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Political and Public Acceptability of Congestion Pricing: Ideology and Self-Interest

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Abstract

Studies of the "stated preferences" of households generally report public and political opposition by urban commuters to congestion pricing. It is thought that this opposition inhibits or precludes tolls and pricing systems that would enhance efficiency in the use of scarce roadways. This paper analyzes the only case in which road pricing was decided by a citizen referendum on the basis of experience with a specific pricing system. The city of Stockholm introduced a toll system for seven months in 2006, after which citizens voted on its permanent adoption. We match precinct voting records to citizen commute times and costs by traffic zone, and we analyze patterns of voting in response to economic and political incentives. We document political and ideological incentives for citizen choice, but we also find that the pattern of time savings and incremental costs exerts a powerful influence on voting behavior.

In this instance, at least, citizen voters behave as if they value commute time highly. When they have experienced first-hand the out-of-pocket costs and time-savings of a specific pricing scheme, they are prepared to adopt freely policies which reduce congestion on urban motorways.

JEL Codes: R41, R48, Q58
Keywords: highway tolls, voting behavior, commuting costs

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I. Introduction

The political inability of government to price the use of scarce roadways is a most conspicuous failure in the application of economics to government policy. Congestion pricing is a powerful example of the potential use of simple economic principles to control externalities, to reduce pollution and congestion, and to improve economic efficiency. Indeed, congestion pricing is *the* standard example of the control of externalities described in principles-of-economics textbooks.[1]

Thirty-five years ago, John Kain proposed several simple pricing mechanisms to "improve urban transportation at practically no cost." (Kain, 1972) Nobel laureate William Vickrey proposed many simple pricing mechanisms (e.g., Vickrey, 1963), especially in the context of New York City, to reduce traffic congestion and to improve efficiency in the transport sector. Some of these proposals indeed involved "practically no cost," even using the technology available in the 1960's (for example, varying the tolls on New York's George Washington Bridge with the time of day). But the proposals were never seriously considered by government agencies.

Only in Singapore were these simple ideas implemented in a simple way. In June 1975, the world's first comprehensive road pricing scheme was introduced. This Area Licensing Scheme imposed a toll on vehicles entering a Restricted Zone near Singapore's central business district during business hours on workdays. After some experimentation

[1] Exposition of the principles of congestion pricing for highways and bridges is the key illustration of Pigovian taxes discussed in economics principles texts by Perloff (2004: 645-646), Mankiw (2004: 232-235), Hall and Lieberman (2007: 508-509), Layard and Walters (1978: 194-195), Lipsey, Steiner, Purvis and Courant (1990: 429-429), among many others. Congestion pricing for highways and transit has an even more central role in textbooks devoted to urban, regional, and economics. (See, especially, Mills and Hamilton, 1994, for an extensive discussion, pp. 261-270.)

with toll levels and changing conditions, this manual system of toll collection reduced congestion substantially, increased vehicle speeds, reallocated traffic by time of day, choice of route, and choice of mode. (See Phang and Toh, 2004, for a detailed discussion.)

Some fifteen years after the Singapore demonstration, the three largest cities in Norway – Bergen, Oslo, and Trondheim – successively introduced urban toll ring systems. The rationale for these innovations was not Pigovian efficiency or demand management at all, but rather the generation of revenues for urban transport investments. (But the Trondheim toll system did include a slight differentiation of the toll by time of day.) However, the road pricing scheme adopted a decade later in 2001 by Norway's fourth largest city, Stavanger, differentiated tolls by time of day and day of the week.

In 2003, the City of London adopted Singapore's Area Licensing Scheme (See Leape, 2006, for a review.) The pace of technical change permitted the London system to be automated and enforced through photometry, but otherwise the toll system was identical to that of Singapore. (By this time, of course, a much more sophisticated electronic Road Pricing Scheme had been imposed in Singapore. See Willoughby, 2001, and Goh, 2002, for details.)

The examples of London, Singapore and the Norwegian cities have come to the attention of politicians and administrators in many other cities, and serious discussions of congestion pricing have been reported in New York (City of New York, 2007) and San Francisco (US Department of Transportation, 2007), among other U.S. cities.

