The Political Market of Transit Provision in US Urbanized Areas: Urban Scale, Spatial Forms, Fiscal Capacity and MPO Structure

Zhirong (Jerry) Zhao
Shengnan Lou
Humphrey School of Public Affairs
University of Minnesota
256 Humphrey School of Public Affairs
301 19th Ave. S. Minneapolis 55455, MN
zrzhao@umn.edu

Richard Feiock
Ruowen Shen
Jonathan Lubin
Askew School of Public Administration and Policy Florida State University
627 Bellamy Building, Florida State University
Tallahassee, FL 32306-3250
rfeiock@fsu.edu

Abstract

This research seeks to explain patterns of capital investment and operating expenditures for urban transit systems. We isolate supply factors including urban scales, urban spatial forms and financial capacity. Individual and group transit demands are accounted for by education immigrant populations, poverty levels, senior population and race. The results demonstrate that transit investments are super-linear to population. This result directly contradicts Bettencourt's popular urban scale theory. Transit expenditures are explained primarily by demand forces, but poverty and senior population have strong effects as well. For a subset of urban areas in three states we examine how MPO institutional structure, staff resources, and representation system affects transit spending applying a political market framework. We then explore whether these institutions have an interactive moderating effect on supply and demand forces.

Keywords: urban transit, political market, institutions

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1. Introduction

Lack of investment in urban transit systems is a pressing issue for urban areas in the US and much of the world. How to invest sufficiently in urban transit is a practical challenge for current and future cities in their efforts to ensure social-economic activities and address social inequities. Urban infrastructure is treated as a local public good because urban infrastructure sectors are subject to market failures, such as monopoly, externalities and free-rider problems (Prud'Homme 2004). In public choice the median-voter theorem captures the impact of these factors on public demand at the city level (Fisher 2007). Charles Tiebout (1957) added to these conventional economic factors, the idea that individuals' residential location decisions in an urban area reveal citizen preferences for public goods (Tiebout 1956).

Governmental supply also shapes the provision of public services (Mikesell 2003, Fisher 2007). Theories of public goods provision, conventional economic factors, such as service prices, household income, user population size, etc., have been found to have a significant impact on provision of public goods or services.

Leviathan and bureaucracy theories assume the motivation of decision makers to supply public goods is to pursue their individual interests by structuring fiscal policy and public service provisions to maximize revenues (Brennan and Buchanan 1980, Niskanen 1971). Along with these political incentives, fiscal capacity and managerial capability, from local to federal governments, also affect the amount of investment in urban infrastructure (Gramlich 1994, Oates 1999). For example, a local government with higher managerial and political capability can manage to pass an earmarked tax for infrastructure investment at the local level (Hannay and

Wachs 2007) or adopt innovative financial tools (such as public-private partnership and land-value capture) to fund infrastructure projects (Rybeck 2004, Koppenjan and Enserink 2009, Wang and Zhao 2014). These actions, in turn, enhance local governments' financial capacity.

Although extent theories address the drivers of public services and goods provisions, limited empirical research focuses on the capital investment in infrastructure at the local level, particularly transit infrastructure. One recent study explored the relationship between capital investment in infrastructure and the fiscal capacity, economic status, and community features at state and local levels using the median-voter model (Fisher and Wassmer 2015). Another study investigated the determinants of local governmental investment in infrastructure in Connecticut towns and cities from 2000 to 2010 (Bates and Santerre 2014). Both studies have found that community economic and political features significantly influence investment.

In the sections that follow we explain the patterns of capital investment and operating expenditures for urban transit systems in 500 urbanized areas in the US. We first isolate supply factors including urban scales, urban spatial forms and financial capacity. We test the Bettencourt urban scale theory that infrastructure investments are sub-linear to population. Next we add individual and group demands for transit as it is reflected in education levels, immigrant populations, poverty levels, senior population and race. Transit capital expenditures and operating expenses are then estimated with a set of regression models. The results find support for both demand and supply factors. For a subset of urbanized areas in three states – Florida, Georgia and Minnesota - we examine how MPO institutional structure, staffing and representation systems influence transit spending applying a political market framework. We test the direct effects of these instructions and explore whether these institutions may have interactive moderating effect on supply and demand forces.

1.1 Metropolitan Planning Organizations, Urbanized Areas, and Transit Funding

Metropolitan regions are the primary drivers in economic growth and infrastructure investment (Feiock and Coutts 2013). Transit systems are central to both the economic development and sustainability of urban regions (Mullins et al. 2015). Urban regions in the U.S, vary in scale and urban form and economic resources and the underlying local governments vary in their political economic and fiscal capacities. These demand and supply factors are anticipated to directly impact capital investments and operating expenses of urban transit systems. Because these demand and supply pressures are filtered through MPOs we apply the political market framework (Feiock 2013; Lubel et al 2005; 2009) to add the effect of MPO governance institutions and processes.

The 1973 Federal Aid Highway Act authorized creation of MPOs to carry out regional planning activities for transportation. By definition, any urbanized area with more than 50,000 people (UZA) must be part of an MPO, and an MPO can include more than one UZA. MPOs are responsible for developing long range transportation plans (LRTPs), which set priorities for a region's transportation network and contain those transportation projects that can be funded with expected revenues over the life of the 20-year plan. MPOs also have authority to allocate federal and state transportation funds. They channel funds to projects that buttress regional goals and policies defined in the LRTPs; these goals may encompass not just transportation, but also air quality, housing, equity, and economic growth and development. A region's LRTP characterizes not only how a region's transportation system will manifest, but also how the system will connect to the unique and often diverse population centers within the area. Because MPOs play the central role in regional transportation planning and implementation, effort to achieve more flexible, integrated, and sustainable transportation systems.

The MPOs that serve various regional areas are not equal in size or capacity. There is great variation in the geography they cover ranging from 34 square miles to 38,649 square miles and populations ranging from 50,000 people to 1 million or more. Staff capacity varies widely; the median size staff for all MPOS is six but median size of staff ranges between three and 37 employees (Council of State Governments 2015; Federal Highway Administration 2010). The largest source of operating funds for MPOs come the federal government but state and local governments also supply a substantial amount of funding and may also use local funds (Federal Highway Administration (2010).

Nearly half of all MPOs also serve as the Regional Council or Council of Governments for their region. The MPOs that do not serve as Regional Councils focus exclusively on their required mission to assist in the planning and implementation of the use of federal transportation funds within their region. Regional Councils have a broader focus where local governments work together on social and environmental issues (National Association of Regional Councils 2016; Association of Metropolitan Planning Organizations 2016). MPOs that also serve as Regional Councils have broader missions often related regional transportation planning such as energy, air quality, infrastructure, development and climate change mitigation and adaptation. MPOs may have both the institutional capacity and technical knowledge to work, if not directly, indirectly on issues that could impact sustainability through their transit related decisions. MPOs in particular maintain a unique nexus of government arrangements and missions that balance transportation, development and sustainability through their coordination of transportation investments of local, state and federal agencies.

