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From bus to tramway: Is there an economic impact of substituting a rapid mass transit system? An empirical investigation accounting for anticipation effect

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ABSTRACT

Hedonic pricing models and price equations have been extensively used to retrieve the implicit prices of urban externalities through real estate markets. Many applications have been devoted to investigating the impact of new mass transit systems, such as rail infrastructures. However, the implementation of such infrastructures usually takes some time and markets can react with an anticipation effect that can vary according to the different development phases. Moreover, the impact may be different if it acts as a substitute to existing rapid transit services. This paper focuses on the impact of substituting bus rapid transit (BRT) for light rail transit (LRT) services, taking into account temporal and spatial decomposition of the effect of new urban infrastructures using a spatial difference-in-differences (SDID) estimator based on a repeated sales approach. An empirical investigation is conducted for the case of the implementation of the tramway in Dijon (France) between 2008 and 2012 using apartment transactions occurring between 2001 and 2014. The results indicate that the impact of substituting LRT to BRT is partly anticipated at the construction phase, while the cumulative impact returns a complex pattern where the positive effect is mainly concentrated around stations located in the center of the city.

1. Introduction

As underlined by the hedonic pricing theory (Rosen, 1974), the price of a complex good is a reflection of the different combinations of distinct amenities composing the bundle. Many empirical applications have now been based on the hedonic pricing model to retrieve the implicit prices of individual amenities of the bundle (intrinsic amenities), as well as their relative location (extrinsic amenities). As an old mantra states (location, location, location), spatial position is clearly related to real estate prices. This includes proximity and quality of nearby schools (Agarwal et al., 2016), accessibility to shopping places (Des Rosiers et al., 1996), proximity to green spaces and public gardens (Boyle and Kiel, 2001), but also proximity to mass transit (MT) systems and public transportation (PT) (Mohammad et al., 2013; Debrezion et al., 2007). Thus, hedonic pricing models have been seen as a useful tool to measure the implicit value of urban externalities.

One of the main challenges when estimating a hedonic price equation (first step) is to ensure that the usual assumptions regarding the error term are respected when estimating the model. There is an important issue related to the omission of a significant variable that could introduce bias on the estimated coefficient, and thus invalidate the main conclusions drawn from the statistical analysis.

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Another challenge is related to the fact that omitted spatial amenities could result in the detection of spatial autocorrelation among residuals (McMillen, 2010), made evident by the work of Can (1992) and Dubin (1998). The temporal dimension of the spatial data is also another concern since real estate transactions consist of spatial data pooled over time (Dubé and Legros, 2014), while the development of a mass transit system is usually not instantaneous and anticipation effect is possible (Golub et al., 2012; Agostini and Palmucci, 2009; McMillen and McDonald, 2004). Recently, emphasis has been placed on the possible endogeneity problem related to the fact that the route of the new mass transit system is oriented towards places that could maximize the impact on prices (Billings, 2011). Thus, trying to isolate the impact of the development of a new infrastructure on real estate prices is a complex task (Higgins and Kanaroglou, 2016).

The aim of the paper is to study the impact of substituting a light rail transit (LRT) service with an existing bus rapid transit (BRT) service using a framework that adequately controls for potential bias problem and spatial autocorrelation, to isolate the impact on real estate prices. To do so, the paper uses a spatial difference-in-differences (SDID) estimator (Dubé et al., 2014) based on a repeated sales approach (Case and Shiller, 1987; Bailey et al., 1963) (see also Dubé et al., 2014, 2013). The model also accounts for temporal decomposition of the effect by introducing three distinct construction phases (announcement period, construction period and the opening of the service – Devaux et al., 2017) as well as spatial variation of the effect depending on the location around the station (Chen et al., 1997) and related to the distance to the city center (Mulley et al., 2016), while adequately controlling for an endogeneity issue. The model allows testing for the significance of the impact in different periods as well as for the cumulative impact. It also proposes to spatially analyze and decompose the effect of substituting a rapid mass transit system on prices using maps based on a projection of the estimated effects.

