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# Do Commuters Free-ride? Estimating the Impacts of Interjurisdictional Commuting on Local Public Goods Expenditures

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**Abstract.** In an era of political pressure to reduce taxes while increasing government services, local officials face difficult choices regarding what services to provide and how to finance them. One outcropping of this dilemma is that local citizens are expressing concerns that commuters use local government services but without paying for them. In response, some communities are considering taxing commuters. In this study we develop a basic model of congestion in a two-city model to examine commuters' effects on the optimal provision of public goods. The theoretical result suggests that taxing commuters at the difference in marginal congestion costs between the two cities can attain market equilibrium. We then specify an empirical model to determine this tax's size for Pennsylvania municipalities. The econometric results show differences in marginal congestion costs between workplace and resident communities, providing evidence that commuters may free-ride. The difference in marginal congestion costs, however, tends to be small, so we advise policymakers to be hesitant in adopting such a tax.

## 1. Introduction

Residents often perceive commuters as "free-riders." Commuters use services provided by the local government of their workplace but do not pay for consuming these goods. For example, commuters commonly use police protection and roads near their workplace, but generally give the providing jurisdiction only token reimbursement, primarily via local sales taxes, if applicable.

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Concomitantly, local governments are facing increased pressure to provide more and better services to their residents while reducing local tax burdens. Given this fiscal situation and electorate sentiments, it is understandable why local governments are pursuing user fees and tax exportation strategies to capture additional revenues from non-resident sources. With respect to commuters, some municipalities are considering taxing commuters so they pay their "fair share."

While a commuter tax may seem an intuitive solution to compensate for free-riding across communities, in practice they are political quagmires. The controversial nature of commuter taxes was recently witnessed in New York City's hotly debated repeal of their commuter tax,[2] with *The New York Times* dubbing the acrimonious atmosphere as part of "a destructive competition between the city and the suburbs" (July 24, 1999). A proposed re-emergence of the tax so it applies only to commuters who are non-residents of the Empire State raised the ire of Senator Joseph Lieberman (CT) for its "legislative chutzpah."

One important lesson from the New York experience is that before undertaking the ambitious and controversial policy of a commuter tax, jurisdictions might be well-served by examining whether or not commuters indeed strain public services to the point that they increase the costs of providing these services. To date, however, there has been little applied research examining the specific effects of commuters on municipal government expenditures.[3] In this applied research we address this shortcoming, providing an empirical analysis of commuters' impacts on local government expenditures in Pennsylvania. Our empirical work is important in that it helps determine 1) if a commuting tax is appropriate (i.e., do commuters free-ride?); and 2) if it is appropriate, what should be the size of the tax.

Before our empirical work, we offer a theoretical examination of the impact of commuting on Pareto-efficient resource allocations. Beginning with the assumption that commuters congest public goods, we compare a competitive equilibrium with the Pareto efficient solution, finding that traditional jurisdictional taxing mechanisms (i.e., poll taxes) will generally fail to generate Pareto-efficient outcomes. Recognizing that commuting is indeed an essential part of regional economies, we introduce a commuting tax that ensures a Pareto-efficient resource allocation that can be attained in a competi-

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[2] The city commuter tax was initially levied on all people who worked in New York City but did not live there, and was set at 0.45 percent of wages and 0.65 percent of self-employment income. In 1999, this tax was initially repealed for residents of New York state only, infuriating residents and lawmakers in other states. The state-level discrimination was overturned on appeal. In light of current fiscal stress in the city, the tax is once again being considered.

[3] Neenan (1970) suggests that the suburbs "exploit" central cities, with residents enjoying cultural public and recreational public goods that can only be sustained by large populations. He offers a cost-benefit analysis that supports his contention. Our work differs in both method and theoretical construct, but the underlying arguments are comparable.

tive equilibrium with labor mobility. This tax is set at the difference in the marginal congestion costs of the local public good between two cities.[4]

Summarizing our results, we offer a theory that suggests that commuters should be taxed; but our empirical findings suggest the impacts of commuters on local government expenditures at the workplace are slight. Given that our model does not explicitly consider taxes paid by firms—which should cover some of the public service costs associated with the business' operations -- our results should give pause to policymakers examining commuter taxes for "fairness" reasons.

