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A data-driven methodology for equitable value-capture financing of public transit operations and maintenance

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ABSTRACT

Despite the importance of rail infrastructure to the effective and efficient functioning of dense urban areas and their commercial business districts, funding for operations and maintenance of transit systems is a common challenge for cities. Operational funds are derived from a range of sources, including fare and toll revenues, taxes, and fees. In cities with aging infrastructure, traditional funding mechanisms are falling short of actual need, even as many cities experience record ridership levels. Therefore, new funding streams are necessary to safely, efficiently, and equitably operate and maintain an aging rail infrastructure in the face of growing demand. This paper presents a socio-spatial model of rail transit ridership demand to develop a computational method for value-capture funding mechanisms that link existing commercial properties and transit infrastructure operations. Using a diverse range of large-scale data for New York City (NYC) and the surrounding region, our methodology provides a data-driven approach to address fundamental issues of horizontal and vertical equity in value-capture fees, including (1) the magnitude of the special assessment, (2) the property types to include, and (3) the boundaries of the special assessment district. We find that a marginal special assessment of $0.50 to $1.00 per square foot on commercial properties, proportionate to the lost wages and output associated with system delays, within 1/4-mile of a subway station in NYC's core commercial district could yield between $332 and $664 million annually to support the Metropolitan Transit Authority's operating budget. This is equivalent to the revenue generated by an average, system-wide per ride fare increase of $0.22, and significantly less than the estimated implicit transit subsidy for these buildings of $4.58 per square foot per year.

1. Introduction

Dense urban areas rely on the proper function and maintenance of public transportation infrastructure for economic viability, resident mobility, and long-term sustainability (Kennedy et al., 2005). Access to rail and subway transit, in particular, has been shown to provide residents and employers with an array of benefits, including lower transportation costs, reduced commute times, and higher activity levels (Lewis-Workman and Brod, 1997). The network of rail infrastructure in many older cities, such as New York City, encouraged and reinforced land use and development patterns that spread population growth away from congested centers, while concentrating employment and commercial activities around the convergence of transit lines. In New York City, these commercial centers are located at specific hubs that integrate subway and regional rail transit in Midtown and Lower Manhattan, Downtown Brooklyn, and Long Island City and Jamaica in Queens.

Despite the importance of rail infrastructure to the effective and efficient functioning of dense urban areas and their commercial business districts, funding for operations and maintenance of transit systems is a common challenge for cities. Operational funds are derived from a range of sources, including fare and toll revenues, taxes, and fees. In cities with aging infrastructure, traditional funding mechanisms are falling short of actual need, even as many cities experience record ridership levels since 2013 (Dickens, 2016). These budget shortfalls create significant equity concerns, as the burden for raising revenues often falls disproportionately to those with the least ability-to-pay, typically in the form of fare increases (Hickey, 2005; Nahmias-Biran et al., 2014; Nuworsoo et al., 2009; Sharaby and Shiftan, 2012). Therefore, new funding streams are necessary to safely, efficiently, and equitably operate and maintain an aging rail infrastructure in the face of growing demand.

This paper presents a new data-driven methodology for calculating special assessment fees to support transit operations and maintenance.

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We begin by developing a socio-spatial model of rail transit ridership demand, focusing on a case study of the use and accessibility of the subway and regional rail systems in New York City and its commercial business districts. We describe subway commuting patterns to determine the implicit value of the transit system for commercial properties in core areas of the City. We then propose a special assessment fee district to internalize the positive externalities of transit access for large, existing commercial office buildings and provide a new funding mechanism for rail transit operations. Our methodology provides a data-driven approach to determining some of the most politically challenging issues of value-capture financing mechanisms, including (1) the magnitude of the special assessment, (2) the properties types to include, and (3) the boundaries of a special assessment district. In our approach, we specifically address issues of horizontal and vertical equity in the determination and implementation of this type of funding stream. The paper concludes with a discussion of the implications of the proposed scheme in the context of its financial impact on the transit system and commercial property owners, and its effect on social equity in transit accessibility for existing infrastructure.

2. Literature review

The linkages between land use and public transit have been well-studied (Keating, 1986; Mathur, 2015; Giuliano and Agarwal, 2010). Most analyses focus on understanding the economic impact of transit on surrounding properties and the implications of transit-oriented development (TOD). Building on the economic relationship between transit and property values, various funding mechanisms have been proposed to leverage property value increases to support the financing of new transit infrastructure. These include value-capture programs and tax-increment financing (Medda, 2012; Smith and Gihring, 2006; Zhao et al., 2010). These approaches have been used with some success (Calavita, 2014), but they are designed to provide funding for capital improvements, particularly the development or extension of new light rail infrastructure, rather than ongoing operational and maintenance funds.