In New York, San Francisco, and in Manchester as well, proposals for road pricing developed by municipal authorities were ultimately rejected as politically

infeasible by elected officials at the local level (or, in the case of New York, by public officials at the state level). These judgments about political feasibility are consistent with survey results, at least for Europe. Schade and Schlag (2000) report extensive results of commuter surveys in four European cities. They observe that "an important precondition for the successful implementation of [road] pricing measures is public and political acceptability. However, empirical findings show that the acceptability of such measures is rather low."

As evidenced by Norwegian experience, this assertion about "preconditions" need not always hold. Political support by elites is certainly needed, but the cities of Oslo, Bergen and Trondheim all introduced their charging systems in the face of rather strong public resistance reported in opinion polls. However, according to polls conducted after implementation, public opinion shifted. The fraction opposed to the charging systems fell, and the fraction in favor of the tolls increased in all three cities (See Tretvik, 2003). But even *ex post,* congestion tolls received majority support only in Bergen. Nevertheless, before-and-after shifts in opinion of this kind suggest weaknesses in stated preference studies of road pricing.

The low level of support for congestion charging reported by public-opinion and stated-preference studies is consistent with the experience of Edinburgh -- where a proposal to implement a system of congestion tolls was evaluated *ex ante* by a plebiscite. The proposal failed miserably, obtaining the approval of only about one fourth of the electorate. (See Gaunt, Rye and Ison, 2006, Gaunt, Rye and Allen, 2007, for details.)

The only city in which congestion pricing has been adopted by a vote of the electorate is Stockholm. In Stockholm, a congestion toll system was adopted and

implemented by the government with the understanding that the system would be subject to ratification by majority vote sometime after implementation. The political acceptability of congestion pricing was demonstrated, in this instance, when the system of tolls was approved by a majority of voters in a local plebiscite after a "trial" of about seven months.

In this paper, we examine the political and public acceptability of congestion tolls using the experience of the Stockholm experiment. Our research differs from all previous analyses of the public acceptance of congestion pricing in one important respect – the quantitative analysis is based upon the observed choices and the revealed preferences of citizens in a referendum. Other quantitative analyses of public acceptance of pricing are based upon the stated preferences of consumers in sample surveys (for example, the surveys of European consumers reported by Schade and Schlag, 2000, and Jones, 2003, or the surveys of California commuters analyzed by Harrington, *et al*, 1998).

Importantly, our analysis considers explicitly the variability in the advantages to consumers, in terms of time savings, and the disadvantages to consumers, in terms of the out-of-pocket costs associated with a specific proposal. We exploit information on the voting behavior of citizens in several hundred election precincts in Stockholm as well as estimates of the variation in time savings and out-of-pocket costs experienced by voters in these different areas in the city.

We describe the Stockholm experiment in congestion pricing in Section II. In Section III, we analyze the public acceptance of congestion pricing as measured by the preferences of local citizens registered at the ballot box. Section IV considers briefly the implications of those results for other choices made in other cities.

II. The Stockholm Experiment

A. The Election.

Shortly after the 2002 elections in Sweden, the national government resolved to sponsor a full-scale experiment with a system of congestion charges for the city of Stockholm. A specific pricing scheme for roadways was combined with a short-term increase in the capacity of the public transport system. The principle was adopted by the Stockholm Municipal Council in June 2003 "on a trial basis," and this was ratified by the national Parliament in May 2004. After much refinement, the congestion charge was put into effect from January 3 through July 31, 2006, and the associated public transport investments were implemented beginning in August 2005 and extending through December 2006.

At the time the trial was approved, it was also decided that a referendum on the permanent implementation of the charges should be held in the city of Stockholm in conjunction with the general election in September 2006. After a trial of almost seven months, Stockholmers were asked to vote yes or no on the permanent implementation of the pricing system.[2]

About 52 percent of the Stockholm voters approved the measure. Thus the pricing scheme was re-introduced in August 2007 and has been in force continuously since. This represents the first time this kind of tax was imposed by a plebiscite.

[2] The decision to confine the referendum to the city that imposed the charge was strongly criticized by municipal politicians in other parts of the Stockholm Region. As a consequence, many of the other municipalities also decided to organize referenda. The ballot initiatives were worded differently in these suburban jurisdictions, making the results hard to compare with those in Stockholm. Importantly, the ballot results in Stockholm determined the fate of the congestion-charge scheme. The ballots in other jurisdictions were merely "stated preferences."

