A CORDON CHARGE FOR THE DISTRICT OF COLUMBIA: A SOLUTION TO DC'S FISCAL PROBLEMS AND THE REGION'S CONGESTION?

Alexander Fairfax Marks
Undergraduate Student Researcher – Plan II Honors Program
The University of Texas at Austin
6.9 ECJ, Austin, TX 78712-1076
afmarks@gmail.com
Phone: 512-471-8270
FAX: 512-475-8744

Kara M. Kockelman
Associate Professor & William J. Murray Jr. Fellow
Department of Civil, Architectural and Environmental Engineering
The University of Texas at Austin
6.9 ECJ, Austin, TX 78712-1076
kkockelm@mail.utexas.edu

Presented at the 86th Annual Meeting of the Transportation Research Board,
Washington, D.C., January 2007.

ABSTRACT

This paper investigates a solution to an existing federal policy which prohibits the District of Columbia (DC) from imposing commuter taxes on non-residents, a tool which other cities in the US use to address revenue problems associated with high numbers of non-resident workers. DC, which has higher local governance costs per capita than its surrounding suburbs, must impose higher income tax rates to balance its budgets. However, because DC cannot legally levy a commuter tax under existing federal policy, many workers in the region currently "escape" taxation: as residents of the surrounding suburbs, they pay substantially lower income taxes.

Non-residents account for more than 70% of DC's workforce. These workers enjoy costly city services without any substantial remuneration to DC. This scenario has resulted not only in a structural fiscal imbalance for DC, but also one of the highest levels of congestion of any region in the US. A per-vehicle cordon charge may be the answer, internalizing the costs to DC for providing services to non-residents visitors by collecting revenues for the services it provides, while reducing congestion.

Here, it is estimated that DC spends $3.50 per visitor per day on city services for nonresidents. Thus, this amount is proposed as the approximate cordon charge per vehicle, to help cover services DC provides such visitors. Electronic toll collection (ETC) technologies allow DC to impose a cordon charge without significant impacts on existing traffic flows. An estimate of ETC costs suggests that implementation could easily be supported by the region, while economically viable for DC.

KEYWORDS

Congestion, electronic toll collection, cordon charge

INTRODUCTION

The Government of the District of Columbia (or DC) has sued in federal court for the right to impose an (income-based) tax on the thousands of commuters who flood its territory each day. However, under the DC Home Rule Act of 1973, DC is prohibited from taxing the incomes of any non-residents. While over 40 US cities (including communities in Pennsylvania, New Jersey and Ohio) impose commuter taxes in order to provide services to a high-number of non-residents who may work in their jurisdiction, a federal court ruled that Washington, DC, is specifically blocked from imposing any commuter tax or commuter charges without direct Congressional approval.

According to DC Mayor Anthony Williams, "The infrastructure of our city is obviously taxed by the daily wear and tear of tens of thousands of commuters who work in the district but who do not pay for the city services that they use**"** (Cauvin 2006, pp. B04). In a report issued earlier, the General Accounting Office (GAO) somewhat substantiates these claims by finding that DC has a "structural imbalance," a situation where a jurisdiction does not have enough revenue-raising capacity to cover its expenses (GAO 2003). The income tax burden that DC imposes, 9.5% on incomes above $30,000, is one of the highest in the nation (only Montana imposes a comparable income tax of 9% on incomes above $32,101; four other states impose a comparable tax rate on incomes of $82,952 or higher). Yet the "District's spending is 5 percent below that needed to fund an average level of services" (Dalton 2004, pp. 6). The GAO notes that this structural imbalance may not be entirely caused by the large daily inflow of commuters. Nevertheless, the fiscal impact of non-resident commuters and visitors may in fact be much higher than the GAO's estimates.

Consider that 71.6% of DC's workforce (481,112 out of 671,668 workers) is comprised of non-residents. These workers pay substantially less income tax if they choose a residence in nearby Maryland or Virginia. For workers with incomes above $35,000, upper income tax brackets are 9.3% for residents of DC, but just 4.75% in Maryland and 5.75% in Virginia. The associated tax savings is substantial for many households. For example, if a married couple with one child enjoys earnings of $200,000, under 2006 tax rates, they would save close to $8,650 by living in Maryland or $6,340 by living in Virginia, rather than DC (Federation of Tax Administrators 2006). An extra $6,500 per year can translate to an extra $100,000 for home purchase, perhaps creating an exaggerated preference for more distant residential locations (in addition to common preferences for suburban living), resulting in large net flows of workers that strain the region's infrastructure, as non-resident workers travel into and out of the District each day.

Data from the Census Bureau's 2000 county-to-county worker flow files were used to characterize these flows (2003). The number of non-resident workers is substantial: 71.6% of the District's workforce (481,112 out of 671,668) are non-residents, with 68.1% (457,730) from the study area, which includes, the Maryland counties of Anne Arundel, Baltimore, Calvert, Charles, Frederick, Howard, Montgomery, Prince George's, and St. Mary's, as well as the city of Baltimore; and the Virginia counties of Arlington, Fairfax, Fauquier, Loudoun, and Prince William, as well as the cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park. Table 1 provides approximate distance measurements between the DC Central Business District (CBD) and the cities and county seats in the study area.

Table 1. Approximate Distances from Washington CBD to County Seat/City
(Source: Google Maps, 2005)

Jurisdiction (County Seat in parentheses)	Approximate Distance (miles)
Anne Arundel (Annapolis)	32
Baltimore (Towson)	59
Calvert (Prince Frederick)	43
Charles (La Plata)	34
Frederick (Frederick)	48
Howard (Ellicott City)	40
Montgomery (Rockville)	21
Prince George's (Upper Marlboro)	19
St. Mary's (Leonardtown)	57
Baltimore City	44
Arlington	5
Fairfax (Fairfax City)	19
Fauquier (Warrenton)	47
Loudoun (Leesburg)	36
Prince William (Manassas)	32
Alexandria	7
Fairfax (City)	19
Falls Church	9
Manassas	32
Manassas Park	30

A DC-focused calculation of *net* worker flows illustrates the severity of the imbalance. Table 2 reports a listing of the jurisdictions in the study area and the net number of workers reporting their workplace in DC. The results are not surprising; every jurisdiction in the study area sent more workers to DC than DC sent back.