## 2. Pareto Efficient Resource Allocation in a Model of Commuter-congested Public Goods

Economists are as interested as politicians in debating the issues of public goods, efficiency, and fiscal equalization. Although Tiebout (1956) suggests that "voting with one's feet" leads to an efficient level of public goods provision, it is widely recognized that free migration seldom leads to a Pareto-efficient outcome, both because of congestion in the consumption and / or provision of public goods and fiscal externalities arising from rent sharing. If such externalities are not internalized in the central decision making process, then one region may be overpopulated and the other may be underpopulated.

In this section we examine these issues in a two-city model with commuting. In our model, congestion of the public good is treated as an argument of the household utility function, with more users adversely impacting happiness. This model builds on several earlier studies, including those by Flatters *et al*. (1974) and Wildasin (1987), who derive conditions for ensuring a Pareto-efficient allocation of labor across regions when public goods are congested and labor is mobile (but no commuting is allowed). One key finding common to both studies is that Pareto efficient labor allocations when public goods are subject to congestion requires that differences in per worker taxes be equal to differences in marginal congestion.

More recently, Sasaki (1991) addresses this same issue, allowing for commuting. In Sasaki's work congestion enters the system through an adverse effect on the public good supply cost function. In describing the market equilibrium, he suggests a commuter tax based on differences in marginal congestion costs will ensure a Pareto-efficient outcome. Admittedly, Sasaki's model is more general than the one we describe below, complete with a land

[4] A reviewer pointed out that transport economists examine 'marginal congestion costs' in terms of the value of time people lose due to additional users of the transportation network; in our work we examine these costs in terms of the marginal impact on the costs of providing local public services.

market that introduces firm location decisions and the possibility of land taxes; but our results here are the salient ones for our empirical model, and are consistent with previous constructs.

### *2.1 The set up*

Our model consists of two jurisdictionally independent cities ($i$ = 1,2). For historic reasons, firms are more productive in city 1 than city 2; thus, city 1 attracts workers from city 2. Overall, there are $N$ utility maximizing households with homogenous tastes and preferences who are employed in either of the two cities such that:

$$N = N_{11} + N_{21} + N_{22} \tag{1}$$

where $N_{ij}$ is the population residing in city $i$ and working in city $j$. In this model, $N_{21}$ is the number of commuters from city 2 to city 1.

There are $k_i$ profit-maximizing firms located in each city that face exogenous output prices in producing a homogeneous product ($Y_i$), using land ($l_i$) and labor ($n_i$) as inputs. Firm output is used both as a private consumption good and public goods. The production function is concave and homogeneous of degree one, thus the marginal product of labor is positive and decreasing. The following characterize this situation:

$$Y_i = F_i(n_i,l_i),\ F_{in} > 0,\ F_{inn} < 0 \tag{2}$$

It also follows for the labor force that:

$$k_1 n_1 = N_{11} + N_{21} \tag{3a}$$

$$k_2 n_2 = N_{22} \tag{3b}$$

Now, household utility depends on the consumption of the private good $x_{ij}$, and two types of local public goods $Z_i$ and $G_i$. Here, the public good $Z$ affects the environment for commuting and working (e.g., highways), while the public good $G$ relates to the quality of the living environment (e.g., schools). In the model, the utility households draw from the public goods is influenced by the extent of crowding, which can be represented by the general congestion functions $c_i(Z,N)$ and $d_i(G,N)$. The following important properties are assumed:

$$\delta U / \delta c < 0,\ \delta U / \delta d < 0 \tag{4a}$$

$$\delta c / \delta Z < 0;\ \delta c / \delta N > 0 \tag{4b}$$

$$\delta d / \delta G < 0;\ \delta d / \delta N > 0 \tag{4c}$$

So that the marginal utility from an increase in either of the public goods is positive, while an increase in the number of users, *ceteris paribus*, leads to a decrease in utility. Given this set up, we can see the households have the following utility functions:

$$U_{11} = u(x_{11},c_1(Z_1,N_{11} + N_{21}),d_1(G_1,N_{11})) \tag{5a}$$

$$U_{21} = u(x_{21},c_1(Z_1,N_{11} + N_{21}),d_2(G_2,N_{21} + N_{22})) \tag{5b}$$

$$U_{22} = u(x_{22},c_2(Z_2,N_{22}),d_2(G_2,N_{21} + N_{22})) \tag{5c}$$

In addition to private good purchases households spend their income on a poll tax (*t*) in order to pay for the public goods in their resident community. Furthermore, commuters face a transportation cost (*q*). Hence the representative budget constraints allocate distributed household income ($y_{ij}$) accordingly:

$$y_{11} = x_{11} + \tau_1 \tag{6a}$$

$$y_{21} = x_{21} + \tau_2 + \theta \tag{6b}$$

$$y_{22} = x_{22} + \tau_2 \tag{6c}$$

Each household in this model maximizes their utility subject to their budget constraint.

Our next step is to combine the two cities. Since firm output is used as both public and private goods, and households own the firms, we can write the aggregate resource constraint:

$$Y_1 + Y_2 = N_{11}x_{11} + N_{21}x_{21} + N_{22}x_{22} + \theta N_{21} + Z_1 + Z_2 + G_1 + G_2 \tag{7}$$

As noted above, each city offers each type of public good. In this model, governments use a poll tax ($\tau_i$) to pay for these goods. In practice, this tax is generally only applied to residents, giving:

$$Z_1 + G_1 = \tau_1 N_{11} \tag{8a}$$

$$Z_2 + G_2 = \tau_2(N_{21} + N_{22}) \tag{8b}$$

Equations (1) through (8) describe the two-city economy.

### *2.2 Market equilibrium*

We now are interested in describing the market equilibrium in the two-city economy where households are free to choose their location. In equilibrium, we have the following outcome:

$$U = U_{11}(?) = U_{21}(?) = U_{22}(?) \qquad (9)$$

That is, with a homogenous population, household utility is equalized wherever individuals work or reside.

We can now look at the optimization problem for the Pareto-efficient resource allocation, with the supply levels of the public goods determined exogenously (Wildasin 1987 and Sasaki 1991). Specifically, we examine $\{x_{ij}\}$ $\{n_i\}$ $\{N_{ij}\}$ $\{Z_i\}$ and $\{G_i\}$ in the following Lagrangian. A key result will be the allocation of a fixed total population between the two regions, allowing for commuting.

$$\begin{aligned} L = u &+ \lambda_1[u(x_{11},c_1(Z_1,N_{11}+N_{21}),d_1(G_1,N_{11}) - u] + \\ &\lambda_2[u(x_{21},c_1(Z_1,N_{11}+N_{21}),d_2(G_2,N_{21}+N_{22})) - u] + \\ &\lambda_3[u(x_{22},c_2(Z_2,N_{22}),d_2(G_2,N_{21} + N_{22})) - u] + \\ &\lambda_4[N - N_{11} - N_{21} - N_{22}] + \\ &\lambda_5[Y_1 – F_1(n_1,l_1)] + \\ &\lambda_6[Y_2 - F_2(n_2,l_2)] + \\ &\lambda_7[Y_1 + Y_2 - N_{11}x_{11} - N_{21}x_{21} - N_{22}x_{22} - \theta_{21} - Z_1 - Z_2 - G_1 - G_2] \end{aligned} \qquad (10)$$

This problem's solution leads to a number of interesting optimization conditions. First of all, we see the modified Samuelson condition for the optimal mix between private and public good consumption for the population in each region:

$$c_{11Z}\left(N_{11}\frac{u_Z^{11}}{u_X^{11}} + N_{21}\frac{u_Z^{21}}{u_X^{21}}\right) = 1 \qquad (11a)$$

$$c_{21Z}\left(N_{22}\frac{u_Z^{22}}{u_X^{22}}\right) = 1 \qquad (11b)$$

$$d_{12G}\left(N_{11}\frac{u_G^{11}}{u_X^{11}}\right) = 1 \qquad (11c)$$

$$d_{22G}\left(N_{21}\frac{u_Z^{21}}{u_X^{21}} + N_{22}\frac{u_Z^{22}}{u_X^{22}}\right) = 1 \qquad (11d)$$

Note that when there is no congestion (i.e., $c_{ijz} = d_{ijz} = 1$), then these are the quite familiar Samuelson conditions in a two-region economy. Thus, when these conditions hold, output should be allocated across public and private goods such that the sum of the marginal rates of substitution is equal to the marginal rate of transformation for any population.

