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Transportation costs and urban sprawl in Canadian metropolitan areas

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ABSTRACT

We conduct an econometric analysis of the potential impact of gasoline and parking prices on urban sprawl in ten Canadian metropolitan areas from 1996 to 2011. Two measures of urban sprawl related to density and proximity are used as dependent variables: the proportion of low-density housing and the median commute distance. We explain these measures by four main variables based on the natural evolution model: population growth, median household income, the cost of surrounding agricultural land, and transportation costs. We show that, *ceteris paribus*, higher parking and gasoline prices have contributed to reduce the extent of urban sprawl. On average, a 1% increase in gasoline prices has led to a decrease in low-density housing by 0.17% and to a 0.04% decrease in median commute distance. Furthermore, we show that a 1% increase in the price of off-street parking has led to a 0.12% decrease in low-density housing and to a 0.05% decrease in median commute distance. We argue that results for parking prices are relatively modest because much free parking is available.

1. Introduction

Many contemporary urban development patterns found in North American cities are referred to as urban sprawl. These patterns are characterized by some degree of population and employment growth stagnation in established city centers while population tends to increase in surrounding peripheral municipalities, which themselves spread over broader areas. Evidence of this form of development can be seen across North America, where within the 40 years following 1960, suburbs housed a greater share of the population than cities and countryside put together" (The Economist, 2008). Between 2006 and 2010, Canadian peripheries of census metropolitan areas (CMA) registered soaring population growth rates of up to 50% in comparison with the country's total population growth rate of 5.9% for that same period (Statistic Canada, 2014). What explains this current trend across Canadian cities, and what can be done about it? The objective of this study is to determine whether two types of transportation costs have had an effect on urban sprawl in Canadian cities. We base our analysis on previous work by Tanguay and Gingras (2012), who, using the natural evolution model, conducted a study on the effects of gas prices on urban sprawl in Canadian cities and showed that on average, a 1% increase in the price of gasoline caused a decrease in low-density housing by 0.60% and an increase in the population living in the inner city by 0.32%. Similarly to Tanguay and Gingras (2012) and other studies (Burchfield, Overman, Puga, & Turner, 2006; Molloy & Shan, 2013; Ortuño-Padilla & Fernández-Aracil, 2013), we perform a panel regression analysis using data from 10 Canadian metropolitan areas over a 16-year period. We measure urban sprawl using two dependent variables related to density and proximity. Main independent variables of interest include downtown parking prices (on-street and off-street), and gasoline prices.

In the next section, we identify the hypothesized causes of urban sprawl and discuss the different methods used to measure its extent. We then focus on transportation costs, emphasizing the novelty and importance of including parking prices in urban sprawl equations. After describing our methodology, we present the results of our regressions and discuss their implications. The conclusion follows.

2. Urban sprawl and the natural evolution theory

Definitions of urban sprawl vary depending on the authors and the fields of study in which they are employed. Authors such as Brueckner and Fansler (1983), Mcgibany (2004), Burchfield et al. (2006) and Sun, Forsythe, and Waters (2007) use spatial features to define urban sprawl, claiming for example that it is "characterized by vigorous spatial expansion of urban areas" (Brueckner &

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Fansler, 1983, p. 479). They also emphasize the required travel distances of such urban areas: “Sprawl is often used to describe cities where people need to drive large distances to conduct their daily lives” (Burchfield et al. 2006, p. 607).

Others, such as Nechyba and Walsh (2004), Pendall (1999), Eidelman (2010), and Banai and Priest (2014) rather describe urban sprawl by the growth of low-density areas: “By sprawl, we will mean the tendency toward lower city densities as city footprints expand” (Nechyba & Walsh, 2004, p. 178). They commonly use changes in population and dwelling density to measure the degree of sprawl.

A third noteworthy definition is the center-periphery opposition put forth by Bussière and Dallaire (1994), Chapain and Polèse (2000) and Bordeau-Lepage (2009). This idea underlines the importance and presence of displacement of residential and commercial sites from city centers to peripheral regions: “Cities expand, with population and employment increasing faster on the periphery than in the center of the city” (Bordeau-Lepage, 2009, p. 13). Similarly, the definition proposed by Wassmer (2000), describes urban sprawl as “another word for a certain type of metropolitan decentralization or suburbanization” and follows by adding: “suburbanization occurs over time when a larger percentage of a metropolitan area's residential and/or business activity takes place outside of its central locations” (Wassmer, 2000, p. 2). Wassmer (2002) also re-examines suburbanization – which he believes to be a direct substitute to urban sprawl – and explains how, according to economists, suburbanization is a process determined by household's residential location decisions. These household decisions are in turn determined through weighing the private benefits of a suburban, decentralized location (e.g. cheaper land) against the private costs of this housing choice (e.g. longer commute times). If private benefits outweigh private costs, households will decide to live further away from the city center.