Table 2. Net Flow of Workers to DC by Jurisdiction
(DC Residential Workforce = 190,556, DC Total Workforce = 671,678)
(Source: Census Bureau 2003)

Jurisdiction	*Net* Flow of Workers to DC from Jurisdiction	Total Workers to DC	Net Flow as a % of All Workers in Jurisdiction	Total Workers In Jurisdiction
Anne Arundel	14,958	15,819	5.85%	255,858
Baltimore	3,298	3,682	0.88%	373,496
Calvert	3,908	3,967	10.41%	37,556
Charles	10,508	10,785	17.03%	61,698
Frederick	2,904	3,025	2.84%	102,318
Howard	7,943	8,461	5.88%	134,992
Montgomery	80,163	99,672	17.61%	455,331
Prince George's	112,483	126,138	28.30%	397,403
St. Mary's	1,702	1,828	3.93%	43,264
Baltimore City	2,208	3,038	0.89%	249,373
Arlington	30,099	42,263	25.94%	116,046
Fairfax	76,664	88,908	14.53%	527,464
Fauquier	1,080	1,139	3.83%	28,224
Loudoun	5,082	5,843	5.51%	92,315
Prince William	15,020	15,368	9.98%	150,526
Alexandria	19,252	23,292	24.94%	77,190
Fairfax (City)	1,178	1,631	9.95%	11,845
Falls Church	1,326	1,696	22.66%	5,853
Manassas	764	864	4.21%	18,145
Manassas Park	240	311	4.36%	5,503

Table 2 demonstrates that DC has imbalances of over 318,000 workers (almost half of DC's workforce) with Arlington, Prince George's, Montgomery, and Fairfax Counties, the four counties nearest to the District. In essence, for every resident that leaves the District each work day, 6.8 workers replace him/her. For instance, Prince George's County is the county of residence for 126,138 DC workers, comprising nearly 17% of DC's entire workforce. While that County's own workers constitute nearly 40% of its own workforce, DC's residents constitute only 28% of the District's workforce (190,556), and less than 3.5% of Prince George's County's workforce.

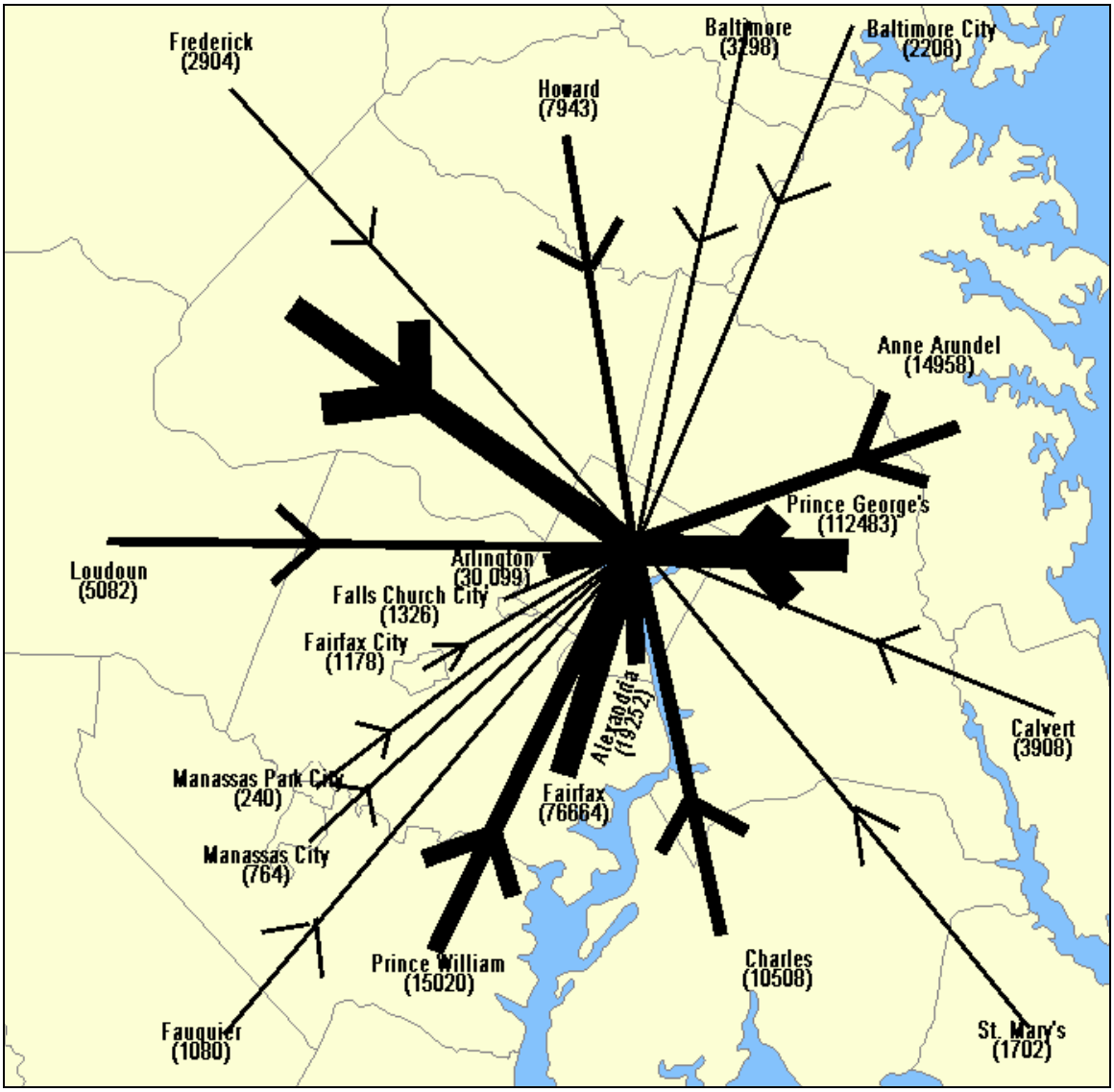

Figure 1. Net Flows of Workers into the District of Columbia from the Study Area
(Source: www.nationalatlas.gov 2006)

Figure 1 illustrates the *net* flow of workers into DC. (As line-thickness increases, net flow increases.) As one can see, though DC is capable of providing substantial job opportunities for the region, these opportunities are not without a price. In addition to the fiscal imbalances discussed earlier, these large volumes of commuters cause substantial congestion in the region's transportation system.

As part of their Urban Mobility Report, Schrank and Lomax (2005), paint a grim picture of the Washington area's congestion, ranking it third highest in level of travel delay of any region in the US, with 69 hours of delay per peak traveler; only the Los Angeles/Long Beach and San Francisco/Oakland areas have higher levels of delay. In terms of their Travel Time Index, only the Los Angeles, San Francisco, and Chicago metropolitan areas have higher values. The

nearly $2.5 billion they estimate as lost each year (in traveler delay and gasoline) is over one half the District's $4.62 billion budget.