The second conditions of interest give us the optimal location of labor across regions:

$$\lambda_4 \quad = F_{1N} - x_{11} + (c_{1N}/c_{1Z} + d_{1N}/d_{1G}) \tag{12a}$$

$$= F_{1N} - x_{21} + (c_{1N}/c_{1Z} + d_{2N}/d_{2G}) - \theta \tag{12b}$$

$$= F_{2N} - x_{22} + (c_{2N}/c_{2Z} + d_{2N}/d_{2G}) \tag{12c}$$

which equates across the three groups the marginal net benefit of an increase in any one population group. Alternatively, this condition assures the optimal allocation of population among the three groups. Specifically, equations 12a-c state that workers should be allocated among regions so as to equate the net social marginal product of labor ($F_{iN} - x_{ij}$), accounting for differences in the relevant marginal costs of congestion ($c_{iN}/c_{iZ} + d_{iN}/d_{iG}$). Note that the ratios $c_{iN}/c_{iZ}$ and $d_{iN}/d_{iG}$ capture the marginal rate of substitution between congestion and the additional production of the public good. In this case we see that the optimal allocation of labor across regions depends on both relative private good consumption and relative congestion. The results in 12a-c are analogous to the theoretical models forwarded by Flatters *et al.* (1974) and Sasaki (1991).

One important question is whether or not a market equilibrium will generate 8a-c. Drawing from the household budget constraints in (6), we get a market outcome:

$$\lambda_4 \quad = \tau_1 + (c_{1N}/c_{1Z} + d_{1N}/d_{1G}) \tag{13a}$$

$$= \tau_2 + (c_{1N}/c_{1Z} + d_{2N}/d_{2G}) \tag{13b}$$

$$= \tau_2 + (c_{2N}/c_{2Z} + d_{2N}/d_{2G}) \tag{13c}$$

The question at hand is whether or not this system can be met under some tax scheme that satisfies each government's budget constraint—in general, we cannot expect that it will.[5] Thus one of the regions will tend to be underpopulated and the other overpopulated. In such an instance, interregional grants would be required to generate an efficient allocation of labor.

However, there may be interest in market-based solutions that do not resort to inter-governmental transfers. For household mobility to ensure this outcome, it must be the case that the difference in the poll tax between the two regions is equal to the difference in the marginal congestion costs of Z. A proposed commuter tax ($\alpha$) states this condition:

[5] Sasaki (1991) provides a detailed derivation.

$$\alpha = c_{1N}/c_{1Z} - c_{2N}/c_{2Z} \quad (14)$$

Now, with (14) and the following tax scheme:

$$\tau_1 - \tau_2 = d_{1G}/d_{1Z} - d_{2G}/d_{2Z} + \alpha \quad (15)$$

and from (8a and b)

$$Z_1 + G_1 = \tau_1 N_{11} + \alpha N_{21} \quad (16a)$$
$$Z_2 + G_2 = \tau_2(N_{21} + N_{22}) \quad (16b)$$

we can achieve the Pareto-efficient resource allocation in a competitive equilibrium.

## 3. Estimating the Size of the Commuting Tax: Evidence from Pennsylvania

The result just derived depends on several strong assumptions; not the least of which is that there exists a social planner whose goal is to maximize social welfare. For now, we distance ourselves from this very real issue and explore a necessary question that determines the relevancy of commuter taxation as a "solution" to the problem. Matter-of-factly, we ask, "Is there a *need* for a solution?" We examine this issue first by determining if three categories of local public good expenditures are subject to congestion in Pennsylvania workplaces (we suggest that they are). We then turn our attention to estimating the appropriate commuting tax ($\alpha$), specifically, differences in the marginal costs in workplace and resident communities. Overall, our empirical estimates of the tax vary by expenditure category, but are relatively small.