1.2 Urbanized Area Transit Investments

Urbanized areas (UZAs) are important units of analysis in understanding transit investments. The Federal Aid Highway Act of 1962 required urbanized areas to coordinate "continuing, comprehensive and cooperative planning process" when using federal dollars. There are presently500 designated urban areas in the US within the boundaries of 405 MPO (Association of Metropolitan Planning Organizations 2016; U.S. Department of Transportation 2016). Figure 1 below presents the geography of UZAs and MPOs. Urbanized Area are a census-designated urban area with 50,000 residents or more. Each of the 500 UZAs is represented by a MPO. There can be multiple Urban Transit Providers (UTPs) that serve a UZA. While an UTP may serve multiple UZA, one of which is designated as its primary UZA. The geography of urbanized areas is depicted below in Figure 1.

Figure 1

Unit of analysis: UZA, MPO and UTP

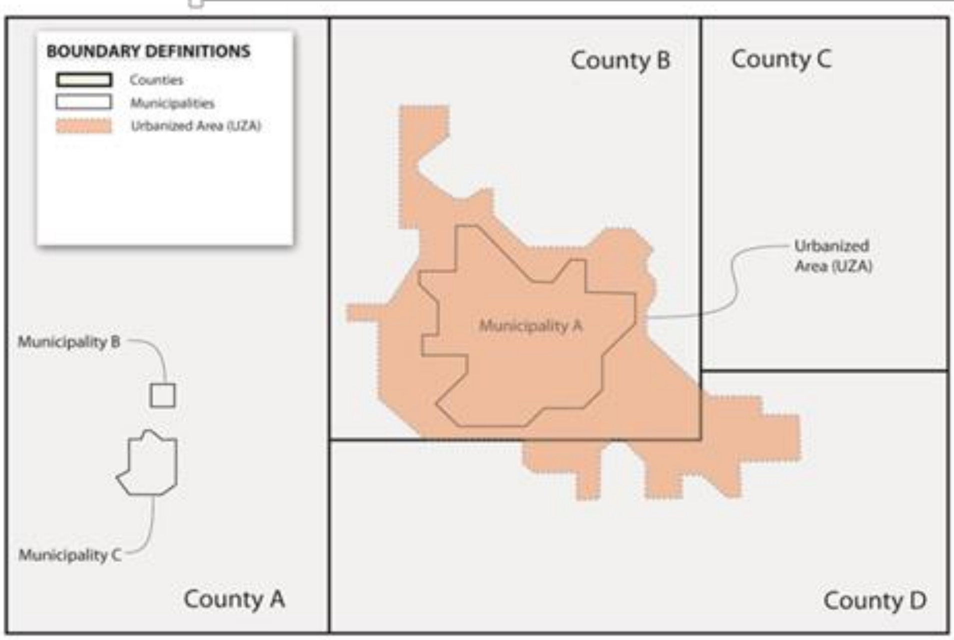
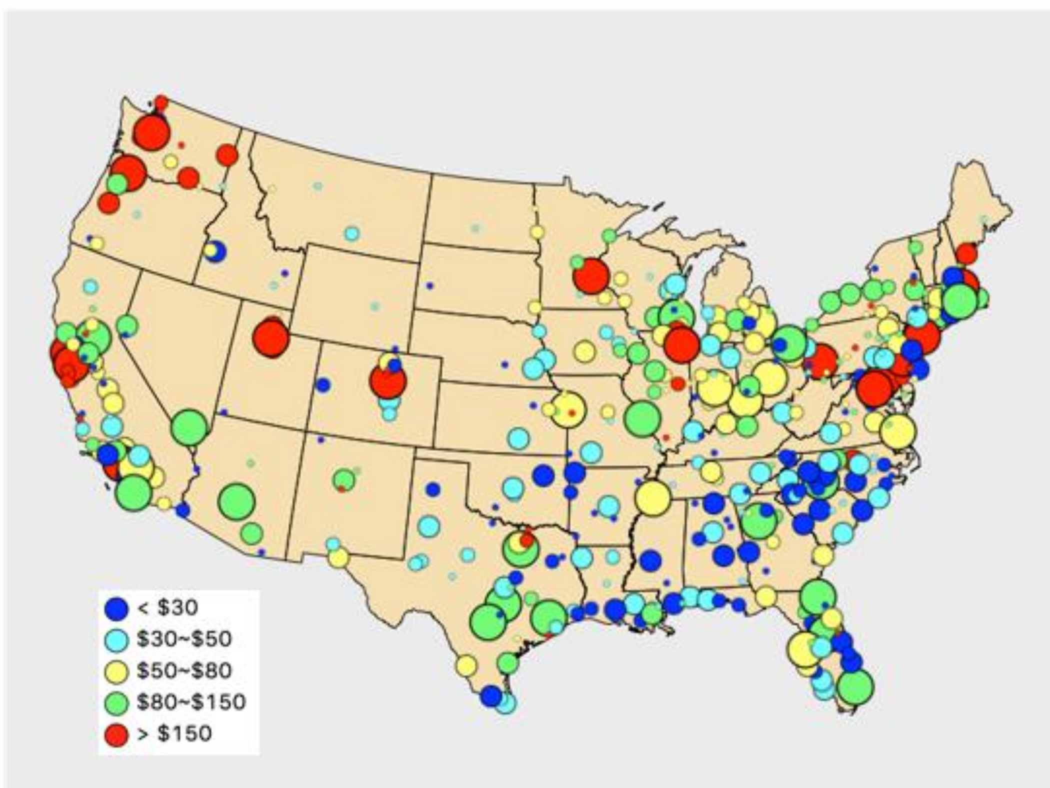


Figure 2 below maps the 2014 operating expenses of transit systems in the 500 urban areas within MPOs. Larger circles indicate larger population service areas.

This research aims to fill this lacuna through analyses of urban transit capital investment and operating expenditures within UZAs. This study undertakes the first systematic effort to apply the political market approach (Lubell, Feiock, and Ramirez 2005, Feiock, Portney, and Bae 2011, Feiock 2013) in the transportation context. Doing so provides insights to how public demands, governmental supply, and regional institutions shape patterns of transit investment. This study not only reveals the determinants of transit investments, it also tests takes initial steps to test theories of public service provision under different political systems.

Figure 2
UZA Pop and Transit Operating Expenses (2014)
(Larger circles indicating bigger UTZ population)



The remainder of this paper is arranged as follows. Section 2 offers a literature review of theories on financing infrastructure as a public service or good and the current studies. Section 3 explains in detail how and why the political market approach is applied and specifies the hypotheses tested. Section 4 describes the model and data. Section 5 presents the results of the regression analysis. The final section offers a discussion of the conclusions.