Local governments often provide a variety of services for a fee to non-residents. These can include access to museums, universities, and libraries (see, e.g., Akuntagawa and Mun 2005). . The GAO (2003) notes that DC's large number of non-resident workers results in a substantial, marginal cost of providing commercial and employment-related services. As a related user fee and solution to the District's continuing budget issues, DC might do well to consider a toll ring or area charge. Similar in set-up to Stockholm's toll ring the introduction of a cordon charge on all auto vehicles would function effectively as a "cordon toll" with DC's boundaries serving as a potential demarcation for the cordon (Stockholm 2006). Unlike Stockholm's plan, the DC cordon investigated in this paper would only charge inbound vehicles, as they first enter the District, just once per day.

As an alternative to entry tolling, DC may also consider payroll taxes. Many types of commuter taxation in the United States are assessed via straight payroll taxes, as in Ohio and Pennsylvania where municipalities are legally allowed to tax up to 1% of an employee's income, regardless of residency (Gessing 2003). However, while some municipalities in other states have found direct commuter payroll taxes to be a successful policy, income taxes will not relate to congestion-based externalities. Thus, it is unlikely that such payroll taxes will have much of an impact on the region's serious congestion levels.

Ultimately, the Washington region's transportation scenario is a complex situation, perhaps spurred on by a highly-subsidized transportation infrastructure and questionable inequities in income taxes. A unique situation may require a distinctive solution: instituting a transportation policy to fund a largely non-transportation program. In effect, a DC cordon charge can help internalize the associated costs of local government services for non-residents. While such an approach may seem taboo in the current policy environment, the initial research described in this paper suggests that DC might be able to institute an equitable cordon charge proposal that recoups payment for the costs that DC incurs in providing services to all non-residents entering by car, while addressing some of the region's significant congestion problems..

COMPUTING THE CORDON CHARGE

In this light, a scenario was developed with a cordon charge based broadly on the expenses incurred by DC on a "per-visitor" basis. It seeks to create a channel through which non-residents can compensate DC for the cost of services provided. An estimate for these expenses was developed from 2004 expense data, as reported by the DC Office of the Chief Financial Officer (DC CFO 2005a). To estimate non-resident costs, this work does the following: (1) identifies services which benefit non-residents, (2) determines how many non-residents share these costs, and (3) adjusts for differences in durations/times of day that services are accessible to non-residents. These stages are described below.

Identifying Non-Resident Services

This analysis sought to identify those services which are ultimately beneficial to a public at-large, versus those which are beneficial only to DC residents. Each line-item expenditure under the FY2004 budget's eight appropriation titles was evaluated to determine whether it benefits (or would indirectly benefit) a non-resident visitor. The District's Annual Operating

Budget (DC CFO 2005b) contains concise descriptions of each expenditure and was used to determine service accessibility, through application of the following three questions:

(1) Does the fiscal expenditure provide a service beneficial to a non-resident visitor? (i.e. could it be accessed and used by a non-resident visitor?)
(2) Does the fiscal expenditure support another agency which provides a service accessible to non-resident visitors?, and
(3) Does the fiscal expenditure provide a regulatory protection to the non-resident visitors?

If any of the test questions were answered in the affirmative, the expenditure was assumed to be of benefit to non-resident visitors and, therefore, included in an estimate of DC's non-resident costs. For instance, the fiscal outlay for the "Council of the District of Columbia" would be considered to benefit non-residents since its role will ultimately support other DC agencies which benefit non-residents. However, the fiscal outlay for "Advisory Neighborhood Associations" would not be included in non-resident costs, since the outlay would not be of benefit to non-residents (DC CFO, 2005a). In this manner, the FY2004 budget was analyzed to determine which expenditures would be accessible to a non-resident visitor and which expenditures would be accessible only to residents. Once each item was identified, the next step was to determine the number of non-residents who use DC services on a daily basis.

Determining Total Visitor Numbers

County-to-county worker flow files reveal that 481,112 non-residents travel to DC each workday (Census Bureau 2003). Though a worker will typically be compensated for 260 days of work, the US Office of Personnel Management (OPM) mandates that federal employees receive 20 days of leave in their third through fifteenth year of service (2006) and ten paid holidays per year. Using these policies as benchmarks for the work-related trips into DC, an assumption was made that an average worker will make 230 work-related trips to DC each year. This results in 110,655,760 personal trips into DC annually.

However, county-to-county worker flow files do not capture persons coming into DC for non-work related reasons, such as tourism, recreation, and cultural excursions. To gain an approximate value for these trips, data was taken from the 1995 American Travel Survey (the most current available, which reported 13,060,000 interstate personal trips into DC for business, visits for friends/relatives, leisure, personal business of vacations (BTS 1997).

Taking trip data from both county-to-county worker flow files and the American Travel Survey, an average annual number of personal trips into DC was estimated to be 123,715,760, or 338,947 per workday. While 338,947 is lower than the number of non-resident visitors that claim DC as their place of work, it may better estimate the average trips taken into DC daily, if both workdays and weekends are included.

Adjusting for Service Access Durations

In determining non-resident costs, most services benefit both non-residents and DC residents; in this case, DC residents will have far more access to these services than a non-resident since they obviously spend more time within DC's territory. To take this discrepancy into account, costs for services that were both continually provided and services that were only provided during a business day were discounted based on the time a service was available to a

particular population group. For services that are continually provided, this ratio can be found in Equation 1. An assumption is made that personal trips (123,715,760, in all) are singular in nature and do not overlap. The following provides the approximate fraction (f_{NRH}) of total person hours in DC that non-resident hours represent.

$$f_{NRH} = \frac{NonResidentTrips \times AverageVisitDuration}{(DCPopulation \times HoursPerYear) + (NonResidentTrips \times AverageVisitDuration)}$$

Equation 1.

Since 89% of these person-trips are generated by non-resident workers traveling to DC each day to their place of employment (rather than by visitors), it was estimated that each of these trips into DC had an average activity duration (at the DC destination) of 10 hours (a standard workday: 8AM to 5PM, with another hour for personal business, and ingress/egress time within DC's boundaries). The US Census Bureau (2006) estimates DC current population to be 572,059 persons. And, of course, there are 8,760 hours in a 365-day year. Introducing these values into Equation 1 results in Equation 2. This is the (estimated) fraction of non-resident time spent within DC relative to resident time:

$$f_{NRH} = \frac{123{,}715{,}760 \times 10}{(572{,}059 \times 8{,}760) + (123{,}715{,}760 \times 10)} = 0.198$$

Equation 2.