B. The Congestion Charge

The system of congestion charges imposed in Stockholm during the first half of 2006 was quite simple. A perimeter surrounding the inner city was established and 18 gantries monitored traffic flowing across the perimeter.[3] Vehicles were identified by means of a transponder or photography of license plates. About 95 percent of charges were identified automatically, and about two-thirds of the charges were processed automatically to pre-registered users. Figure 1 is a schematic of the inner parts of Stockholm showing the perimeter of the toll zone, as well as the locations of the monitoring devices. Vehicles crossing the perimeter were assessed the congestion toll.

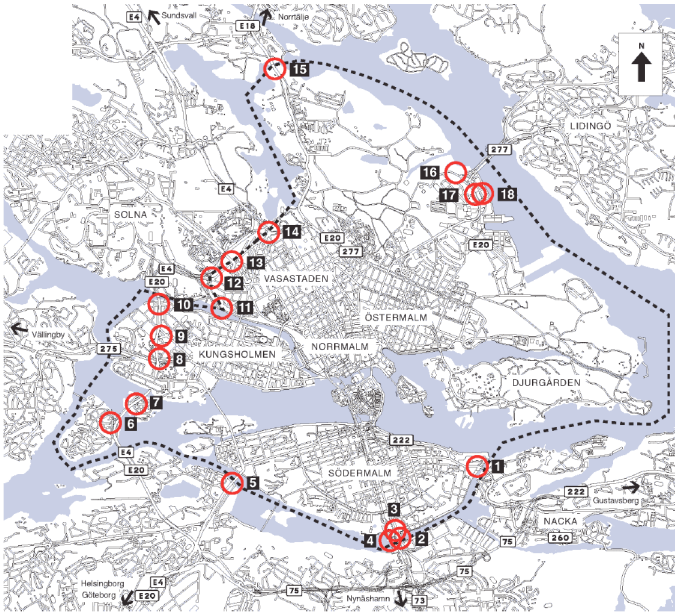
The charging system was simple: 10 Swedish Crowns (SEK) was charged for off-peak travel in both directions; up to 20 SEK for peak-hour travel; with a maximum charge of 60 SEK to any user in a day.[4] Charges were not imposed in the evenings, on weekends or public holidays, and some vehicles were exempt from charges altogether (e.g., taxis, emergency vehicles, etc). According to Eliasson (2008), simplicity and ease of understanding were the main reasons for the symmetry of the design. Figure 2 presents the system of tolls by time of day.

Shortly before the charges for auto use were imposed, 14 new express bus lines were introduced, and service improvements were made on 18 existing bus lines. 197 busses were added. There were some small improvements to rail service, and about 2,500 park-and-ride spaces were added near suburban subway stations.

[3] The area inside the toll zone was about thirty square miles and had close to 300,000 inhabitants during the trial. The populations of the City of Stockholm and the metropolitan region were 771,000 and 1,890,000, respectively.