2. Literature Review

2.1. Theories on public services/goods provision related to urban infrastructure investment

According to the subsidiarity principle of fiscal federalism as advanced by Oates (1999, 2005), local governments are responsible for the provision of local public services (Oates 1999, Oates 2005). Local governments know what public goods and services local residents and businesses need, better than the federal government. This principle is thought to ensure efficient allocation of public resources (Alm 2013, Bahl and Bird 2014, Gramlich 1994, Oates 1999, 1981). Specifically regarding urban transit infrastructure, local governments are generally responsible for "planning, financing, constructing, owning, operating, and maintaining" this infastucture (Alm 2013). Facing these fiscal responsibilities, local governments can be either the major funders of urban infrastructure or facilitators of urban infrastructure projects, while federal or state governments can use intergovernmental transfer to increase the investment in infrastructure sectors, having significant spillover effects (Alm 2013, Bahl and Bird 2014).

The subsidiary principle of Oates is part of the first generation fiscal federalism, which assumes governmental officials seek to maximize social welfare. Further considering political institutions, Weingast and his colleagues expanded the first generation fiscal federalism and proposed a second generation theory of fiscal federalism (SGFF) (Qian and Weingast 1997, Weingast 1995, 2009, Oates 2005). SGFF highlights the impacts of political factors in fiscal federalism and how governmental power and political factors influence fiscal policy (Weingast 2009). SGFF emphasizes the importance of enhancing local governmental revenue generation to ensure local public service provision (Weingast 2009).

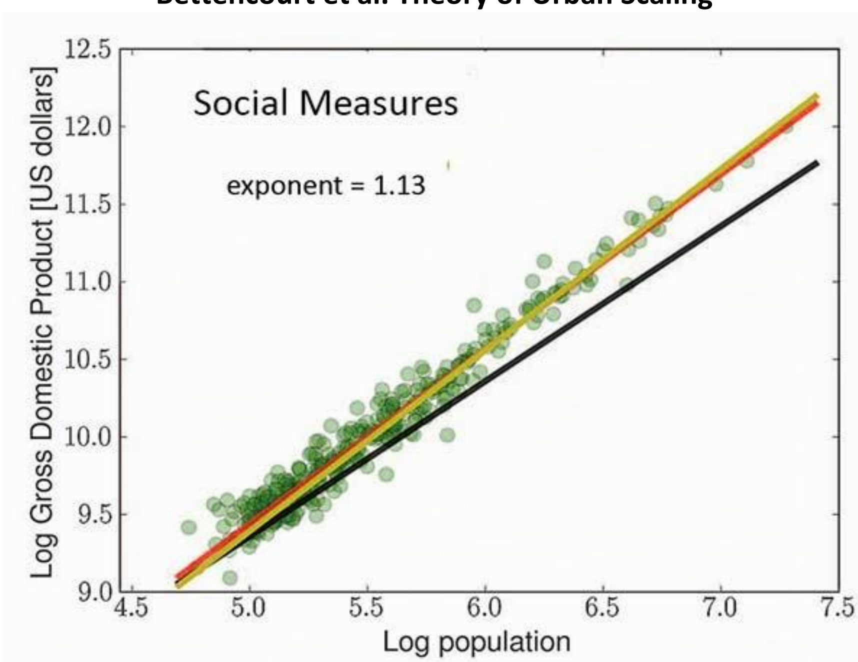
Both the first and second generation of fiscal federalism address fiscal responsibility and how it is allocated in the federalism system, but neither of them fully account for the impact of supply and public demand forces on public service provision. Economic factors, that shape the characteristics of the supply problem such and size and geography of he population served and their resources influence provision of public service/goods (Fisher 2007).

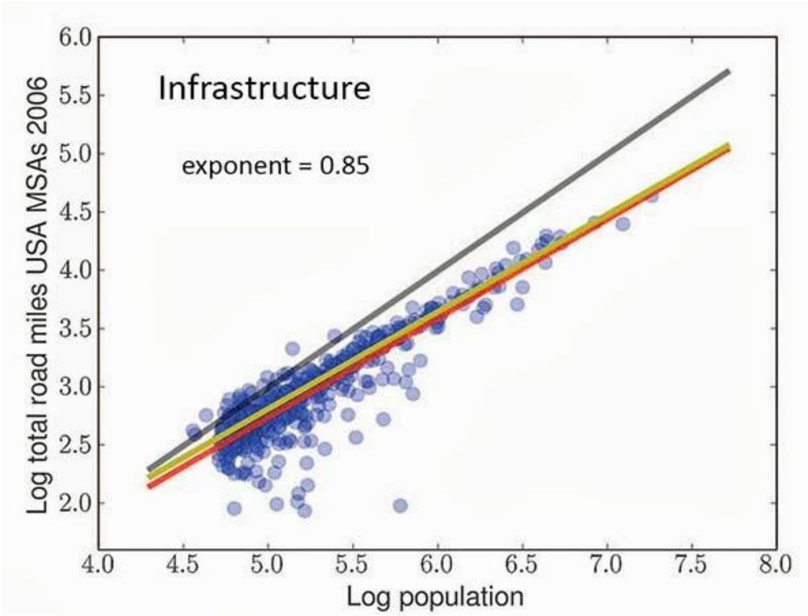
Public demand for public services and goods at the local level is also a major drivers for the provision. In a democratic society, the median voters signal a voting majority, thus elected officials seek to represent the median voters' preferences for public services. This means that demands for public services and goods can be reflected by the demands of median voters. In empirical studies, the features of median voters, such as income, demographics, education status, and political ideology, are used to indicate public demand for public goods and services in a community or city. This model has been applied in empirical studies on capital investment at the state or local levels. A study of capital investment in urban infrastructure in Connecticut cities and towns from 2000 to 2010 revealed that the demand for capital investment was sensitive to the tax rate, while household income did not affect the demand for capital investment (Bates and Santerre 2014). Local demand, indicated by household income, tax price, population size, previous capital stock, and residential preference, has a demonstrated significant influence on the state-local capital investment in transportation (Fisher and Wassmer 2015).

2.2 Transit Supply, Urban Scaling, Form and Capacity

Recently there has been considerable interest in the theory of urban scaling. The work of Bettencourt and his associates has captured much attention across multiple disciplines (Bettencourt et al. 2007; Bettencourt and West 2010). Formal models based on urban scaling theory predict city development pattern and conclude that GDP growth is super-linear to population growth; Infrastructure is sub-linear to population growth; and deviation from the norm is sub-optimal.