Thus, 0.198 is the share of costs applied here to the estimates of DC expenses benefiting non-resident visitors via services that are provided 24 hours a day, 7 days a week. For example, if a service costs $1 million annually to provide, and is provided continuously to residents as well as non-residents, then the visitor expense would be calculated as $198,000. However, if a program or agency does not provide services continuously, and can be accessed only during business hours (for business purposes, for example), then the fraction rises. If work days per year are 260 and 9 hours per workday apply per visit, then only 2340 hours exist of service access in a year, to a DC population of only those DC residents (190,556) with workplaces in DC, resulting in an f_{NRH} of 0.735, as shown in Equation 3.

$$f_{NRH} = \frac{123{,}715{,}760 \times 10}{(190{,}556 \times 2{,}340) + (123{,}715{,}760 \times 10)} = 0.735$$

Equation 3.

An inherent shortcoming in this approach is that every hour of the day is treated equally. This implies that DC provides an equal level of continual services at both 2AM and 2PM, which may or may not accurately reflect DC spending patterns. Also, assumptions of average trip time, though estimated to be 10-hours in duration, are also highly variable, though this was not considered in the overall estimate. Finally, this method does not account for the

fiscal impact that DC residents traveling to other jurisdictions for work may cause, though the underlying rationale for this cordon charge is that non-resident visitors traveling into DC have greatly swelled the capacity needed for city services beyond those needed for its residential population of 572,059. Distributing inbound DC trips across 365 days reveals that, on average (and inclusive of workdays and weekends), 348,947 individuals make trips into DC. This represents nearly a 60% increase in DC's resident population. Such a high number definitely dramatically increases demand on city services. While such considerations point to inaccuracies into the f_{NRH} estimates, the purpose of this analysis is not to arrive at a specific, exact value that may lead to a revenue-neutral policy, but to a general approximation of the costs DC incurs for non-resident visitors.

ANALYSIS OF DC'S FY2004 BUDGET

With assumptions on how to identify line items in DC's budget that are applicable to a non-resident visitor (i.e., using a 19.8% fraction for continually provided services and 73.5% for services only provided during business hours), DC's budget was analyzed to provide a per-visitor cost estimate for daily service provision to non-residents.

As seen in Table 3, $483 million of the DC's FY2004 budget (from DC's eight appropriation titles) were estimated to be made specifically to support agencies that provide services accessible to non-resident visitors. This amount constitutes nearly one-tenth of DC's annual budget (10%).

It is important to note that the end-goal of this analysis is not an exact tally of DC expenses incurred on behalf of non-resident visitors, but rather an approximation upon which potential cordon charges that seek to recapture the costs of non-resident visitors may be based. The $483 million stands in stark contrast to a similar GAO (2003) estimate, which ranges from just $44 to $77 million dollars. One key difference in assumptions is that the present paper looks at DC services made accessible to non-residents, while the GAO report emphasizes variable workload factors for different components of DC's services. The GAO's method may better internalize the (economic) benefits that non-residents provide by working and shopping in DC. The net effect may lay somewhere in between, and further investigation of specific impacts due to worker inflows will be crucial before such a pricing policy can even be implemented.

Table 3. District of Columbia Non-Resident Expenses in FY2004
(Source: DC Office of the CFO, 2005c)
(Dollar Amounts in Thousands for FY2004)

APPROPRIATION TITLE	TOTAL OUTLAY	NON-RESIDENT EXPENSE
GOVERNMENT DIRECTION AND SUPPORT	$231,364	$82,595
ECONOMIC DEVELOPMENT AND REGULATION	$117,251	$44,313
PUBLIC SAFETY AND JUSTICE	$746,064	$147,721
PUBLIC EDUCATION SYSTEM	$1,029,193	$467
HUMAN SUPPORT SERVICES	$1,117,038	$101,620
PUBLIC WORKS	$314,620	$61,414
ENTERPRISE AND OTHER FUNDS	$660,069	$45,023
FINANCING AND OTHER	$400,963	--
GRAND TOTALS	**$4,616,562**	**$483,153**

With total non-resident expenses estimated at $483 million, the next step is to reduce this to an approximate per-day, per person charge. Again, data from the 2000 US Census (Census Bureau 2003) and 1995 American Travel Survey (BTS 1997) were used to estimate the number of non-residents visitors traveling to DC each day. The US census reports that 481,112 workers travel to DC each workday. From prior assumptions, it will be assumed that this occurs on 230 days each year. The American Travel Survey reported a total of 13,060,000 person- trips to DC annually; assuming that this is distributed equally each day, this amounts to 35,781 visitors per day, each day of the year. Taking a weighted average of these two values, it was estimated that 378,491 visitors will travel to DC each day.

Attributed equally to all non-resident visitors, DC spends roughly $3.50 per visitor per day. For a non-resident worker who commutes to DC for 230 workdays annually, this translates to an annual cost of $805. For someone who travels every day of the year, the cost would be $1278. If DC sought to recapture expenses for services provided to all non-resident visitors per-day, a $3.50-per-visitor charge would be needed.

THE EFFECTS OF A $3.50 CORDON CHARGE

A sudden daily travel cost increase of $3.50 could represent a shock to the heavily subsidized commuter transportation landscape of the Washington, DC area, especially when focused on a single mode (the private car). Nearly all major road links, with the exception of tollway links providing service between the Capital Beltway, Dulles Airport, and Leesburg, Virginia, are non-tolled. Mass transit services, provided by the Washington Metropolitan Area Transportation Authority (WMATA), remain heavily subsidized through complex sales tax agreements and transfer payments. Thus, they are relatively inexpensive for WMATA users. In addition, a motley mix of private bus services, public commuter bus programs, state-initiated commuter rail services, and the National Rail Passenger Corporation (AMTRAK) provide commute options for work-based trips.

However, when compared to the actual costs of owning and operating a car, $3.50 seems rather reasonable. After analyzing the distances to suburban Washington communities (Table 1) and weighting these distances for the total number of workers who travel to DC from county-to-county worker flow files (Table 2), the average non-resident visitor with a workplace within DC

commutes 20.5 miles each way each workday. In terms of a worker's round trip, this equates to 41 miles each workday.