These definitions exemplify the lack of consensus surrounding the concept of urban sprawl and ways to measure its extent. Bearing in mind that our research focuses on transportation costs, two measurements for sprawl will be retained in our research: density and proximity.[1]

Traditionally, urban economists have relied on monocentric city models pioneered by Alonso (1964), Mills (1967, 1972, p. 480) and Muth (1969, p. 355) to explain urban expansion. These models claim that as households move further away from the city center, their housing costs diminish whereas their journey costs increase. Brueckner (1987) later coined this the Muth-Mills model and through its key components, studied the effects of exogenous variables on land usage, using natural evolution factors as independent variables. The Muth-Mills model assumes that households aim to maximize their utility according to their choice of residential location. As illustrated in Fig. 1, the model portrays housing costs (in monetary units) in relation to distances from the central business district (CBD), and displays the monetary differences between agricultural rent and developed land rent for each distance depicted. A horizontal line portrays agricultural rent[2] (R_a) and a decreasing exponential function describes land rent (R_0). This implies that R_a and R_0 intersect at a given point (X_0), where the city limits are located.

Variations in city limits are also easily depicted through the monocentric model. Consider for instance the effects of a decrease

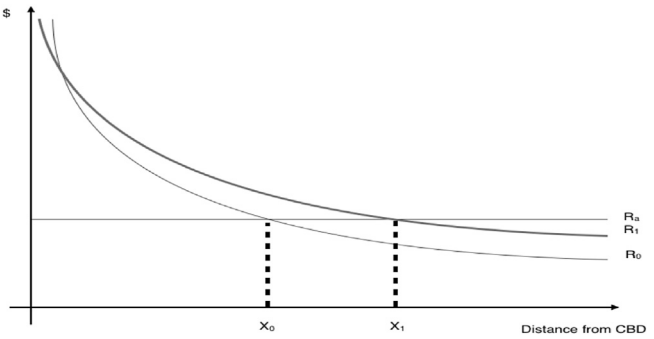

Fig. 1. Property values, agricultural land values and the city limits.

in transportation costs. Following this decrease, the advantages of living near the city center would be reduced and the cost of housing beyond X_0 would be increased. To portray this decrease in housing costs near the city center and simultaneously show the increase in those same costs in the relative suburban areas, the land rent curve would have to flatten, as depicted by R_1. This in turn, would cause the city limits to move outwards to X_1, as illustrated in Fig. 1. Thus, according to this model, all other things being constant, lowering transportation costs would cause cities to sprawl. The following section presents the socioeconomic variables of interest for this study and examines how they may impact the size and density of urban areas.

3. Transportation costs

It is widely agreed upon that “one of the cardinal features of sprawl is driving, reflecting a well-established, close relationship between lower density development and more automobile travel” (Frumkin, Frank, & Jackson, 2004, p. 117). Empirical evidence of this association can be found in work by Travisi, Camagni, and Nijkamp (2010), in which they show that sprawl increases automobile dependency because its form supports a greater dispersion of activities and makes it necessary to spend more time traveling between activities. Many authors have demonstrated the negative relationship between transportation costs and the size of metropolitan areas (Ayala et al., 2012; Brueckner & Fansler, 1983; Burchfield et al., 2006; Mcgibany, 2004; Mcgrath, 2005; Mieszkowski & Mills, 1993; Song & Zenou, 2006; Tanguay & Gingras, 2012; Wassmer, 2008; Wheaton, 1998). For example, Mcgibany (2004) used the natural evolution model to test the hypothesis that urban land areas are negatively related to gasoline prices and concluded that, all else being held constant, urban areas in states that had raised their gasoline excise taxes by 1 cent in the late 1980s were 4.7 square miles smaller than their counterparts in states that had not raised their gasoline excise tax. Newman and Kenworthy's (1999) work on automobile dependency argues that the greatest factor to have influenced the shape and form of cities is the automobile as it has enabled growth as far out as 50 km in all directions and completely changed the appearance of cities. Using population density as an indicator for sprawl, they confirm the presence of lower population densities in suburban neighbourhoods and attribute this to transportation factors. As per capita gasoline consumption increases, as is often the case in suburban neighbourhoods due to a lack of alternative modes of transportation, population density decreases. Furthermore, these results were conclusive both on an inner city and regional level.

Another extensively studied element of transportation costs is congestion (Anas & Rhee, 2006; Ayala et al., 2012; Brueckner, 1987). Again, the underlying logic is that if congestion can increase

[1] The applicability of these definitions in a Canadian context is reflected by their usage in previous Canadian studies: Sun et al. (2007) for spatial expansion, and Eidelman (2010) for low-density areas.

[2] Agricultural rent is depicted by a horizontal line because it is unaffected by its distance to the CBD.

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