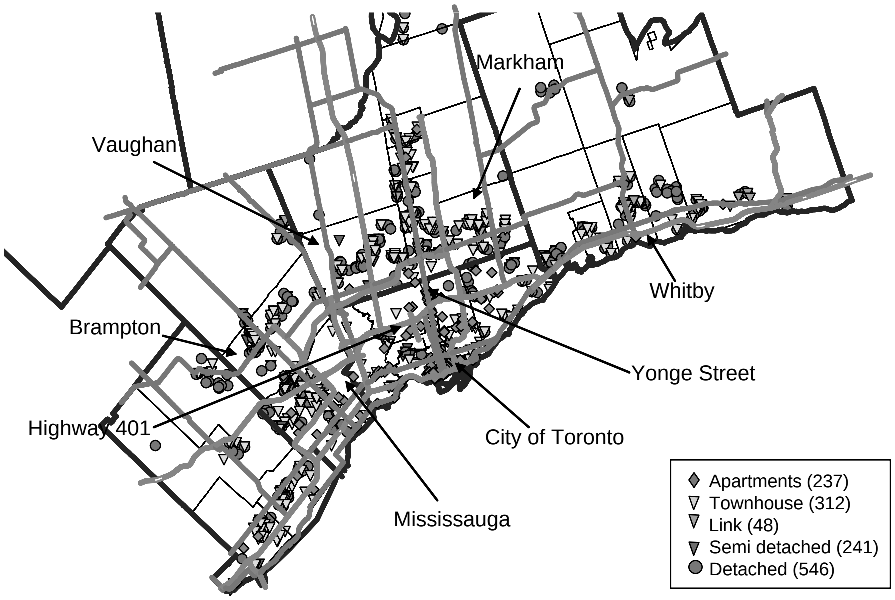

FIGURE 1 Location of all starts in GTA and transportation network.

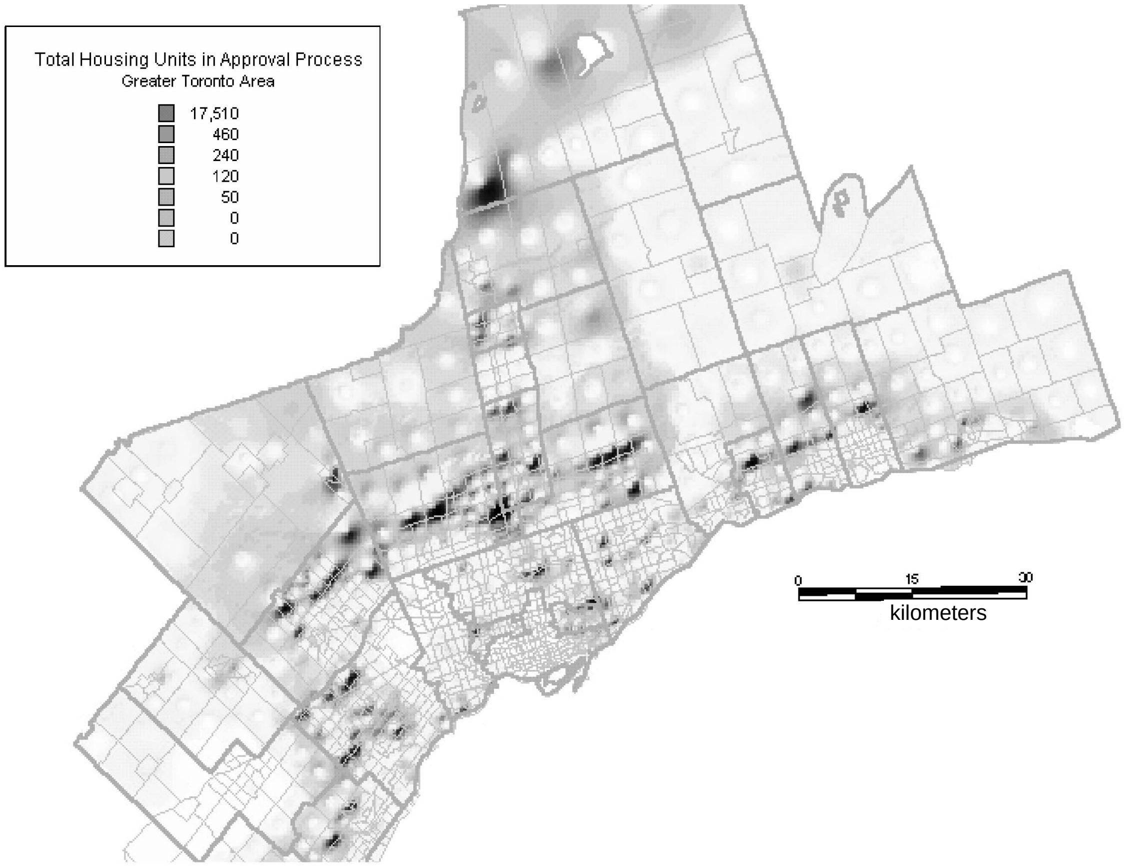

FIGURE 2 Spatial distribution of land inventory in GTA.

ties in a zone has returned a statistically significant coefficient, suggesting that zones with a high percentage of SFD housing will attract more housing of the same structural type.