From the county-to-county worker flow files (Census Bureau 2003), counties and municipalities serviced by toll roads represent about one-fifth of all workers who identify DC as their place of work. The Dulles Toll Road and the Dulles Greenway are the region's only existing tollways, with respective tolls of approximately $.05 and $.23 per mile for two-axle vehicles, traveling on a weekday. Tolls can be paid with a SmartTag, which is compatible with the prolific E-ZPass system found in the northeast US. (Dulles Greenway 2006). The tollways function both as collectors for Fairfax County commuters and as a high-speed route between Lessburg, VA (or more broadly, Loudoun County) and the Capital Beltway. Census Bureau worker flow files indicate that 88,000 Fairfax County residents claim their workplace in the District, while fewer than 5,000 Loudoun County residents make their way to the District for their place of work (2003).

In order to characterize the traffic impacts that a $3.50 cordon charge may have, the top 10 corridors, as seen in Table 4 were analyzed using elasticity estimates ranging from -0.3 to -2.9, as reported for urban commuting by the Victoria Transport Policy Institute (VTPI) (2005a). Existing costs for daily commutes to work were estimated to be $41.48. (This figure includes the per-mile cost of owning and operating a vehicle, at 56.2 cents per mile (BTS 2004) for an average of 21 miles each way, and a $13.75 value of time for the 1.3 hours average round-trip travel time (AASHTO 2002; Schrank and Lomax 2005). It does not include parking charges, which may add another $10 per day or more, for many workers and visitors.) Incorporating a $3.50 charge may represent just an 8.4% increase in the cost of such commutes.

With an increase of 8.4% in the cost of traveling, the VTPI elasticties suggest a 2.5 to 24.4% reduction in traffic levels. Even a 10% drop has the ability to offer substantial travel time improvements on congested elements of the system (see, e.g., Kockelman 2004).

Looking at average traffic volumes over an entire day on the most heavily traveled 10 corridors into DC, a cordon charge suggests shorter, and more reliable travel times on several routes. Table 4 assumes that average annualized daily traffic levels are spread uniformly over an 8 hour period each day, suggesting that several exceed capacity and almost all operate at level of service (LOS) C through F (HCM 2000). Assuming minimum and maximum responses to a $3.50/day toll ranging from 10% to 20% reductions in vehicles, the anticipated changes in LOS are significant, with almost all routes experiencing a noticeable improvement. Certainly, speeds are expected to improve (and travel times fall) as the number of vehicles travelling falls, even if the associated LOS does not change.

Table 4. The Impact of a $3.50 Cordon Charge: Flow Rates and LOS for the District's 10 Most Heavily Traveled Entrance Corridors.

CORRIDORS	AADT (veh/day)	#LANES INBOUND	VEHICLES PER HOUR PER LANE			LEVELS OF SERVICE (LOS)		
			EXISTING	10% CHANGE	20% CHANGE	EXISTING	10% CHANGE	20% CHANGE
IH-395	250000	4	3906	3515	3125	F	F	F
US-50	132000	4	2064	1858	1651	E	D	D
DC-295	106000	3	2208	1987	1766	E	D	D
IH-66	100000	4	1563	1407	1250	D	C	C
IH-295	75000	2	2343	2109	1874	F	E	D
Memorial Bridge	73000	3	1521	1369	1217	D	C	C
US-29	60000	3	1251	1126	1001	C	C	C
Connecticut Ave. NW	38000	3	792	713	634	B	B	B
East Capitol St.	36000	3	750	675	600	B	B	A
16th St. NW	35500	2	1110	999	888	C	B	B

Note: LOS values are based on HCM estimates for a homogeneous-freeway with a 60 mi/h free-flow speed assumption. In reality, design conditions, speed limits and free-flow speeds in many corridors are lower than this for the DC area, which would lower the implicit capacity levels and push LOS values closer to F.

When faced with an additional $3.50 in travel costs, some fraction of commuters (perhaps 10 to 20%) will shift to other modes, including carpools and telecommuting, where costs are shared or avoided altogether. In the longer term, workers' job and home location selections may change as well.

In order to encourage such shifts, while avoiding the administrative burden of charging tolls on all modes entering DC, policymakers may choose to waive cordon charges on passengers entering via non-auto modes. Data from the American Association of State Highway Transportation Officials (AASHTO) (2002) was used to identify a weighted-average commute time for those traveling into DC via automobile versus those commuting via transit. The 421,160 individuals with workplaces in DC, driving either alone in their vehicle or with a carpool of two or more individuals are estimated to face a (weighted) commute time of 39 minutes versus 47 minutes for the 197,590 workers who traveled via rail or bus. In essence, those workers choosing the auto vehicular modes over the transit mode saved, on average, 8 minutes of travel time each way, or 16 minutes per day (AASHTO 2002).

Schrank and Lomax (2005) report that the average value of time for Washington-area residents was $13.75 per hour in 2003 (the most current year available). In monetary terms, a 16 minute-per-day savings in time translates to $3.66 per day. Thus, while there may be more compelling reasons to exempt users of mass transit travelers from the fee, policy-makers may elect to exempt transit users, who face longer commute times, based simply on cost comparability.

A Comparison with Other Road Tolls

In the United States, direct charges for the usage of surface transportation facilities are not as prevalent as in many other countries. However, as motor fuel excise taxes become scarcer as transportation needs increase, it is likely that new capacity will be financed through the use of

tolls and other transportation charges. Charges currently in existence in the US include the Port Authority of New York and New Jersey (PANYNJ 2005) which assesses a $6.00 ($5.00 for users with an E-ZPass transponder) toll to traffic crossing the Hudson River, heading into New York from New Jersey, and the Bay Area Tolling Authority (BATA 2005), which charges (non-HOV) autos $3.00 to cross Bay Area bridges. Dallas drivers traveling on North Texas Tollway Authority's (NTTA) Dallas North Tollway facilities can expect to a pay a toll of approximately $.10 per mile (NTTA 2003).

Outside of the United States, transportation charges and tolls, especially those addressing the congestion and air-quality problems of large, international cities are much more commonplace, especially in Europe and Asia. As mentioned earlier, Stockholm assesses a variable cordon toll between SEK 10 and 20 (or $1.25 to $2.50) on vehicles entering the commercial core between 6:30 AM and 6:30 PM (Andersson 2006). Driving across major toll points in Norway usually costs NOK 15-30 ($2.30 - $3.60), typically at cordon lines around the larger cities (NPRA 2005). In Singapore, an Electronic Road Pricing policy assesses an electronic toll at gantries located on most of the city's major freeways; drivers are typically debited SGD $0.50 to $2.00 (or $0.31-$1.24 in US dollars) (Land Transport Authority 2005).