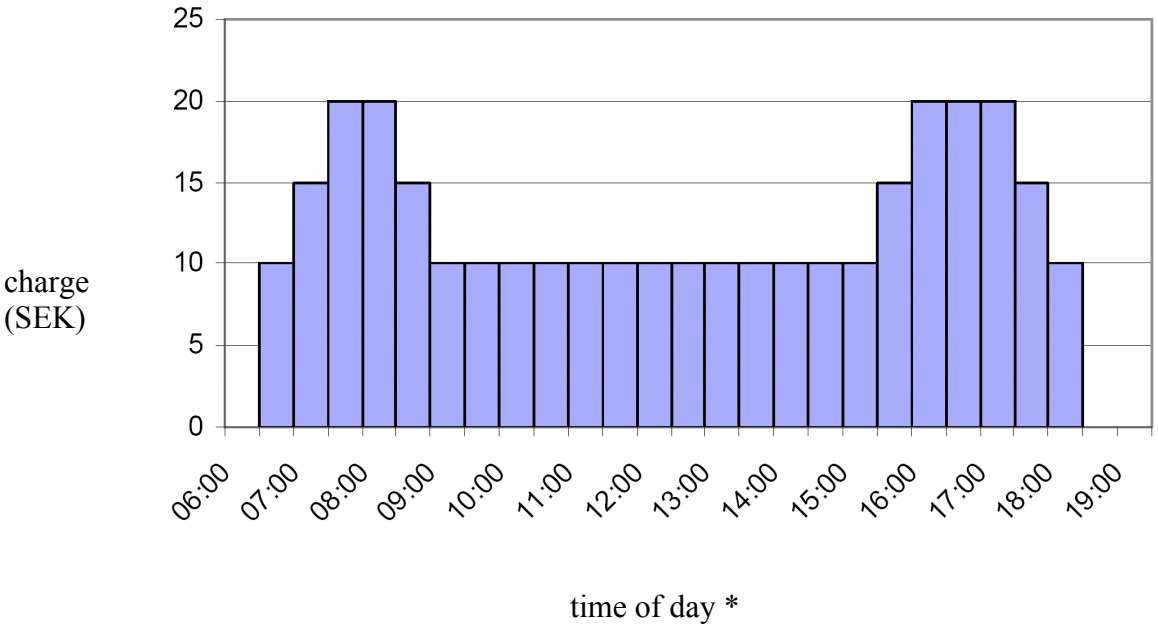
[4] 100 SEK = 14.57 USD = 9.91 EUR, in 2006.

Figure 1
Map of Perimeter of Congestion Zone and the Eighteen Gantries



Source: Vägverket, 2005.

Figure 2
Congestion Charges by Time of Day



* weekdays only

Source: Vägverket, 2005.

C. The Politics

Political discussion of the proposal to implement congestion charges dates from the 1980s (See the report of the Commission on Metropolitan Traffic, 1990). Throughout, the discussion was characterized by strong differences among political parties as well as between politicians at the national level and at the local levels. The debate was also influenced by the shifting political majorities and alliances nationally and locally.[5]

In 1991 the Social Democrats, the Conservatives and the Liberal Party in the Stockholm Region, inspired by the Oslo toll ring system, agreed to support a comprehensive package of road and public transit investments, including a toll ring around inner Stockholm. The Social Democrats took the initiative at the national level by commissioning the Governor of the Central Bank (Bengt Dennis) to develop a transport investment and financing agreement for the Stockholm Region. But the final compromise package, the so-called "Dennis Agreement," was negotiated while the conservatives were in power. The agreement was strongly criticized by the political parties which had not been directly involved in the negotiations. In the 1994 elections, the Social Democrats were returned to power after a three-year interlude of conservative rule. In this election, however, the Socialists were supported by political parties which had opposed the Dennis Agreement, and these other parties held the balance of power. This effectively killed the toll proposal, and in 1997 the Social Democrats at the national level ultimately came out in opposition to the system of tolls they had initiated and had helped design just a few years earlier.

[5] Malmsten and Person (2001) and Gullberg and Isaksson (2008) provide detailed descriptions of the long and dynamic political process which resulted in the experiment and the referendum.

Congestion pricing was resurrected by the Environmentalist Party after the 2002 election, and the Social Democrats at the national level were forced to agree to an "experiment in congestion charging." Together they convinced the Social Democrats in the city to implement the experiment despite repeated earlier promises by the latter not to implement congestion charging should they maintain political control the city after 2006.[6] For the first time ever after the 2002 election, the opposing parties, i.e., the Christian Democrats, the Conservatives, the Liberals, and the Centre Party formally decided to cooperate.[7] They named themselves "*The Alliance*" and presented a common platform on all major political issues, including opposition to the congestion charges, during the run-up to the 2006 election. This common front was presumably an important factor behind their victory in the 2006 election; at least this made it much harder for the Social Democrats to criticize the opposition by referring to their conflicting views.