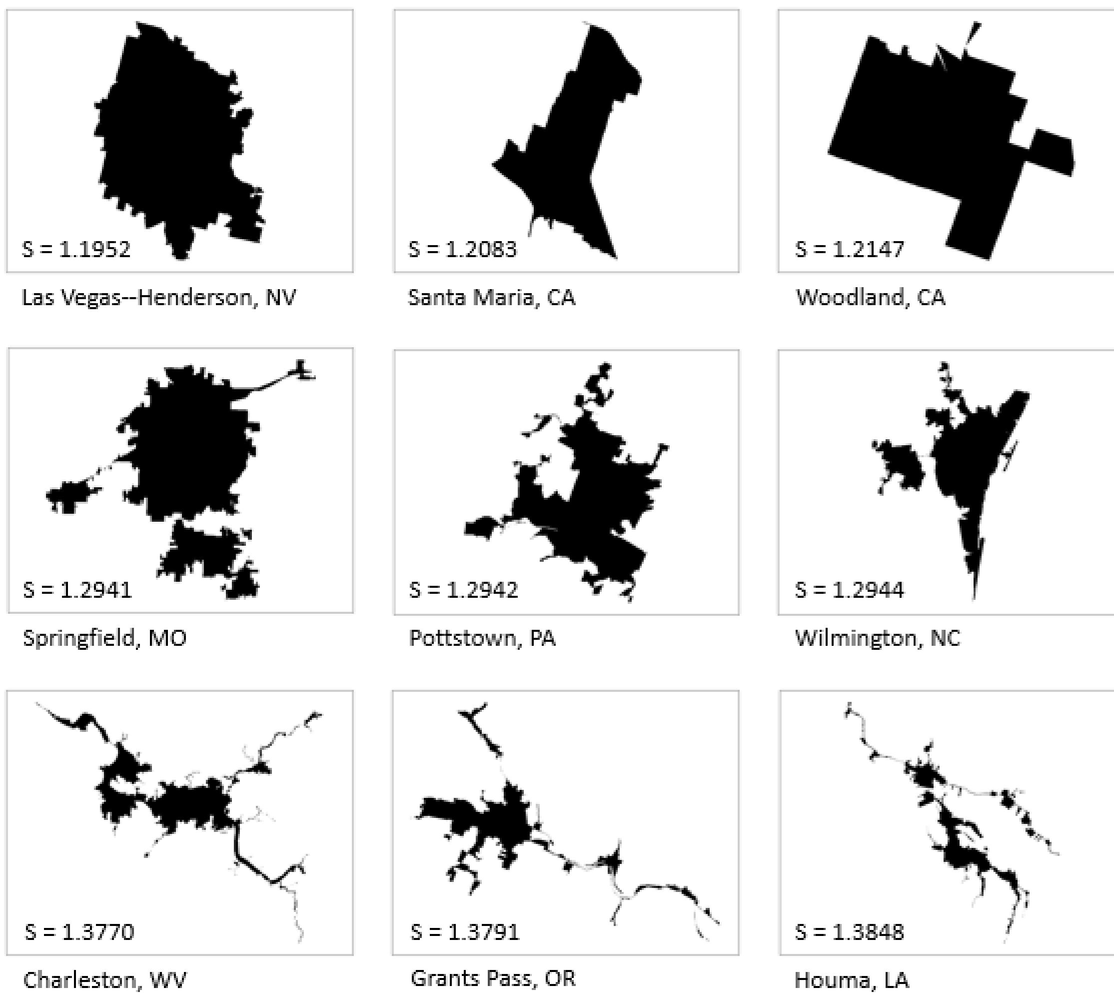
Figures 1a and 1b
Bettencourt et al. Theory of Urban Scaling





The central prediction is that economic growth is greater than population growth while infrastructure growth is slower than population growth. We believe there are two problems with this theory. First, based on the public finance literature, not all infrastructure are sub-linear, since not all types of infrastructure scale in the same way. Different infrastructures have different urban scaling features and public transit might be different from other infrastructures. Second, the scaling literature only relies on correlation, without controlling any other variables. Third, the underlining assumption is that the average pattern is the optimal, and any deviation is sub-optimal. We seek to explain the deviation from the scaling line keeping in mind that in social science studies, the norm is not necessarily the goal. We not only pay attention to the average pattern, but also deviation and don't consider deviation to necessarily be bad. The scaling law in urban development emphasizes that urban parameters are in an exponential relationship with city population (Bettencourt and West 2010). Several urban parameters, such as economic development, energy and material use, and innovation, have been tested in previous studies in cities (Bettencourt et al. 2007, Ramaswami, Jiang, et al. 2016, Kennedy et al. 2015). However, the scaling effect of transit investment versus population has not yet been tested. In addition to urban scales, urban spatial forms and financial capacity are supply factors to predict transit expenses. Three dimensions or urban form may influence transit expenditures: population density, urban compactness (1/(Area-Perimeter fractal), and central city population concentration i.e. the population of the central city relative to the UZA pop. Spatial forms may affect transit funding and transit performance. Figure 3 illustrates the variation in spatial forms.

Figure 3
Urban Spatial Forms



Area-Perimeter Fractal Dimension: S = 2Log(Perimeter)/Log(Area)

Public infrastructure production in a denser region is expected to be different from a region with a less dense population. Current findings indicate the investment in transportation infrastructure is subject to "congestion," which means that the investment amount increases in cities with higher population density (Fisher and Wassmer 2015).

Financial Capacity to supply transit infrastructure and service is has citizen and governmental dimensions. Financial capacity to support urban infrastructure is strongly linked to personal income levels within the community. Fisher (2007) found public service and public goods are produced at higher levels in wealthier communities (Fisher 2007), but studies demonstrate mixed results regarding the relationship between investment amount and household income across different studies (Bates and Santerre 2014, Fisher and Wassmer 2015, Kwon 2006) Government fiscal capacity can be measured by the per capita expenditures of the underlying governments. We advance the following supply side hypotheses.

H1: The scaling effect of transit investment versus population will be superlinear.
H2a: Population will positively influence transit capital and operating expenditures
H2b: Population change will positively influence transit capital and operating expenditures
H3a: Urban density will positively influence transit capital and operating expenditures
H3b: Urban compactness will negatively influence transit capital and operating expenditures
H4a: Income will positively influence transit capital and operating expenditures
H4b: Local government expenditures will positively influence transit capital and operating expenditures

2.3 Transit Demand

In addition to these conventional supply factors, public choice theories of public good markets explores how constituency groups demands and policy preferences of mobile residents can influence public services and goods provision. A Tiebout model assumes that 1) residents are knowledgeable about the tax differences among different locations; 2) public services/goods do not have spillover effects; 3) residents are free to move; 4) local managers can optimize the size of cities to minimize the cost for public services and goods; and 5) there are many communities to choose (Fisher 2007), residents are free to move to a community, where the provision of public services and goods can meet their preferences and expectations (Oates 1981, Tiebout 1956). Mobility produces competition among local governments for new residents, which drive local fiscal policies aiming to attract residents and businesses in their jurisdictions. These policies may distort public resource allocation. Although it is difficult to achieve the Tiebout assumptions in the real world, research in this tradition has emphasized the importance of mobility on indicating public demand for public services and goods at the local level (Teske et al. 1993).