Another point of comparison lies between toll charges and income taxes. Some cities, such as Philadelphia, Detroit, and Cleveland tax the incomes of non-resident workers at a rate of 1 to 2% (GAO 2003, p. 44). While it is important to note that a $3.50 cordon charge would in no way function as a commuter tax, the charge would equate to a 1.8% tax on an income of $45,930, the average per capita income in the Washington region (BEA 2005). The introduction of a cordon charge of $3.50 would not only be comparable to other commuter tax policies in the United States, but would also moderate incentives for living in Maryland and Virginia on the basis of lower income tax liabilities. (As noted earlier, the differences are roughly 4%. In this way, the $3.50 per day charge on households of above-average income could still be far less than the tax-related benefits of living outside DC.)

IMPLEMENTATION OF A CORDON CHARGE

The introduction of an auto-based visitor charge would function effectively like an area-based "cordon" toll along DC’s boundaries. Rather than a traditional cordon toll (where the toll is assessed each time a vehicle crosses the cordon), the proposed charge would be similar to London's current area licensing scheme, which charges only once per day and exempts residents living within the tolled area from paying the charge (though London actually only gives residents inside the area a 90% discount). Transport for London (the authority overseeing London’s congestion charge) uses automatic number plate recognition (ANPR) technologies, which requires a large network of cameras to capture images of all vehicles inside the congestion charge’s boundary. Stockholm uses similar technology (as well as RFID technology) but has instituted a cordon charge (tolling vehicles each time they cross into and out of the city).

Ukkusuri et al. (2004) note that many other cities have had success using electronic toll collection (ETC) technologies under a policy comparable to that used in London and Stockholm. In London's case, Litman (2006) notes concerns that its widely-used ANPR approach to collecting the congestion charge seems "an invasion of privacy." As a counter to this claim, he notes that "British cities already have extensive video surveillance systems, and access to vehicle location data is controlled to limit invasion of privacy" (p. 9). However, privacy may be a concern for any policy which seeks to record the travel of nearly all vehicles in a geographic area. Kockelman and Kalmanje (2005) investigated the public's response to (credit-

based) congestion pricing policies in Austin, Texas and note that privacy is still an issue which needs to be addressed under the policy proposal, suggesting that abuse of data can be prevented by the use of neutral third-parties and appropriate legislative protections.

For the purposes of a proposed DC cordon charge, an ETC approach utilizing predominantly RFID technology and set up in a manner similar to Stockholm's tolling system (but using area, rather than cordon, pricing) may be an optimal solution, since such technology approaches have already been successfully deployed in the United States. In a survey by the FHWA's Intelligent Transportation Systems Joint Programs Office (ITS JPO 2005a), 3789 (or 77.3%) of the nation's 4901 total toll collection lanes are equipped with ETC capabilities (and 772 of the nation's 807 toll collection plazas have ETC capabilities) (ITS JPO 2005a). Similarly, of the 91 toll collection lanes in the Washington, DC metropolitan statistical area, 90 are equipped with ETC technology (31 of 32 toll collection plazas), making it a reasonable choice for implementation of this proposed policy (ITS JPO 2005b).

Some Details of Implementation

With an ETC approach, DC should be able to assess a charge on all non-resident visitors as they pass the cordon in a car – without slowing traffic. Since the policy is aimed at all non-resident visitors, not simply non-resident workers, the policy would be enforced 7 days a week. The policy would be similar to London's in that DC residents would be exempt from paying such a charge if they maintained a residence within DC. Upon registration of their vehicle, DC could simply provide a resident with a license plate or registration decal with a built-in transponder, hopefully minimizing any potential to illegally resell their transponders by including them as part of one's legal vehicle documentation.

In crafting an infrastructure for the proposed cordon charge policy using ETC, the charge could be assessed at a close proximity to DC's political boundary with Maryland and on all bridges crossing the Potomac River to Virginia. In total, there are 181 routes that provide access to DC's CBD. Implementation costs, of course, need to be evaluated.

Satellite photographs (Google Map Service 2005) offer a view of these 181 sites, providing information on lane separation, number of lanes, and any physical characteristics that would lead one to believe that the site is residential or highly local in nature (e.g., roadways without center-line stripping and/or corridors surrounded by homes). With this in mind, District DOT traffic volumes were used to characterize the 181 sections in question, to determine their functional purpose (as a freeway, major arterial or local road). If the 2002 DDOT data indicated an average weekday traffic volume over 2,000 (vehicles per day), the segment was considered a major arterial, while traffic volumes of 75,000 or higher (with appropriate infrastructure characteristics) were considered freeways (DDOT 2002). In this manner, a final inventory of the 181 prospective ETC points was generated, identifying 6 freeways, 62 major arterials, and 113 local roads crossing the DC boundary.

A cost estimate (in 2004 US$) of an ETC system to collect the proposed cordon charge was created using data from the US Department of Transportation's ITS JPO Cost Database (2005c), inclusive of both on-vehicle and on-infrastructure equipment.

On-vehicle equipment was assumed to be transponders. It was estimated that 964,629 individuals may need transponders in their vehicles.

Roadside equipment includes roadside readers and cameras (for enforcement), ETC integration software, mainline toll collection structures, and variable message signs. Using the ITS JPO Cost Database averages, the capital and on-going costs were estimated for

representative toll collection points on freeways, arterials, and local roads. Replacement costs were annualized over the equipment's lifetime to ensure adequate savings.

In addition, Gulipalli and Kockelman's (2006) lane-mile administration-costs estimates, based on NJIT, NDTA, and SJTA tollway experiences suggest that administration costs could be $100,000 per entering lane per year. With a total of 235 lanes entering DC on 181 entering routes, Gulipalli and Kockelman suggest an annual on-going administration cost of $23.5 million.

Table 5 tallies these estimated implementation costs. Maximum capital costs are estimated to be approximated $35 million, while annual on-going costs are estimated to be under $30,000,000.