An empirical application of the model is developed based on the case of the implementation of the tramway in Dijon (France), by replacement of existing BRT lines (Lianes). Using information on 8450 multiple apartment transactions between 2001 and 2014, the model is estimated and the interpretation of the results is discussed and mapped. The results show that the impact of the development of the tramway varies according to the period, but also according to the distance to the center of the city, with the higher impact in the center, and a decreasing impact with distance, becoming negative in the extremity of the lines.

The paper is divided into five sections. The first section proposes a brief review of the literature concerning the impact of proximity/accessibility to a mass rail transit system on real estate prices, with a particular emphasis on a possible anticipation effect. The second section presents the methodological framework used to isolate the impact of a change in mass transit systems on the variation of real estate prices and location rent, accounting for a potential anticipation effect related to the announcement and construction phases, as well as the effect related to the opening of the lines. The third section presents the data used to estimate the impact of the implementation of a tramway for Dijon (France). The fourth section presents and discusses the estimation results, while the last section concludes the paper.

2. Literature review

The Alonso-Muth-Mills (AMM) model of bid-rent curves was developed to explain why prices are not constant over space (Alonso, 1964; Muth, 1969; Mills, 1972). According to the first development of the model, a city is composed of a center, usually denoted as the central business district (CBD), and the land prices are a function of the distance to the CBD. The negative relation between prices and distance to CBD is explained by the fact that for a given utility level, land prices need to be lower to compensate for the travelling distance cost that increases as distance to CBD increases.

It is hard to find studies that concentrate uniquely on evaluating the location rent from a perspective of vacant land transactions, even more so in an urban context since vacant land is rare (Kostov, 2009; Kowalski and Paraskevopoulos, 1990). In general, empirical applications rely on the use of hedonic pricing models (Rosen, 1974) to retrieve the implicit price associated with extrinsic amenities. The focus is on location as a given characteristic composing the real estate bundle of goods, and accounting for distance to different infrastructures to measure willingness-to-pay (WTP) to be located “close” to a given place, taking into account a more complex and polycentric scheme (Heikkila et al., 1989).

The question of whether implementing mass transit (MT) rail services does raise real estate values has been empirically studied for more than forty years, starting with the works of Dewees (1976) and Bajic (1983) on the metro in Toronto. The literature suggests that the impact of proximity to rail transit systems returns a higher impact than buses (Mohammad et al., 2013; Bartholomew and Ewing, 2011; Debrezion et al., 2007), with the impact, in the worst-case scenario, being non-significant (Landis et al., 1994; Gatzlaff and Smith, 1993). The impact is more spatially concentrated for commercial than residential uses (Debrezion et al., 2007), while commuter train services result in higher impact (Dubé et al., 2013). It has also been shown that impact can vary according to the distance to CBD (Mulley et al., 2016) and among stations (Hess and Almeida, 2007). The results also appear to vary considerably according to study design (Higgins and Kanaroglou, 2016).

The development of PT raised important concerns about its profitability, and the economic impact of the development of new services is hard to establish. If proximity to such infrastructures is valued by the market, then one should expect to see prices increase around these infrastructures, and this increase in value can be used to finance part of the operational cost (Dubé et al., 2013, 2011). This is the rationale behind the idea of using the value capture system to finance such infrastructures (Pavlinek and Zenka, 2016; Ma and Lo, 2013). However, the development of a PT infrastructure is not instantaneous, as opposed to bus services (Dubé et al., 2011) and one needs to account for such reality when trying to estimate the impact of rail infrastructure proximity on real estate prices.

The “before operation” effect is clearly a challenge that needed to be accounted for when trying to evaluate the impact of new urban infrastructures, such as a transport facility, on real estate values. A recent work of Agostini and Palmucci (2009) proposes to decompose such effect to take into account three distinct phases: (i) the announcement period; (ii) the construction period; and (iii)