The vulnerable position of the Social Democratic Party in Stockholm was underlined by the opinion polls undertaken before the election.[8] As described by Winslott-Hiselius et al (2009), the fraction of the adult population in the Stockholm Region supporting the idea of undertaking the congestion charge experiment fell from 52 to 43 percent between the autumn of 2004 and 2005. In June 2006, Stockholm's largest newspaper characterized the congestion trial as "the most expensive way ever devised to commit political suicide." (*Dagens Nyheter*, June 22, 2006). Ultimately, the confidence of the position of the Socialists increased when the results from the last opinion poll

[6] See Gullberg and Isaksson (2008) for an analysis of the pivotal role played by the Environmentalist Party - locally as well as nationally - in this political power game.
[7] In 2002 the fraction of votes for the Centre Party was below the limit for representation in the city council.
[8] Four major opinion polls, three before and one during the experiment were undertaken as a part of the information program managed by the city of Stockholm.

undertaken during the trial were released. This poll showed a marked shift of opinion; the fraction supporting the experiment increased to 54 percent.

The increased public support reported during the experiment turned out to be a good predictor of the referendum outcome. This did not, however, lead to more votes for the political parties advocating the experiment. On the contrary, the election resulted in clear victory for the parties opposing a system of tolls. The Alliance opposing the tolls polled 53.8 percent of the vote, up from 47.5 percent in 2002.

Table 1 reports the strength of the individual parties in the Stockholm municipal elections in 2002 and 2006.

Table 1
Distribution of Votes in Stockholm Municipal Elections
2002 and 2006
(in percent)

	Year	
	2002	**2006**
Christian Democrats (KD)*	4.4	3.9
Conservatives (M)*	26.0	37.2
Center (C)*	1.3	3.1
Liberals (FP)*	15.8	9.6
Socialists (V)	11.2	7.9
Social democrats (S)	32.1	24.4
Environmentalists (MP)	5.3	9.2
Minor local parties	4.0	4.4

* The first four parties constitute "*the Alliance*" formed after the 2002 election.

E. The effects of the charging system

Well before the referendum was held, the city of Stockholm published a detailed compendium of the aggregate results of the congestion cost trial. The 128-page compendium included summaries of the "facts" observed during the trial period (e.g., an overall decline of about twenty-two percent in vehicles passing over the charge cordon) as well as many qualitative assessments of the overall impact. The document was widely distributed in the summer of 2006, several months before the vote. Because there were many immigrants eligible to vote and also because there was a strong interest expressed by elites in other European cities, the document was published in English as well as Swedish, and it was widely available to the populace. (See City of Stockholm, 2006, for the English language version of the report.)

The report was careful to indicate that the distribution of benefits and costs associated with the congestion toll trial varied significantly across neighborhoods and sections of the city; the benefits and costs varied for those who chose different modes of travel and for those in different professions (e.g., downtown retail merchants). Underlying this broad discussion were the results of a sophisticated, but standard, traffic engineering model which simulated the effects of the tolling system on neighborhoods and traffic zones within the city.

An overview of the various effects observed during the experiment is also provided by Eliasson, *et al* (2009). Some, but certainly not all, of the information reported by these authors in 2009 was available to voters at the time of the referendum. In addition to the declining number of vehicles crossing the cordon, Eliasson, *et al* (2009) reported significantly reduced congestion on the approach roads and a decrease of sixteen

percent in driving in the inner city. As a consequence, traffic emissions were reduced noticeably.[9]

III. The Public Acceptance of Congestion Pricing

The adoption of congestion tolls in Stockholm was unique in that the decision was made by referendum, and the referendum itself was held after a seven-month trial of the specific tolling scheme put up for ratification. As noted above, a detailed compendium of "facts" observed during the trial was widely available in two languages three months before the election. Moreover, as discussed below, three technical reports concerning the anticipated long-run effects of the congestion tolls were also available three months before the referendum (Anderstig, *et al*, 2006). But most important, for almost seven months it had been possible for each and every voter to experience the effects of the tolling system on his or her personal travel times and costs. Each voter could observe the extent of congestion and the other environmental impacts of the trial at various geographical levels.