We carry out these tasks using the well-established public good demand estimation framework first forwarded by Borcherding and Deacon (1972), and Bergstrom and Goodman (1973). The foundation of our approach is to examine and compare the marginal effects of commuters on congestible public good expenditures in both workplace and resident communities. While a number of earlier studies address the general notion of congestion in a single region (Gramlich and Rubinfeld 1982, Craig 1987, and Schwab and Zampelli 1987), we diverge from our predecessors by providing the first empirical estimates of differences in a two-city model framework.

As a first step, our empirical demand equations are derived from the representative household's maximization problem.[6] Without loss of general-

[6] The social planner does the same. Mueller (1989) describes the median voter model, which suggests that the demand for public goods can be estimated from a single agent's demand (i.e., the median voter) under certain assumptions.

ity, a simplified form of the household utility function—looking only at commuter congested goods-- can be written:

$$U_i(x_{ij}, Z^*) \tag{17}$$

Here, $Z^*$ capture the usefulness of the public goods to the household, accounting for congestion.

A central aspect of the analysis regards the relationship between the number of users and the amount of a good that these users can consume. A characteristic of a congestible good is that when there are more users of a fixed amount of a public good, there is less of that good available per user. Adopting a common variant of the congestion function, we can write, for example, $Z^*=n^{-g}Z$, where $n$ is the number of users of the public good.[7] If $g = 0$, the public good is a "pure" public good in the Samulesonian sense, or one individual's use of a public good does not reduce its usefulness to others. Conversely, if there is crowding of municipal services, and $g > 0$, then an individual receives something less than $Z$. In the case where $g = 1$ the individual's preferences are if they received 1 / n of the total public good.

Now, suppose the household maximizes its utility subject to a budget constraint:

$$x_{ij} + \tau_i Z_i = Y_i \tag{18}$$

or, equivalently,

$$x_i + \tau_i p n^{\gamma} Z^* = Y_i \tag{19}$$

This differs little from the "ordinary" consumer problem; here the price of the public good is simply $t_i p n^g$, with $t_i$ representing individual *i's* share of the total amount spent on the public good (i.e., tax share). Now, assuming the consumer has constant income *(e)* and price *(d)* elasticities, we can then solve for a demand function for $Z^*$:

$$Z^* = c[\tau_i p n^{\gamma}]^{\delta} Y_i^{\varepsilon} \tag{20}$$

where $c$ is a constant. The quantity of $Z$ demanded is $n^g$ times the quantity of $Z^*$ demanded. Substituting $Z/n^g$ for $Z^*$ produces:

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[7] We adopt the most commonly specified form of the congestion function. Means and Mehay (1995) examine several alternative specifications of congestion functions--including quadratic and exponential--finding that there is no compelling reason to choose one particular functional form over another.

$$Z = n^{\gamma} c[\tau_i p n^{\gamma}]^{\delta} Y_i^{\varepsilon} = c p^{\delta} \tau_i^{\delta} Y_i^{\varepsilon} n^{\gamma(1+\delta)} \tag{21}$$

Here, we see that public good demand depends on both price and income. The exponent $\gamma(1+\delta)$ can be interpreted as the elasticity of demand with respect to population, or the percentage change for *Z* given a one percent increase in the number of users. This is our parameter of interest.

After taking the natural logarithm, we arrive at the general formulation of our empirical model:

$$\ln(pZ) = c + \gamma(1+\delta)\ln n + \delta \ln \tau + \varepsilon \ln Y + \sum_{j=1}^{k} \beta_j X_j + \mu \tag{22}$$

where *pZ* is total local government expenditures on the public good.