Variables indicative of zones with low auto ownership, which is a result of urban form and transit availability, return significant negative coefficients, suggesting that SFD housing is less likely to be built in such zones. Again, zones with low auto ownership in the GTA are central areas with high land values and are thus not conducive for low-rise construction. Similarly, zones with high accessibility to schools are also likely to attract detached real estate development. Finally, higher retail density in a zone, which is indicative of high-density neighborhoods, does not attract new SFD housing.

FIGURE 3 Spatial distribution of employment accessibility index (3D rendering).

In other models for detached housing (not reported in this paper because of space restrictions), the propensity to locate SFD housing in a zone increases with distance from the CBD and with higher detached housing values. This implies that the likelihood of new SFD housing construction is high for suburban zones with high property values. Zones in proximity to subway lines are not the preferred choice for detached units: the variable for subway accessibility returned a negative coefficient.

The data set for semidetached housing consists of 241 semidetached housing projects in the GTA. All variables return expected coefficients. Adjusted ρ^2 for semidetached housing is 0.207. Some variables in the model have returned counterintuitive results. For example, area zoned as residential returns a negative (and statistically insignificant) coefficient. The positive coefficient for area zoned as industrial suggests that the likelihood of semidetached housing construction is high for zones where industrial land is available. This may be because industrial land can be rezoned as residential. In contrast, zones with predominantly residential land uses may indicate that the zone is built out.

The coefficient for the variable semidetached units in the approval process is statistically significant, this suggests that builders will act on their initial spatial choices, which they made by applying for

TABLE 4 Discrete Choice Models of Builder's Location Choice

Detached Housing				
Variable	**Coefficient**	**T-stat**		
Percentage of freehold properties	2.10E-03	1.459	Observations	546
Percentage of households with no vehicles	-0.0401	-3.746	Log-L with no coefficients	-1257.2115
Individuals without drivers license	-0.0180	-2.517	Log-L for the model	-1000.4209
Total length of roads in the zone	-0.0051	-0.764	Rho-Squared	0.2043
Intersection density	-0.0027	-4.315	Adj. Rho-Squared	0.2025
Percentage of land dedicated as open space	0.0013	0.823		
Housing units in the approval process	7.53E-04	6.449		
Accessibility to green space (Factor)	0.0964	3.018		
Accessibility to schools (Factor)	0.0143	3.441		
Retail density	-0.0034	-3.422		
SFD housing units in the approval process	8.09E-05	2.243		

Semi-detached Housing				
Variable	**Coefficient**	**T-stat**		
Population density	-5.21E-05	-2.286	Observations	241
Proximity to subway	-0.7123582	-1.682	Log-L with no coefficients	-554.9230
Proximity to large malls	-0.3258709	-1.307	Log-L for the model	-437.8372
Development charge for semi-detached housing	-2.57E-05	-1.087	Rho-Squared	0.2110
Employment nodes (factor)	-0.8592248	-3.672	Adj. Rho-Squared	0.2066
Accessibility to power centers (factor)	0.13718885	1.8		
Semi-detached units in the approval process	1.34E-03	3.854		
Built land use	-0.2427657	-1.265		
Housing units in the approval process	1.12E-03	6.122		
Semi-detached housing values	6.05E-06	2.816		
Area in sq. km zoned as industrial	1.28603924	2.597		
Area in sq. km zoned as residential	-7.56E-02	-0.234		

Row-Link Housing				
Variable	**Coefficient**	**T-stat**		
Percentage of freehold properties	-8.84E-03	-5.001	Observations	360
Population density	-1.409E-05	-1.329	Log-L with no coefficients	-828.9306
Households without driving licenses	-0.0121611	-1.952	Log-L for the model	-742.6640
Proximity to freeways	-3.05E-01	-2.422	Rho-Squared	0.1041
Proximity to large malls	-0.3910196	-2.167	Adj. Rho-Squared	0.1007
Area in sq. km zoned as residential	0.35717675	1.526		
Housing units in the approval process	3.98E-04	2.8		
Accessibility to green space	-0.3921423	-2.634		
Row/link housing units in the approval process	1.30E-03	5.931		
Development charge for row/link housing	3.19E-05	1.963		
Row/link housing values	7.166E-07	0.336		
Accessibility to power centers (factor)	6.30E-03	0.132		

Condominium Housing				
Variable	**Coefficient**	**T-stat**		
Distance from CBD	- 2.06E-02	-2.074	Observations	237
Condominium property values	2.7664E-06	2.377	Log-L with no coefficients	-545.7127
Condominium housing in the approval process	0.00046557	4.402	Log-L for the model	-340.8120
Accessibility to green space	-2.46E-01	-3.824	Rho-Squared	0.3755
Proximity to subway	0.81383966	3.565	Adj. Rho-Squared	0.3730
Proximity to highway	0.79539351	3.694		
Share of condominiums in housing stock	6.83E-03	2.252		
Professional employment in the zone	0.00026014	4.126		
Condominium property values	2.77E-06	2.377		
Accessibility to shopping centers	1.05E-01	1.761		

zoning and other approvals. Similarly, zones with higher semidetached housing values are more likely to attract new construction of semidetached housing. The presence of “power centers” in a zone attracts new semidetached housing. Population density and proximity to work centers, the subway, and large regional malls are negatively correlated with semidetached housing. Higher development taxes (municipal tax per new housing unit levied on the builder) also deter semidetached builders, although the coefficient for this variable is not statistically significant.