Table 5. Total Estimated Costs for an ETC System

QTY	CATEGORY	CAPITAL COSTS		ONGOING COSTS	
		MIN	MAX	MIN	MAX
965K	TRANSPONDERS	$27,009,612		$5,401,022	
6	HIGHWAYS	$456,000	$732,000	$50,700	$123,900
62	ARTERIALS	$1,736,000	$2,976,000	$186,000	$322,400
113	LOCAL ROADS	$2,655,500	$4,294,000	$265,550	$440,700
---	ADMINISTRATION	---		$23,500,000	
	MINIMUM COSTS	**$31,857,112**		**$29,403,272**	
	MAXIMUM COSTS		**$35,011,612**		**$29,788,022**

It should be noted that these costs do not include installation charges, which may or may not be included in existing labor contracts held by DDOT, or incorporated into other highway maintenance positions.

These estimates suggest that a DC cordon charge could be a very sustainable and effective policy. To cover the lower end of annual costs ($29.8 million), DC would need to successfully collect a charge on 32,700 cars per workday, less than 10% of the current auto traffic entering DC each workday (based on AASHTO's Transportation Planning Package (2002)). Similarly, the $35 million in (maximum) associated capital costs could easily be recouped by DC in the first year of operation, if the cordon charge were successfully collected on the over 300,000 vehicles entering DC each workday. Again, this is covered by less than 10% of the estimated automobiles entering with destinations in DC each day.

With no mode shifts at all, DC could expect to collect over $1.2 million in revenues each workday (based on a $3.50 cordon charge), or roughly $300 million annually. Even considering the maximum mode shift reflective of the highest VTPI elasticities, a 24.4% decrease in auto traffic could still result in $266 million annual revenues. Both amounts are well in agreement with GAO estimates of DC's recurring fiscal imbalance. In this regard, on-going capital costs require less than 10% of total revenue-raising capacity.

CONCLUSIONS

Looking at past rulings related to DC's desire to institute a commuter tax, federal judges would most likely find a DC Cordon Charge in violation of the DC Home Rule Act provisions. Nevertheless, such policy has the potential to address two critical problems, which threaten the fiscal solvency of our nation's capital, the region's quality of life and its economy (in the form of gridlock). Indeed, European policy-makers have found much success in cordon and area

charging schemes. As lessons learned abroad find application in major US cities, cordon and area charging schemes are likely to become more acceptable.

San Francisco, California, and Fort Myers, Florida, already are investigating cordon and area charging policies as potential solutions to their congestion problems under the FHWA's Value Pricing Pilot Program (FHWA 2006). And discussions of commuter charges have been considered by New York City policy-makers and business leaders in light of the London experience (Grimes 2005). This highlights the fact that DC is the only major American city that cannot legally institute nor consider such policy under the current regulatory framework. In this light, a redress of the DC Home Rule Act to allow DC access to such innovative policy tools seems hopeful, if not inevitable.

While "there is no such thing as a free lunch," many of DC's visitors and workers are getting roughly $3.50 worth of city services per visit, a dollar amount comparable to a lunch-time meal for most Americans. When one considers that DC gifts $3.50 worth of services to over 300,000 non-resident visitors each day, one can imagine how this may result in a higher tax-burden and depressed city services for more than 500,000 DC residents, while resulting in an enormous price to the region, in terms of traffic delays, congestion, and other negative externalities, such as air pollution. Of course, the generalized costs before and after such pricing policies may be much more complex than the analysis performed in this paper (see, e.g., Santos and Bhakar 2005). Such questions represent an excellent opportunity for further research.

While further formal study will be needed to appropriately address critical policy concerns associated with an area pricing policy, DC suffers from serious financial and congestion problem issues that may be tackled via innovative transportation policy. Such policy represent a departure from current tendencies that all-but-require pricing-based revenues to be used for transportation-related services. Surely, many other questions remain, namely the real impact that the large inflow of commuters has on DC's structural deficit. Rectifying the basic differences found here versus in the GAO's (2003) report represents an important first step. And many other questions remain — including person-flow impacts on local economies, critical transportation infrastructure capacity, and political viability of such policy. More detailed research, using household survey data, systems-level travel demand models, and other tools will offer further insight into the impacts and benefits of such a policy.

ACKNOWLEDGEMENTS

The authors wish to thank Ronald F. Kirby, Ron Milone and G. Toni Giardini of the Metropolitan Washington Council of Governments for generously providing data in this research. Also, Kenneth Vaughn, Director of User Support at Citilabs Software was most helpful in resolving data questions. The authors are also grateful for those who administer UT's Plan II Honor's program, a selective four-year interdisciplinary arts and sciences major, especially Dr. Paul Woodruff and Professor Michael B. Stoff.

REFERENCES

American Association of State Highway Transportation Officials (AASHTO). 2002. Census Transportation Planning Package (CTPP) 2000 Profile Sheets. Accessed April 12, 2006, from http://ctpp.transportation.org

Akuntagawa, Kazunori and Mun, Se-Il. 2005. Private goods provided by local governments. *Regional Science and Urban Economics,*35, 23-48.

Andersson, Frederik J. M. 2006. Car tolls reduce Stockholm traffic. Accessed November 11, 2006, from http://www.sweden.se/templates/cs/Article____14227.aspx

Bay Area Tolling Authority. 2005. Bay Area Toll Authority – Tolls and Traffic. Accessed April 11, 2006, from: http://bata.mtc.ca.gov/tolls/index.htm

Bond Market Association, The. 2006. Tax Tables. Accessed July 26, 2006, from The Bond Market Association website: http://www.investinginbonds.com/learnmore.asp?catid=3&id=61

Bureau of Economic Analysis. 2005. Metropolitan Area Personal Income. Accessed April, 10, 2006, from: http://www.bea.gov/bea/newsrel/MPINewsRelease.htm

Bureau of Transportation Statistics (BTS). 1997. 1995 American Travel Survey. Accessed June 11, 2006, from: http://www.bts.gov/publications/1995_american_travel_survey/index.html

Bureau of Transportation Statistics (BTS). 2004. Average cost of owning and operating an automobile. Accessed June 11, 2006, from: http://www.bts.gov/publications/national_transportation_statistics/html/table_03_14.html

Cauvin, Henri E. 2006. High court won't hear commuter tax bid. *The Washington Post,* p. B4.

Census Bureau. 2003. *U.S. Census 2000 County-to-County Worker Flow Files.* Accessed March 26, 2006, from: http://www.census.gov/population/www/cen2000/commuting.html

Census Bureau. 2006. *District of Columbia QuickFacts from the US Census Bureau.* Accessed March 27, 2006, from: http://quickfacts.census.gov/

Dalton, Patricia A. 2004. *District of Columbia: Structural Imbalance and Management Issues.* Testimony before the Subcommittee on the District of Columbia, Committee on Appropriations, U.S. Senate, Washington, DC.