### *3.1 About the data*

In our empirical model we consider three local expenditure categories: for Pennsylvania municipalities, streets and highways, police, and parks and libraries. Of all municipal expenditure categories in Pennsylvania, these are most likely to be enjoyed by both residents and commuters; although it is reasonable to expect that commuters may congest some "workplace public goods," such as roads, more extensively than others, such as parks and libraries. In terms of the theoretical model described above, these can be thought of as *Z* goods. It is important to note that we look at annual maintenance and operating expenses and not capital investment. We do this because capital investments are lumpy—occurring in one year and then not reoccurring for a number of years. Including such investments would thus skew our dependent variables, given we are dealing with a cross-section analysis.

Important explanatory variables are the income (*Y*) and tax share (*t*,) of the median voter household.[8] The $X_j$'s are descriptive social and economic variables for the municipality, and are chosen based on a review of the empirical literature to capture the importance of other local demand characteristics. We include population density (Oates 1969, and Borcherding and Deacon 1972) and the percent elderly (Bergstrom and Goodman 1973, Craig 1987 and Edwards 1990) in all equations, and the number of serious crimes per 100,000 residents for the police expenditure category.

Our primary interest here, however, is *n*, which is the number of users of the public good. In estimating the commuter tax we apply the empirical

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[8] To calculate tax share, we determined tax rates and ratios of assessed to market value for each municipality. The product of these two is multiplied by the municipality's median valued house to determine the tax bill on the median valued home. This figure is then divided by total property tax revenue to estimate the share of real property taxes paid by the household with the median income.

model to each of two regions. The first is the "workplace," which we define as any municipality where the number of incommuters exceeds the number of outcommuters by at least 5,000. While the net commuting cutoff point is arbitrary, it provides a good representation of the state's employment hubs and may give a reasonable universe of communities that may actually consider instituting a commuter tax.[9] Based on 1990 Census data, there were 56 such municipalities in Pennsylvania. In the workplace models we define the number of users as the sum of the local population and the number of incommuters. In terms of the theoretical model described above, this can be thought of as $N_{11} + N_{21}$.[10]

Our second region is the "bedroom community," which we define as any municipality that is home to at least 10 people who commute to any of the workplace communities. There are more than 1,800 such municipalities in Pennsylvania. In the residence model we define the number of users as the local population net of the number of outcommuters. This definition is analogous to $N_{22}$ in the two-city model.

Fiscal data is drawn from the *1990 Local Government Financial Statistics* for Pennsylvania. The crime rate is measured at county level as the number of serious crimes per 100,000 residents, and is drawn from the City and County Data Book for 1991. Remaining variables are from the 1990 Census. We provide basic descriptive statistics for each of these variables in Table 1. The model is estimated with Weighted Least Squares (WLS) to correct for heteroscedasticity.

# 4. Empirical Results

We present the empirical estimates by expenditure category in Table 2. Column (a) gives the estimates for the "workplace" equations; and column (b) gives the estimates for the "bedroom" equations. The income elasticity is positive and statistically significant only for bedroom communities, ranging from 0.16 (streets) to 2.25 (police). As expected, the tax share elasticity is

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[9] Because this is an arbitrary cutoff, we also ran the model where workplace is defined as net commuting exceeding 2,500; 7,500; and 10,000. In general, we found the results less robust at the lower threshold. This may have been expected as this cutoff does less well in capturing employment hubs. For the higher thresholds, we found little variation in the explanatory abilities of the models, and the statistically significant variables did not vary. The magnitude of the parameters was also generally stable; while the population + incommuting coefficient did notably change from the 5,000 – 10,000 level, the difference has little real impact on the effective level of the commuter tax. Thus, we believe our conclusions are robust across specifications.

[10] A reviewer suggested that commuters and residents might have differential impacts, thus separate coefficients should be estimated for each user group. While we agree in principal, the existence of an extremely strong correlation between the population and incommuters (? = 0.96) for the workplace communities introduced multicollinearity into our models; effectively nullifying our hypothesis tests. We did, however, estimate a version of the workplace model with only $N_{11}$ and our results were consistent with those we report here.

negative—ranging between –0.24 and –1.24-- for all equations where it is statistically significant. In general, then, our basic findings here are consistent with previous empirical studies of public good demand.