Political factors can significantly shape public resource allocation. The "Tax Constitution of Leviathan" proposed by Brennan and Buchanan argues that the interest of government is to maximize its own revenue, increasing the size of government (Bernauer and Koubi 2013, Brennan and Buchanan 1980). Demographic difference in the population particularly age, race and income align with preferences with public goods and predict spending on public goods (Peterson 1981). Demand for transit is anticipated to be related to education levels in the community, immigrant populations, racial composition, poverty levels and the senior citizen population. These are considered as a key factors in local sustainability, development and public service provision (Lubell, Feiock, and Ramirez 2005, Krause, Feiock, and Hawkins 2014). The demand side hypotheses are:

H5: Education level will positively influence transit capital and operating expenditures

H6: Percent immigrant population will positively influence transit capital and operating expenditures

H7: Percent white population will positively influence transit capital and operating expenditures

H8: Percent below poverty will negatively influence transit capital and operating expenditures

H9: Percent senior population will positively influence transit capital and operating expenditures

2.3 MPO Institutions in a Political Market Theory

All MPOs operate as regional governance mechanisms to link diverse actors at multiple scales, but their ability to reconcile and constrain conflicting demands and to successfully support regional transit systems is anticipated to vary depending on their governance capacity and institutional design. Federal legislation does not spell out how MPOs must be structured or what powers they must have beyond those necessary for the compilation of regional transportation plans (Lewis and Sprague 1997). MPOs vary substantially in terms of size, and staff resources. Internal decision-making is shaped by the proportions of voting seats on the governing board held by elected officials rather than administrators.

The institutional features of MPO institutional design may be critical for MPOs' ability to translate supply and demand forces into action. We anticipate that several features of MPO governing structure will play a role in building capacity for transformative policy making. First the scope of issues an MPO addresses if determined by whether MPO responsibilities reside in a council of governments or a freestanding MPO that focus only on transportation. Separating responsibility for a single policy area within a specialized government can improve responsiveness to public demands under some circumstances, but it also can create barriers to coordination on complex goals related to regional transportation systems. Second, when bureaucratic organizations such as MPOs have more staff it provides access to information, time and expertise that enhances their capability and facilities creation and implementation of effective policy. While possession of resources does not translate directly into intelligent policy, professionally staffed bureaucracies have more opportunities to scan for useful policy innovations; find, evaluate, and tailor them; take care in crafting implementation strategies; and pursue monitoring and assessment to secure implementation (Carpenter 2001). Conversely, when bureaucrats' capacity is limited, they are less likely to implement policy mandates (Huber and McCarty 2004) or to implement a policy innovation completely or effectively (Hill 2003).

Third, the composition of the MPO governing board in terms of representation of elected officials rather than administrators shapes interactions with stakeholders, citizens, and governmental and non-governmental actors. The incentive structure of elected officials may lead them to focus on local, rather than regional issues based on pork barrel politics (Clingermayer and Feiock 1995; Gerber and Gibson 2009; Hamilton 2014). Greater representation of administrative and technocratic officials on the governing body may lead to greater commitments to regional transit.

The political market approach explores the determinants of policy change at the local level. This approach posits that public demand, governmental supply, and the exchange between the demand and supply within the local political institutional structure influence policy change at the local level (Feiock et al. 2014). It is built upon property rights and interest group theories and emphasizes the impact of local political institutions. In its original conceptualization, the political market framework was applied to analyzed demand for policy change to address the problems related to land use and property rights (Lubell, Feiock, and Ramirez 2005). Land and climate change problems are common-pool resource problems and thus require policies to address property rights in order to solve them. At the same time, interest groups shape policies to favor their preferences and requirements during the policy-making processes, because they often have greater power and influences than individuals. The agreement between citizens and group policy demanders and governmental policy suppliers operates within the context of existing political institutional structures. Thus, local political institutions are posited as another key factor influencing policy change at the local level (Lubell, Feiock, and Ramirez 2005, Feiock, Tavares, and Lubell 2008). Different political institutional structures pose different transaction costs on policy demanders and policy suppliers.

First tested on land conservation policy (Lubell, Feiock, and Ramirez 2005), this approach has been applied to a variety of other policy arenas, including fiscal policy, economic development, climate change, and sustainable policy (Hawkins 2014, Krause, Feiock, and Hawkins 2014, Lubell, Feiock, and Handy 2009, Lubell, Feiock, and De La Cruz 2009, Jeong and Feiock 2006, Feiock et al. 2014), but not infrastructure. Demand for policy or policy change varies in different policy arenas. For example, the demand for land property rights is driven by population pressure and urban density (Lubell, Feiock, and Ramirez 2005), while demand for economic growth policies is influenced by the need of local residents and businesses (Feiock et al. 2014). Factors influencing governmental supply also vary from fiscal policy to environmental policies. Local political institutions, as a key component in this framework, have been proved to significantly influence the policy decisions in some policy arenas, when controlling other variables related to public demand and policy suppliers (Hawkins 2014, Feiock, Tavares, and Lubell 2008, Lubell, Feiock, and Ramirez 2005, Lubell, Feiock, and De La Cruz 2009, Jeong and Feiock 2006, Feiock et al. 2014). The advantage of this approach is that it provides flexibility to adjust specific factors associated with demand, supply, and political institutions in different policy arenas.

The institutions examined in the political market literature focus primarily on MPO governance, structure and decision processes. Regional political institutions such as rules that define the powers scope of responsibilities and capacity of MPOs are anticipated to moderate demand and supply effects. Build upon this political market approach on policy change, the influence of demand and supply factors may depend on local instructions. Because we are limited to three states for this analysis, our hypothesis is more exploratory.

H10: MPO institutional structure will moderate demand and supply factor influences on transit expenditures.

3. Method and Data

The research design includes measures for the main sets of variables in the UZA analysis. The two dependent variables are transit expenditures for infrastructure capital costs and operations allocated in 2014. Capital and operating costs are estimated with a set of regression equations. The supply side factors shaping transit production include population, population change, of the UZA form the 2010 Census. Urban form is captured through indicators of population density in the urbanized area and its spatial compactness. Governmental fiscal capacity is measured by central city per capita expenditure and population fiscal capacity is measured by median household income of an urbanized area in 2014. The demand factors capture specific preferences within the community and include percentage of the percentage of people over 18 years old with less than a high school degree, percent of the population white, percent moving from abroad to the UZA, and the percent of people over 60 years old. Summary statistics are reported below in Table 1.