A. Outcome of the Stockholm Referendum

In the referendum of September 2006 in Stockholm, the proposal to retain the system of congestion tolls passed by a vote of 52 to 48 percent.[10] There was, of course, a

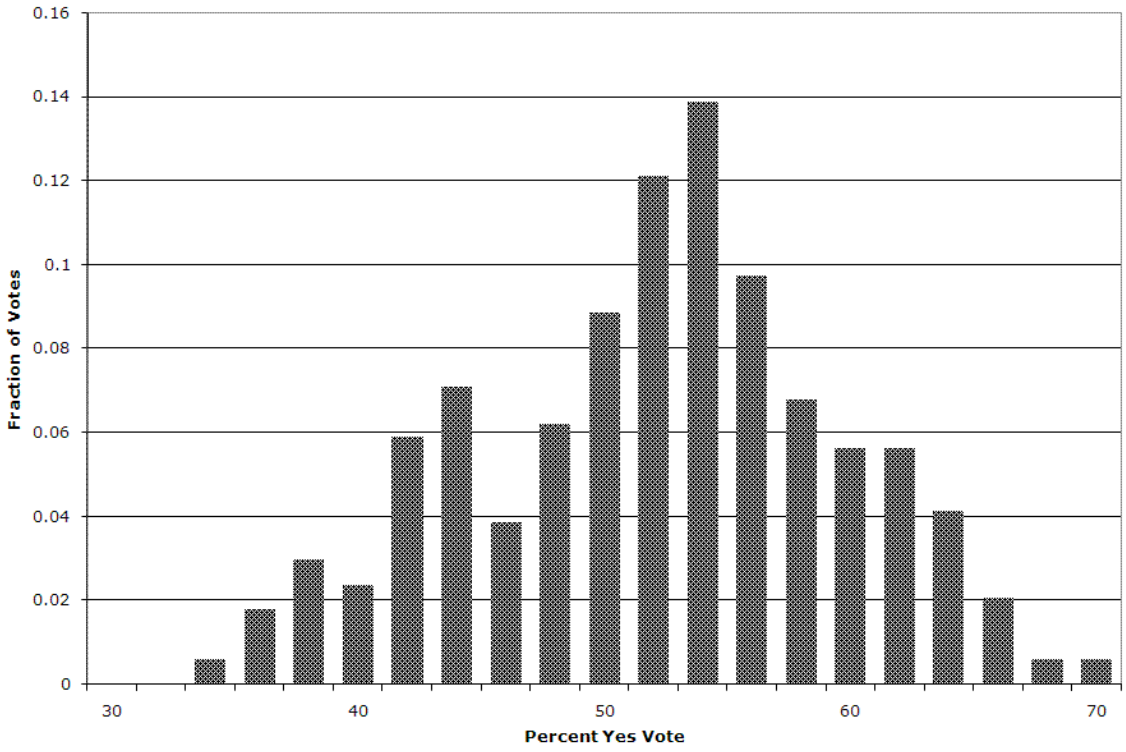
[9] In a cost-benefit analysis of the charging system, Eliasson (2009) reports that the emission of green house gases from traffic in the Stockholm Region decreased by 2.7 percent. The estimated reductions for other kinds of emissions are of the same magnitude, but are much larger in the inner city than in the rest of the region. The cost-benefit calculation indicates a net social benefit of 654 M SEK per year, a surplus large enough to cover both the investment and the operating cost.

[10] The outcomes from the referenda organized by neighboring municipalities recorded a majority against keeping the charging system. But only those municipalities whose political majorities opposed the experiment actually conducted referenda. The ballot proposals were formulated differently in the various suburban municipalities.

reasonable dispersion of opinion across the city. For political purposes Stockholm is divided into 461 voting precincts, with an average of about 1,100 voters in each district.[11]

Figure 3 presents the frequency distribution of the vote on congestion tolls across these districts. The mode and the mean approval ratings were well above fifty percent. But there were 26 districts with approval ratings below forty percent, and another 42 districts with approval ratings above sixty percent.