**Table 1.** Descriptive Statistics for Workplace and Bedroom Communities

| | Workplace | | Bedroom | |
|---|---|---|---|---|
| Variable | Mean | Std Dev | Mean | Std Dev |
| Streets & Highways | $ 5,007,042 | $ 23,614,105 | $ 177,071 | $ 253,013 |
| Police | $ 10,306,446 | $ 53,900,304 | $ 176,950 | $ 437,151 |
| Libraries & Parks | $ 2,630,743 | $ 12,329,169 | $ 39,462 | $ 157,530 |
| Local population | 61,516 | 213,761 | 4,179 | 5,825 |
| Incommuters | 33,629 | 102,054 | | |
| Population less outcommuters | | | 2,577 | 3,585 |
| Median household income | $ 30,249 | $ 12,582 | $ 29,085 | $ 9,829 |
| Tax share | 0.00018 | 0.00028 | 0.0020 | 0.0035 |
| Pct 65+ years old | 17.4 | 4.8 | 15.3 | 5.1 |
| Population density | 4,063 | 2,580 | 1,427 | 2,042 |
| Serious crimes per 100K (county) | 3,017 | 802 | 2597 | 853 |
| | N = 56 | | N= 1,821 | |

Of course, the user estimates are those that we most care about for the purposes of this paper, and our results allow us to comment on several things. First, we see that the user elasticity is positive and statistically significant in each equation, meaning expenditures for all categories increase as we increase the number of users, including commuters. Furthermore, as has been the focus of much empirical work, we calculate the crowding parameters for the workplace communities [$g = a(1 + d)$], showing that all of the public goods are subjected to congestion in the workplace (i.e., [$g \sim 1$]). Once again, this result is consistent with most previous empirical work.

Given evidence that additional users appear to cause congestion, and knowing that commuters do not typically pay for services at their workplace in Pennsylvania, a commuter tax may seem an appropriate policy. As noted in the theoretical development, such a tax would not only ensure that commuters pay for the congestion they cause, but would also serve to alter the allocation of population between bedroom and workplace communities—with such a tax there would be fewer people living in bedroom communities and more at the workplace when 8a-c hold. Of course, before such a policy is implemented, it is necessary to know how large such a tax should be. Using the parameter estimates from the workplace and bedroom equations, it is possible to estimate the size of the commuter tax by examining differences in the marginal costs of additional users in workplace and bedroom communities and is analogous to equation 14, assuming a constant cost technology across jurisdictions for the public good.

**Table 2**. Weighted Least Squares Parameter Estimates by Expenditure Category

| | Streets & Highways | | Police | | Parks & Libraries | |
|---|---|---|---|---|---|---|
| Variable | workplace | bedroom | work-place | bed-room | work-place | bed-room |
| Intercept | 3.01 | 2.63** | -4.30* | -38.55** | -9.01 | -16.03** |
| Number of users ($N_{22}$) | | 0.80** | | 0.56** | | 0.52** |
| Number of users ($N_{11} + N_{21}$) | 0.58** | | 0.93** | | 1.22** | |
| Median household income | -0.10 | 0.16** | 0.30** | 2.25** | 0.43 | 1.33** |
| Tax share of median house | -0.51** | -0.24** | -0.27** | -1.24** | -0.18 | -0.55** |
| Percent 65+ years | 0.32 | 0.06 | 0.04 | 1.80** | 0.64* | 0.32** |
| Population density | -0.01 | -0.08** | 0.26** | 1.64** | 0.14 | 0.42** |
| Serious crimes per 100K | | | 0.12 | -0.54** | | |
| R-Square | 0.88 | 0.79 | 0.94 | 0.56 | 0.74 | 0.59 |
| Crowding parameter | 1.19 | | 1.27 | | 1.49 | |
| Marginal cost of an additional user | $20.66 | $55.18 | $54.03 | $39.01 | $23.46 | $8.88 |
| a = MC workplace - MC bedroom | | $(34.52) | | $9.32 | | $14.58 |

* and ** denote statistical significance at the 10- and 5-percent levels, respectively

To do so, the last row of Table 2 shows our evaluation of the parameter estimates at their respective means.[11] For two of our goods, we find the marginal expenditures of additional users in the workplace exceed those of an additional user in the bedroom community. For police we find that the workplace marginal expenditure is $54, compared with the bedroom community marginal expenditure of $39. For libraries and parks, we find an additional user increases workplace expenditures by $23; while an additional user increases bedroom community expenditures by $9. For these categories, then, we see the possible basis for a commuter tax.