The data set for row–link housing consists of 360 housing projects in the GTA. Row–link housing is being constructed in the suburbs and in the central city. The variety of locations returns a poor model fit, with a ρ^2 of just 0.101. The most significant variable in the model is the number of row–link housing units in the approval process in a zone. The likelihood of new row/link housing construction increases in the zone with the number of similar units in various stages of the approval process. The variable representing spatial inertia (percentage of freehold properties in the zone) returns a negative coefficient, a departure from what have been observed for detached and semidetached location models. At the least, these results suggest that the location decisions for row–link housing are distinct from those for detached and semidetached.

Again, zones with considerable built space (population density) are less likely to be selected for new row–link housing projects. Similarly, zones near highways and malls are also less likely to attract row–link housing projects. The coefficient for the residential land use is positive, yet slightly insignificant. Also, the odds of locating row–link housing in zones identified for their inventory of developable land is higher than the rest, which is deduced from the positive coefficient for housing units in the approval process. The coefficients for row–link housing values and accessibility to power centers are statistically insignificant, yet positive. The coefficient for municipal tax per new row–link housing is statistically significant and positive. The location choice model for condominium builders offers the best fit with an adjusted ρ^2 of 0.373. There are 237 condominium projects in the data set. The negative coefficient for distance from CBD suggests that suburban zones are less likely to attract new condominium housing. Similarly, odds of locating new condominium housing in zones with high accessibility to green space are lower than the rest. In addition, zones where builders have applied for the approval of new condominiums are more likely to receive new condominium construction.

The likelihood of new condominium construction is high in zones near subway systems and freeways. The hypothesis of spatial inertia holds well for condominium housing. Odds of providing new apartment housing in zones with a preponderance of high-rise stock are higher than the rest.

A positive correlation between the location of white-collar work nodes and the location of condominiums is observed. The model suggests that zones with white-collar jobs are more likely to receive new condominium housing projects than the rest. Zones with high condominium values for housing stock are more likely to receive condominium housing. Accessibility to retail centers is also positively correlated with the location of new condominium housing.

CONCLUSIONS

This paper has presented an analysis of housing starts in the GTA with data on 1,384 new housing projects. The data set includes housing projects with more than 10 units, a major share of new housing constructed in the GTA. Results from the estimated models show that the spatial choices of real estate builders (observed as the estimated utility function) differ by housing type. Thus, the explanatory variables used in the four utility functions are not the same because not all variables returned statistically significant coefficients for each housing type. A combination of attributes may make a site suitable for SFD housing projects. However, the same site may not be suitable for high-rise housing, which is unique and distinct. Variables serving as a proxy for built urban form returned negative coefficients for detached, semidetached, and row–link housing, whereas the same variables returned positive coefficients for condominiums.

The likelihood of SFD, semidetached, and row–link housing construction is high for zones that depict suburban characteristics, whereas the likelihood of construction of new condominiums is high for zones in the central areas of the GTA, which enjoy proximity to employment, subway, and shopping. The model fit varied by type of housing as well. Condominium models offered the best fit and row–link housing the poorest fit; this suggests that models are not able to capture the decision-making process fully behind the location of row–link housing. The sporadic spatial distribution of row–link housing might have contributed to the weak model fit.

The concept of spatial inertia in housing markets is presented; it states that housing stock of a particular type acts as a magnet to attract more housing of that type to the vicinity. Estimated models have offered evidence for spatial inertia, which influences the location decisions of housing builders in the GTA.

This paper introduces new data sources for the study of urban form and its relationship with accessibility. The use of spatially disaggregate data on housing construction capturing the choices of real builders sheds light on how builders and developers operate in the real world. Similarly, data on land inventory accounts for speculation in the decision making of builders and serves as a futures markets for the development of new housing. Unlike large, integrated models, which are data hungry and impose a spatial hierarchy (grid structure) for data collection and analysis, this paper uses readily available data.

This paper has value for academics and practitioners alike. The data used in this research are available for most cities from government agencies. The econometric models and spatial data manipulation in the paper can be performed using available econometric and spatial analysis software. This allows practitioners to test these models and approaches in other metropolitan areas. The approach adopted has made it possible to test the hypothesis of profit maximization and will help researchers in developing advanced models of builder’s spatial choice.

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