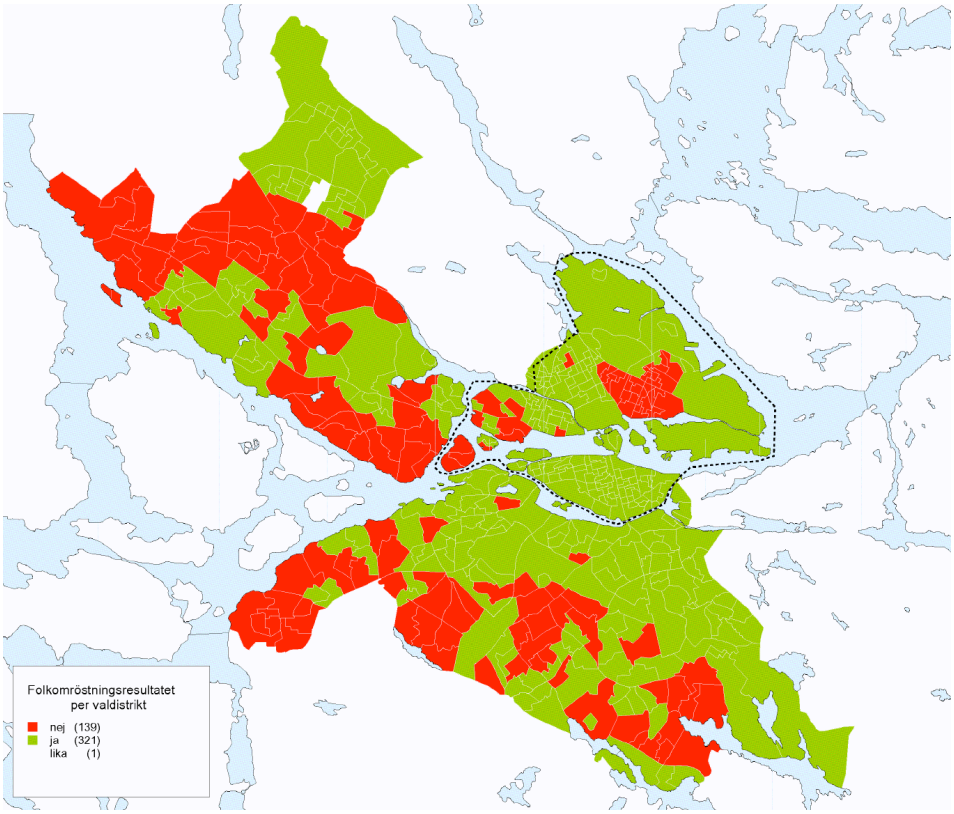
Figure 3
Distribution of Votes to Approve Congestion Tolls,
By Electoral Precinct



[11] 620,912 inhabitants of Stockholm were entitled to vote in the referendum; 490,867 of these actually took part in the plebiscite, and 483,832 votes were recorded as valid (i.e., 7,035 of the votes cast were not counted because of some formal mistake by the voter).

Figure 4 presents the majority outcome in voting precincts inside and outside the charging cordon. Districts with a majority of yes votes are marked by gray (green) and those with a majority of no votes by black (red). The dotted line indicates the charging cordon. As indicated by the map, the support for the charging system was stronger inside than outside the cordon.

Figure 4
Voting Results in the 461 Election Precincts.



As noted above, model-based estimates of the effects of the tolls on travel times and travel costs were available at about the same time that the broader compendium of "results" was published in June 2006. The estimates were developed from the "Transport

Residence Integrated Model," T/RIM, as applied to the Stockholm metropolitan region.[12] Three studies relied upon the T/RIM model to provide a detailed "regional economic evaluation" of the congestion trials in Stockholm. (See Anderstig, *et al*, 2006.) These studies were also available before the referendum.

For analytical purposes, the T/RIM model divided the city into 399 traffic zones and estimated the distribution of travel times, travel costs, and mode usage for residents in each zone to all other zones. About sixty of the zones were exclusively travel destinations and workplaces (e.g., the municipal airport); these contained few residents.

We allocated the voting data summarized in Figures 4 and 5 for the 461 voting precincts, as well as demographic data for these precincts, to the 339 populated traffic zones by assuming that residents were uniformly distributed over space in each electoral precinct. We then allocated voters to traffic zones in proportion to the area of these zones using standard GIS methods. In this way, we developed a data set comprising 339 geographical areas, each containing travel information, demographics, and the voting outcomes on the referendum as well as on the general election.

The T/RIM model provided estimates of the average time saving by auto and public transit from each of the 339 zones of residential origin to each of the 339 zones of employment destination. Similarly, it provided estimates of the increased out-of-pocket costs for auto trips from each zone to all other zones. If we assume that the pattern of work trips was unchanged after imposition of the congestion tolls, then it is possible to

[12] A comprehensive description of this transport planning model is available in Engelson and Svalgård (1995).

estimate the aggregate time saving and out-of-pocket costs of the commuters living in any zone from the zone-to-zone commuting flows.[13]

Figure 5 summarizes the distribution of the average travel time savings of the commuters residing in each of the 339 zones as estimated by the traffic engineering model, T/RIM. The distribution is presented for all trips and for the auto trips taken after the imposition of the toll. The average time saving for all trips is rather low, because a large fraction of work trips, about 73 percent in aggregate, were by public transit before the tolls were imposed (and the time savings engendered by the tolling system for these commuters are small).[14] But the time savings for auto trips are sizeable.