Table 1
Summary Statistics

Variable	Definition	Mean	St. Dev.	Min	Max
Dependent Variable					
OpExp	Transit operating expenses allocated the urbanized area in 2014	88,300,000	691,000,000	2,479	14,000,000,000
Capital	Transit capital expenses allocated to the urbanized area in 2014	35,500,000	235,000,000	0	4,290,000,000
Independent Variables					
Pop	Urbanized area population in census year 2010	466,915	1,304,684	50,428	18,400,000
PopChange	Population change in the urbanized area from 2000 to 2010	0.20	0.25	-0.21	2.12
Density	Population density in the urbanized area in census year 2010	2,112	859	811	6,999
Compactness	Spatial compactness of the urbanized area	1.30	0.03	1.20	1.38
ExpendPerCap	Annual government expenditure per capita in the central city of an urbanized area in 2012	2.45	1.72	0.00	19.44
HHIncome	Median household income of an urbanized area in 2014	50,754	12,549	30,163	109,533
AboveHighSchool	Percentage of people with a degree higher than High School in an urbanized area in 2014 (%)	87.08	5.71	54.76	98.11
Migration	Percentage of people moved from abroad to this urbanized area in 2014 (%)	0.63	0.58	0.00	5.10
White	Percentage of white people in this urbanized area in 2014 (%)	76.97	12.43	26.72	96.07
Poverty	Percentage of people under poverty line in this urbanized area in 2014 (%)	17.46	5.50	5.52	36.83
Senior	Percentage of people over 60-year-old in this urbanized area in2014 (%)	19.24	5.32	7.30	66.90

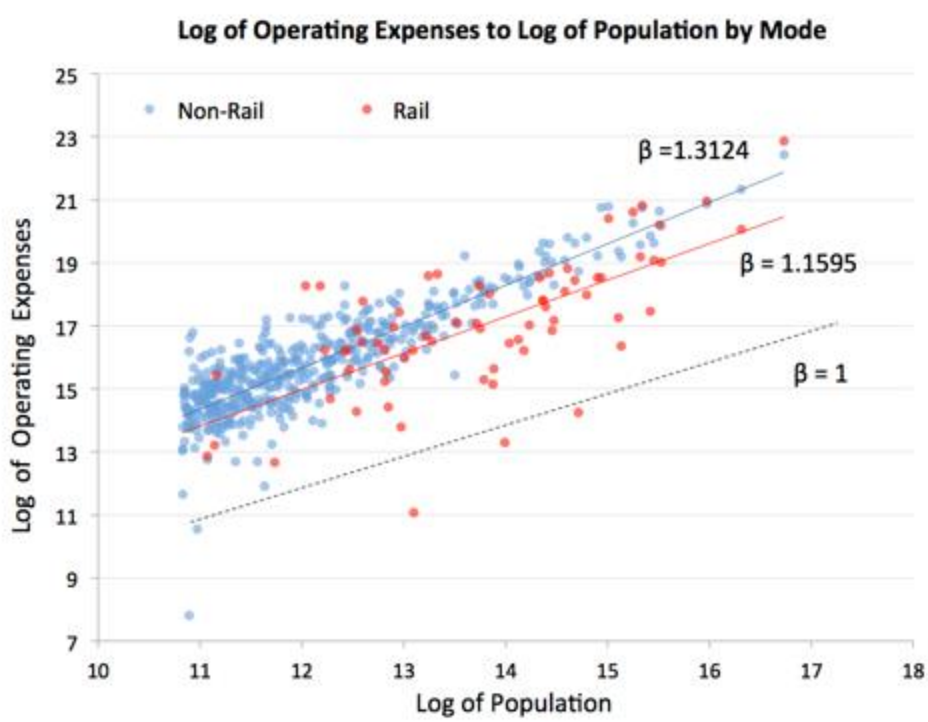
We first estimate the urban scale effect by examining the bi-variate relationship between the log of population and transit infrastructure capital and operating expenses allocated to UZAs. This provides a direct test of the Bettencourt urban scale prediction advanced in hypotheses one. We next add in the other structural supply side factors including urban form and fiscal capacity. The third model then adds community demand factors.

4. Results

4.1 Urban Scale and Infrastructure

Before presenting the repression estimates for our three models we prove graphical summary of the first equation that examines Bettencourt's urban scale theory in the context of urban transit. Urban scaling theory argues that urban infrastructure facilitates tend to be sub-linear relating to urban population scale. We found this to be un-true for public transit consistent with our hypotheses. In fact, the graphs in Figure 4 a and b demonstrate the relationship is in fact super-linear for both capital and operating costs, highly super-linear on the capital side.

Figure 4
Urban Scale and Transit Expenses (Operating and Capital)