Of course, commuters are most irksome to residents when they congest local roads. Our results here are interesting in that they show marginal expenditures of additional users for this category are substantially *higher* in bedroom communities than they are in workplace communities, $55 and $21

[11] Because including Philadelphia significantly increases the mean of the dependent variables we exclude it from the following analysis, hoping to provide a picture of more typical workplaces in Pennsylvania. The estimated regression equations themselves, however, included Philadelphia, as the parameters were quite insensitive to its inclusion.

respectively. Thus, while theory suggests that commuters should be taxed for additional congestion costs, the empirical evidence fails to find such an effect for roads.

Given popular perceptions, this finding is especially notable. Our explanation is that the expenditures we investigate consider only operation and maintenance expenses (e.g., pothole fixing), rather than capital improvements (e.g., road widening). What is more, commuters typically use the main thoroughfares when going to work; it is not uncommon for these roads to be state or federal highways in Pennsylvania, rather than locally funded roads. Finally, roads are likely to be used more intensively by local users, rather than commuters. In light of these practical issues, commuters might not be expected to greatly affect ongoing local expenditures for roads. The issue of commuter impacts on capital expenditures warrants further investigation.

## 5. Conclusions

Our work was motivated by the simple question "Do commuters free-ride?" The theoretical framework we develop presents commuters that congest public goods without necessarily paying for them. Our empirical results show two things. First, they support the notion that commuters have some positive impact on local public expenditures, at least for some goods. Second, they suggest that commuters have differential expenditure impacts at the margin between workplace and bedroom communities. At first blush, our results suggest commuters may be free-riders.

Before recommending a commuter tax, however, we need to consider the revenue side. While our empirical model investigates commuters' effects on the costs of providing public services, it does not investigate commuters' contributions to local receipts. For example, some municipalities in Pennsylvania charge an *occupational privilege tax* (OPT). Workers remit this tax—which widely ranges in amount according to job title—to the municipality in which they work.[12]

More importantly, the model we present does not account for taxes paid by a commuter's *employer*. Realistically, it can be convincingly argued that some of the local taxes paid by a business compensate a municipality for services used by its employees. For example, business taxes are used, in part, to pay for roads, which not only convey capital inputs, but labor inputs as well. Also, it is unlikely that all local business taxes are used solely to finance government services that support businesses. For example, in Pennsylvania all municipal property taxes show up as revenue in the local general fund, regardless of source. In turn, this general fund is used to pay for a variety of local government services. It is not a stretch to imagine that some business

[12] Still, the OPT should not be construed a commuter tax, as it does not discriminate according to place of residence.

taxes may very well be paying for non-business services, such as parks and libraries.

For some casual evidence, we can simply compare revenue streams for workplace and bedroom communities. For the 56 workplace communities defined above, industrial and commercial properties represent 41 percent of the community property tax base. In bedroom communities, these types of properties are only 25 percent of the property tax base. Thus, in the state's employment hubs, businesses tend to finance a larger proportion of the local budget. While we do not analyze the impacts of businesses on local government expenditures, it seems plausible that they are paying for many of the services they receive. In this case, then, commuters may not be free-riding if their congestion impacts are considered in the employer tax bill.

The above two situations suggest that commuters often do pay taxes - or have them paid by someone else - to the extent that municipalities are at least partially reimbursed for commuters' effects on local public goods expenditures. Future work might more fully incorporate the revenue side, but given the rather small differential impact commuters seem to have on local public expenditures, it surely will not take all that much revenue to reimburse the local governments. In sum, we recommend that municipalities think very carefully about levying a commuter tax, as it would be difficult to justify on the grounds that commuters free-ride.

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