Department of the Interior. 2005. NationalAtlas.gov. Accessed October 16, 2005, from: http://www.nationaatlas.gov

District Department of Transportation. 2002. *2002 District Traffic Volume Map.* Accessed October 20, 2005, from http://ddot.dc.gov/ddot/frams.asp?doc=/ddot/lib/ddot/information/maps/2002_citywide.pdf

District of Columbia Office of the Chief Financial Officer. 2005a. *FY 2006 Proposed budget and financial plan – executive summary.* Accessed October 26, 2005, from: http://cfo.dc.gov/cfo/cwp/view,a,1321,q,629492.asp

District of Columbia Office of the Chief Financial Officer. 2005b. *FY 2006 Budget and financial plan.* Accessed October 26, 2005, from: http://cfo.dc.gov/cfo/cwp/view,a,1321,q,629443.asp

District of Columbia Office of the Chief Financial Officer. 2005c. *Summary Tables: FY2006 Proposed Budget.* Accessed March 16, 2006, from: http://cfo.dc.gov/cfo/frames.asp?doc=/cfo/lib/cfo/budget/2006/pdf/

Dulles Greenway. 2006. Dulles Greenway home page. Accessed April 7, 2006, from: http://www.dullesgreenway.com

Federation of Tax Administrators. 2006. State Individual Income Tax Rates. Accessed July 26, 2006, from http://www.taxadmin.org/fta/rate/ind_inc.html

Federal Highway Administration (FHWA). 2006. Cordon Tolls – Value Pricing Pilot Progam – FHWA Operations. Accessed on November 11, 2006 from http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/projtypes/cordontolls.htm

Gessing, Paul. 2003. Commuter taxes: milking outsiders for all they're worth (NTUF Policy Paper 141). Alexandria, VA: National Taxpayers Union Foundation.

Grimes, Christopher. 2005. NYC businesses call of road congestion charge. *The Financial Times.* Accessed on November 14, 2006, from: http://www.ft.com/cms/s/69740444-682d-11d9-a11e-00000e2511c8.html

Google. 2005. Google Map Service (BETA). Accessed on November 3, 2005, from http://maps.google.com

General Accounting Office (GAO). 2003. *District of Columbia: Structural imbalance and management issues.* Accessed August 20, 2005, from http://www.gao.gov/new.items/d03666.pdf

Gulipalli, Pradeep and Kara Kockelman. "Credit-Based Congestion Pricing: A Dallas-Fort Worth Application." Submitted for publication to *Transport Policy*, May 2006.

Highway Capacity Manual (HCM). 2000. Transportation Research Board, Washington, D.C.

Intelligent Transportation Systems Joint Programs Office. 2005a. Metropolitan Intelligent Transportation Systems (ITS) Infrastructure 2004 Electronic Toll Collection Survey. Accessed on June 11, 2006, from: http://www.itsdeployment.its.dot.gov/pdf/Toll_Summary_2004.pdf

Intelligent Transportation Systems Joint Programs Office. 2005b. ITS Deployment Statistics 2004 – Toll Collection Lanes with Electronic Too Collection (ETC) Capability. Accessed on April 4, 2006, from: http://www.itsdeployment.its.dot.gov/Results.asp?rpt=M&filter=1&ID=450

Intelligent Transportation Systems Joint Programs Office. 2005c. *Costs Database.* Accessed November 18, 2005, from http://www.benefitcost.its.dot.gov/its/

Kockelman, K.M. & Kalmanje, S. 2005. Credit-based congestion pricing: a policy proposal and the public's response. *Transportation Research, 39A,* 671-690.

Kockelman, K.M. 2004. Traffic Congestion (Chapter 22), In *Transportation Engineer's Handbook* (ed. Myer Kutz). New York: McGraw-Hill.

Land Transport Authority. 2005. Home Page. Accessed on April 11, 2006, from: http://www.lta.gov.sg/motoring_matters/index_motoring_erp.htm

Litman, Todd. 2006. *London congestion pricing: implication for other cities* [Electronic version]. Victoria, BC: Victoria Transport Policy Institute.

Mun, Se-il, Konishi, Ko-ji, and Yoshikawa, Kazuhiro. 2003. Optimal cordon pricing. *Journal of Transportation Economics, 54, 21-38.*

North Texas Tollway Authority. 2003. Toll rates. Accessed on April 11, 2006, from: http://www.ntta.org/pub/pub/pub_tolls.jsp#DNT

Norwegian Public Roads Administration (NPRA). 2006. *How to Pay.* Accessed on April 11, 2006, from: http://www.vegvesen.no/servlet/Satellite?blobcol=urlpdf&blobheader=application%2Fpdf&blobkey=id&blobtable=SVVvedlegg&blobwhere=1103284778163&ssbinary=true

Office of Personnel Management. 2006. Annual Leave. Accessed March 27, 2006, from: http://www.opm.gov/oca/leave/HTML/ANNUAL.asp#Accrual%20Rates

Port Authority of New York and New Jersey. 2005. *The Port Authority of NY and NJ toll rates.* Accessed April 11, 2006, from: http://www.panynj.gov/CommutingTravel/bridges/pdfs/01_08_05_TollRatesFile.pdf

Santos, Georgina, and Bhakar, Jasvinder. 2006. The impact of the London congestion charging scheme on the generalised cost of car commuters to the city of London from a value of travel time savings perspective. *Transport Policy,* 13, 22-23.

Schrank, David, and Lomax, Tim. 2005. *The 2005 Urban Mobility Report*. Texas Transportation Institute, The Texas A&M University System.

Stockholm for Soket. 2006. Accessed on November 11, 2006, from: http://www.stockholmsforsoket.com

Transport for London. 2006. Congestion charging. Accessed on April 11, 2006, from: http://www.cclondon.com

Ukkursuri, S., Karoonsoontawong, A., Waller, S.T., & Kockelman, K.M. 2004. *Congestion pricing technologies: Synthesis and an evaluation framework*. Paper presented at the 84th Annual Meeting of the Transportation Research Board, Washington, DC.

Victoria Transport Policy Institute. 2005a. Transportation Elasticities. Accessed on June 24, 2006, from http://www.vtpi.org/tdm/tdm11.htm

Victoria Transport Policy Institute. 2005b. Congestion Reduction Strategies. Accessed on June 24, 2006, from http://www.vtpi.org/tdm/tdm11.htm