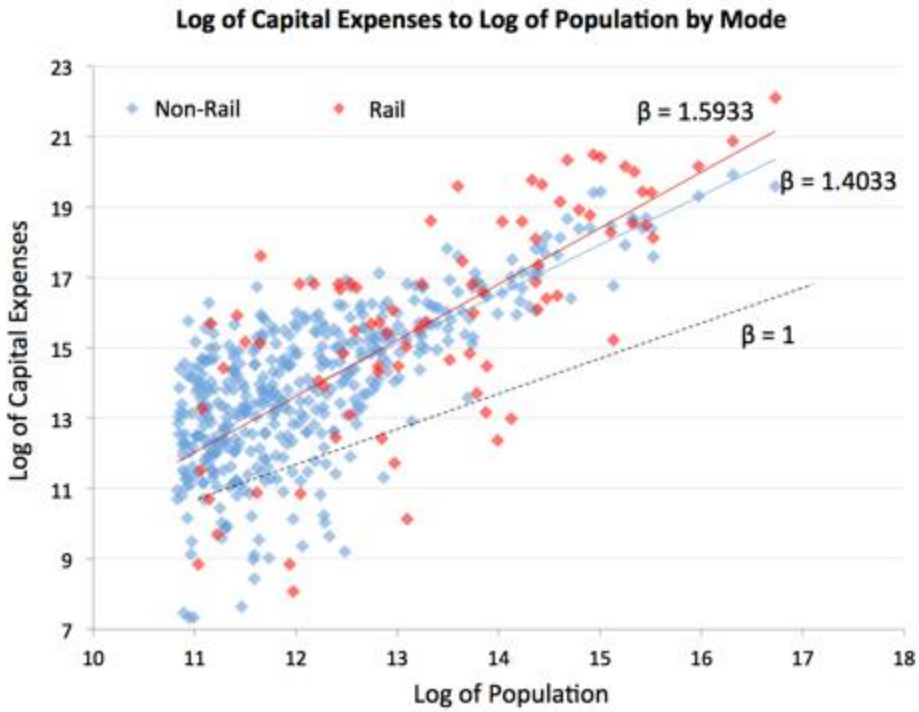


Table 2

Estimation Results: Log Operating Expenses

	Model 1			Model 2			Model 3		
	Es.	*t-value*		*Es.*	*t-value*		*Es.*	*t-value*	
(Constant)	-0.14	-0.29		-7.93	-2.99		-32.85	-5.31	
Pop(log)	1.32	32.41	***	1.16	27.37	***	1.25	26.50	***
PopChange				-1.75	-6.62	***	-1.37	-4.44	***
Density(log)				1.10	8.11	***	0.96	5.74	***
Compactness				-6.25	-2.51	**	-6.46	-2.41	**
ExpendPerCap(log)				0.15	2.21	**	0.03	0.46	
HHIncome(log)				0.60	2.88	***	2.61	5.13	***
AboveHighSchool							0.02	2.15	**
Migration							0.22	1.33	
White							0.01	2.16	**
Poverty							0.10	5.16	***
Senior							0.06	3.64	***
Observations	447			392			315		
R-squared	0.7024			0.7809			0.8262		
Adjusted R-squared	0.7017			0.7775			0.8199		
Root MSE	0.8016			0.67978			0.6272		

4.2 Supply and Demand Explanations

Table 2 reports our model estimates. Model one reports a positive effect for population and transit expenditures super-linear to population size. Not only current, but historical population is important as population change exerts a negative influence. Urban form is important in shaping transit operating costs. Density has a positive effect while compactness leads to lower operating expenditures. Both community and governmental capacity have significant coefficient estimates as well. In model three we again find support for our hypotheses. Although the effect for migration is not significant, UZA white population, povery levels and senor populations each have significant positive effects even after accounting for supply side structural factors. We next estimate capital expenses for transit in Table 3.

Table 3

Estimation Results: Log Capital Expenses

	Model 1			Model 2			Model 3		
	Es.	*t-value*		*Es.*	*t-value*		*Es.*	*t-value*	
(Constant)	-4.01	-3.97		-10.19	-1.70	*	-61.24	-4.29	***
Pop(log)	1.49	17.85	***	1.22	12.98	***	1.32	12.29	***
PopChange				-1.01	-1.71	**	-0.39	-0.53	
Density(log)				2.06	6.80	***	1.70	4.43	***
Compactness				-12.27	-2.19	**	-12.27	-1.97	**
ExpendPerCap(log)				0.31	1.98	**	0.07	0.41	
HHIncome(log)				0.31	0.66		4.55	3.87	***
AboveHighSchool							0.02	0.61	
Migration							0.83	2.19	**
White							0.01	1.33	
Poverty							0.18	4.02	***
Senior							0.12	3.24	***
Observations	417			367			294		
R-squared	0.4343			0.5019			0.5684		
Adjusted R-squared	0.4329			0.4936			0.5516		
Root MSE	1.5788			1.4761			1.4127		

The results in Table 3 for capital expenses also strongly support our hypotheses. The positive effect of population is even greater for transit infrastructure capital expense. The supply factors in model 2 generally support our hypotheses, but only governmental, and not community fiscal capacity matters. Urban form, particularly compactness exerts great influence. In model 3 migration, poverty and senior population have the predicted effects, but education and white are not significant for capital expenses.

4.3 Analysis of the Influence MPO Structure in Three States

The final set of analyses builds upon the preceding sections to explore the role that regional governance institutions have on transit outcomes. A national database of MPO governance and decision making institutions is under construction as part of the NSF-funded Sustainable Healthy Cities project (http://www.sustainablehealthycities.org/). The first stage collected a range of political structural variables for all MPOs in three states – Florida, Georgia, and Minneapolis. This analysis focuses on the MPOs that are responsible for the UZA's in these three states. We focus here on three characteristics of MPOs staff size, whether the MPO is freestanding, and elected official representation in the governing body. Staff is measured as full-time employees including the executive director. Free standing classifies whether an MPO is a freestanding organization or part of an association of governments or some other multifunction entity. Elected official representation is the proportion of voting members who are elected officials on the MPO governing board. Table 4 provides summary statistics for these variables (summary statistics for the supply and demand variables we estimate for just these three states are reported in appendix 1).

Table 4
MPO Structure Variables

Independent Variables					
MPO_staff	MPO staff size (in full-time employees, if available, including executive director)	13.60	32.21	1	225
MPO_Free	MPO is a freestanding organization or part of an association of governments or some other multifunction entity 0=freestanding; 1=part of another organization	.44	.50	0	1
Proportion_elected	The proportion of voting member who are elected officials to total voting member on the MPO governing board	.785	.260	0	1

We estimate three additive models for transit capital and operating expenses. In the first we estimate the impact of MPO structural variable alone in model 1. In model two we add to the equation supply side factors that were significant in the preceding analyses. Finally, we add selected significant demand side variables. The first set of model estimations are reported below in Table 5 which estimates transit infrastructure capital expense and in Table 6 which estimates the three models for operating expense allocated to UZAs in these three states.

Table 5
Additive Effects of MPO Structure on Transit Capital Expense

	Model 1 Coef. (SE)	Model 2 Coef. (SE)	Model 3 Coef. (SE)
(Constant)	8.75e+07	-4.07e+08	-4.08e+08
Free Stand	279607 (1.59e+07)		
MPO staff	1081620 (222827.1)***	841911.9 (183575.6)***	853891.5 (209261.6)***
Proportion Elected	-9.73e+07 (3.20e+07)***	-7.42e+07 (2.44e+07)***	-7.62e+07 (2.94e+07)**
Log (population)		1.05e+07 (7271116)	9808029 (9441215)
Density		26807.33 (13939.01)*	27787.01 (16478.86)
HH_income		2429.469 (1051.725)**	2444.89 (1196.153)**
Compactness		2.42e+08 (4.02e+08)	2.48e+08 (4.19e+08)
Education			79256.83 (1808585)
Senior			109212.7 (853687.9)
Observations	37	37	37
R-square	0.5547	0.7973	0.7975
Adjusted R-square	0.5142	0.7568	0.7396
Root MSE	4.6e+07	3.3e+07	3.4e+07

Table 6
Additive Effects of MPO Structure on Transit Operating Expense

	Coef. (SE)	Coef. (SE)	Coef. (SE)
(Constant)	1.84e+08	-4.98e+08	-6.28e+08
Free Stand	-3.04e+07 (4.76e+07)		
MPO staff	2196299 (66831.2)***	1727554 (376913.1)***	2116684 (363918.4)***
Proportion Elected	-1.72e+08 (8.45e+07)*	-1.32e+08 (5.01e+07)**	-1.70e+08 (5.11e+07)***
Log (population)		3.20e+07 (1.49e+07)**	-338945.8 (1.64e+07)
Density		166349.2 (28619.24)***	210328.2 (28657.72)***
HH_income		102.23 (2159.38)	2494.207 (2080.182)
Compactness		-9.01e+07 (8.26e+08)	1.84e+08 (7.28e+08)
Education			9234081 (3145237)***
Senior			2169058 (1484614)
Observations	37	37	37
R-square	0.3355	0.8584	0.8985
Adjusted R-square	0.2750	0.8301	0.8695
Root MSE	1.4e+08	6.7e+07	5.9e+07

The results reported in Table 5 provide strong support for the importance of regional governance institutions in explaining transit infrastructure capital expense. Although whether an MPO is freestanding has only a small effect, both MPO staff and the proportion of voting MPO governing board members that are elected vs. management professionals both have large and statistically significant effects. The greater the number of professional staff the greater the commitment of operating expense support for transit operating expense.