The justification for linkage programs stems from the expected benefits to property owners surrounding existing and proposed transit hubs. The infrastructure investment is intended to increase commuter and pedestrian activity in the area, thus resulting in greater foot traffic, improved accessibility, and, in most cases, complementary public amenities in the form of streetscape improvements. Transit-oriented development is a planning and land use strategy that explicitly links transit improvements to the development and redevelopment of surrounding land. It is associated with increased allowable densities and other zoning modifications, such as the encouragement of mixed-use development, more comprehensive design guidelines, and requirements to activate street-level floor space with retail uses (Cervero and Day, 2008; Fan et al., 2016; Lund, 2006). This form of development emerged from the shift in land use and transportation planning to a focus a smart growth and new urbanism, which are intended to counter-act the negative effects of urban sprawl and to comprehensively consider density, mixing of land use and housing types, walkability, and public transit infrastructure (Duany and Talen, 2002; Knaap and Talen, 2005).

A significant driver of the shift to TOD has been the increasing demand for accessible and walkable neighborhoods. Recent studies have found price premiums for real estate surrounding transit hubs of between 6% and as much as 45% for housing and between 8% and 40% for commercial properties. In a study of San Jose, California, Cervero and Duncan (2002) find that commercial properties within 1/4-mile of a station that was part of the regional commuter system achieved $25 per square foot rental premiums. Theory suggests, and has been proven in empirical studies, that positive amenities, such as those created by access to public transit, will be capitalized into prices. A few studies have identified negative relationships between distance to transit stations and prices, based on the assumption that negative externalities of transit stations (e.g. crowding, noise, crime) are then reflected in lower relative real estate values (Bowes and Ihlanfeldt, 2001; Pan, 2013). However, this evidence is found in only a small fraction of the literature on the topic, and the dis-amenity effect would not be expected to hold in the study area here given the pervasive nature of crowds, noise, and crime in extremely dense urban environments.

Equity has become an increasing concern in the design and implementation of transit user fees, special assessments, and recapture financing tied to linkage programs (Litman, 2002). Specifically, *horizontal* equity refers to fairness in the distribution of costs and benefits, based on the concept of equal treatment (El-Geneidy et al., 2016; Litman, 2002). *Vertical* equity is concerned with social justice across different groups, which can be defined by socioeconomic status or need and ability (Litman, 2002). These concepts have been operationalized in both structural and programmatic contexts, implicating both the design and management of transit systems. For example, Jiao and Dillivan (2013) use Census data to identify "transit deserts" where limited transit infrastructure intersects with residents with high public transit dependence. Few studies focus specifically on equity issues in funding public transit operations specifically.

The determination of linkage, impact, or special assessment fees has traditionally been calculated for infrastructure capital projects, focusing on rules-of-thumb or reference metrics for expected future demand (Bladikas and Pignataro, 1990). These fees have predominantly applied to the construction or improvement of new infrastructure, and utilize impact assessments of new development or land use changes on system capacity and usage. For instance, in the case of road networks, price or fee structures are based on anticipated vehicle trips using the ITE Trip Generation manual, rather than on an analysis of actual trip behavior in the specific local context (Ewing, 1993; Kitamura et al., 1997). This is a major concern from an equity perspective, as the expected trip generation rates can vary substantially from actual activity, and this variation can be influenced by locational, socioeconomic, demographic, and other socio-cultural factors. New data streams - such as route optimization apps like Waze and in-car GPS data (Gal-Tzur et al., 2014), large-scale origin-destination surveys (Abowd et al., 2004), turnstile and smart card transit ridership counts (Bagchi and White, 2005), and WiFi-based commuter counts and trajectories (Kontokosta and Johnson, 2017) - create new opportunities for data-driven methods that link actual usage to impact fee calculations.

Funding options for operating expenses typically come from a combination of farebox revenues, tax proceeds, fees, and tolls. Table 1 shows the example of operating funding for the NYC region's Metropolitan Transportation Authority (MTA), which relies on a heterogeneous mix of sources to support operations and debt payments.

Farebox revenues and toll revenues account for 52% of total revenues, and are the most reliable sources as they derive from transportation users. Dedicated taxes and fees, as well as state and local subsidies, include: the Payroll Mobility Tax, Corporate Franchise Tax Surcharge, MTA District Sales Tax, Petroleum Business Tax, Mortgage Recording Tax, Urban Taxes, MTA Aid Trust Account Taxes and Fees, Motor Vehicle Fees, Motor Fuel Taxes, and Corporate Franchise Taxes on Transportation and Telephone Transmission. These taxes and fees account for 48% of total revenues, and are a more unstable source given their reliance on exogenous economic activity.

Table 1
2016 MTA adopted budget revenue sources (Metropolitan Transportation Authority, 2016).

Revenue Source	Amount	Percentage Share
Farebox Revenue	$6072 million	40%
Dedicated Taxes and Fees	$5496 million	36%
Toll Revenues	$1809 million	12%
State and Local Subsidies	$1149 million	8%
Other Revenue	$650 million	4%
Total	$15,177 million	100%