The proportion of voting MPO governing board members that are elected vs. management professionals also has a strong negative effect. This means that when decisions are made by technical experts and transportation managers there is greater commitment to transit than when local elected officials play a more dominant role on MPO governing boards. This is consistent with evidence from California MPOs that more elected official representation on MPO boards reduces climate commitment in funded projects (Mullin et al. 2016).

In model two, income and density are also significant. The full estimation in model 3 provides interesting insights. In this fully specified model the strong effects of MPO staff and governing board composition persist, and the only demand or supply side variable that remains significant is household income.

Table 6 estimates the same models for transit operating expense. Once again, the significant effects of MPO structure are robust to model specification. Again, both MPO staff and the proportion of the governing body composed of elected officials have strong effects in predicted directions. In the full model density and education also have positive effects.

4.4 Interactive Effects of MPO Governance Structure

The final analysis provides a preliminary exploration of the interactive effects of MPO governance structure. According to political market theories of local politics, governing institutions moderate demand and supply forces in predictable ways, amplifying the effects of some factors and suppressing those of others (Feiock; 2014; Carr 2015; Lubell et al 20015; 2009).

For this analysis, we focus on the proportion of voting members of the MPO governing board that are local elected officials vs professional bureaucratic managers since theory and previous research suggest a moderating role for this institution (Feiock 2014). The urban politics literature comparing local government headed by elected mayors vs appointed professional city managers has identified both additive and interactive effects. An elected executive suppress supply side forces and environmental and technical professional interests and enhance responsiveness to demand side and enhance the effect of constituency groups. If a similar dynamic is at play in regional transit governance, we anticipate that elected representation will reduce the impact of supply side factors such as urban form and enhance the impact of demographic constituencies transit demands.   We offer a preliminary test by interacting the proportion of the governing board that is composed of local government elected officials with the density of the UZA and with the proportion of the UZA population that is over 60.   We expect the first of these interactions to be negative and the second to be positive if this governance arrangement suppresses supply side and amplifies demand side influence on transit infrastructure decisions. The results of these test for capital and operating expense are reported in Tables 7 and 8.

Table 7
Interactive Effects of MPO Structure on Transit Operating Expense

	Model 1 Coef. (SE)	Model 2 Coef. (SE)
(Constant)	-6,80e+08	-2.55e+08
MPO staff	2231896 (35255.5)***	2182622 (349457.8)***
Proportion Elected	1.54e+08(1.75e+08)	-4.22e+08 (1.41e+08)***
Log (population)	-424596.5 (1.57e+07)	-688605.4 (1.57e+07)
Density	349946.9 (77418.31)***	210009.2 (27385.43)***
HH_income	323.11 (2283.14)	1228.82 (2094.855)
Compactness	5.77e+07 (6.99e+08)	7.66e+07 (6.98e+08)
Education	9041540 (3004595)***	-1.01e+07 (1.05e+07)
Senior	1699412 (1438227)	1694775 (1440156)
Proportion_Elected* Density	-172498.5 (89477.31)*	
Proportion_Elected*Senior		2.28e+07 (1.19e+07)*
Observations	37	37
R-square	0.9108	0.9106
Adjusted R-square	0.8810	0.8808
Root MSE	5.6e+07	5.6+e07

Table 7
Interactive Effects of MPO Structure on Transit Capital Expense

	Coef. (SE)	Coef. (SE)
(Constant)	-4.57e+08	-1.16e+08
MPO staff	963203 (177070.4)***	905476.7 (188990.4)***
Proportion_elected	2.31e+08 (8.78e+07)**	-2.74e+08 (7.60e+07)***
Log (population)	9726765 (7873270)	9534483 (8485684)
Density	160255.3 (38883.21)***	27537.45 (14810.23)*
HH_income	384.98 (1146.70)	1454.95 (1132.93)
Compactness	1.28e+08 (3.51e+08)	1.63e+08 (3.78e+08)
Education	-103423.1 (1509053)	-1.50e+07 (5695175)**
Senior	-336380.7 (722347)	-261828.9 (778851.6)
Proportion_Elected* Density	-163664.2 (44939.82)***	
Proportion_Elected*Senior		1.78e+07 (6431748)**
Observations	37	37
R-square	0.8642	0.8422
Adjusted R-square	0.8189	0.7879
Root MSE	2.8e+07	3.1e+07

Although the small number of observations makes conclusions tentative, the results strongly confirm our expectations and are very consistent with the political market explanation. Greater representation of elected officials on the governing board diminishes the impact of density on transit decisions and increases the impact of constituencies such as the senior population. Table 7 estimates transit operating expense. The interaction of elected representation and density is negative and the interaction of elected representation and senor population is positive. Table 8 tells a very similar story for capital expense, with a significant negative interaction for density and positive interaction for senior population.

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Appendix A

Variables	Definition	Mean	St. Dev	Min	Max
Dependent Variables					
OpExp	Transit operating expenses allocated the urbanized area in 2014	58,400,000	156,000,000	623156	757,000,000
Capital	Transit Capital expenses allocated to the urbanized area in 2014	23,800,000	63,600,000	0	277,000,000
Independent Variables					
MPO_staff	MPO staff size (in full-time employees, if available, including executive director)	13.60	32.21	1	225
MPO_Free	MPO is a freestanding organization or part of an association of governments or some other multifunction entity 0=freestanding; 1=part of another organization	.44	.50	0	1
Proportion_elected	The proportion of voting member who are elected officials to total voting member on the MPO governing board	.785	.260	0	1
Population	Population of UZA	615387	1160428	51456	5502379

Density	Population density in the urbanized area in census year 2010	1836.927	576.978	1036	4442
HH_Income	Median household income of an urbanized area in 2014	46467.22	7128.053	33234	67031
Compactness	Spacial compactness of the urbanized area	.772	.016	.738	.802
Education	Percentage of people over 60 years old	11.92	4.65	4.94	24.76
Senior	Percentage of people over 18 years old with less than a high school degree	22.26	8.28	7.3	40.6