Figure 6 summarizes the distribution of average incremental out-of-pocket costs for the commuters residing in each of the 339 zones, again as estimated by the traffic engineering model. The average toll cost for all work trips is also small (since those commuting by means other than auto pay no toll). The average cost for those who continue to commute by auto after the imposition of the toll is more sizeable.

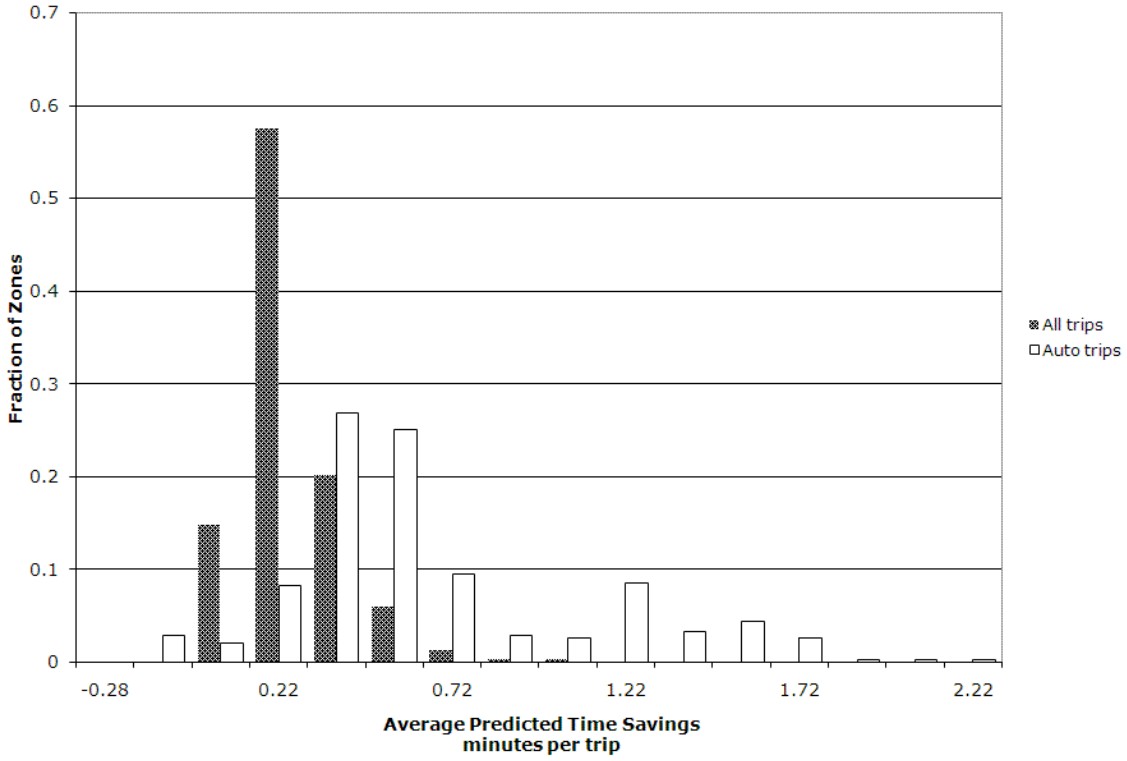
B. Ideology and Self Interest

The general relationship between the political and self-interested motivations for voting on the congestion charge can be illustrated by the pattern of voting across residence zones. Figure 7 illustrates the relationship between the percentage of voters in

[13] Of course, the tolling system can be expected to affect the patterns of residence and workplaces in the long run. (These long-run issues are analyzed in Anderstig, *et al*, 2006.) But in the short run, and for the purpose of citizen evaluation of the pricing system, it may be safe to assume that voters considered the impacts of the system from the perspective of their current residences and workplaces.

[14] Actually, in some cases the actual time savings for transit riders could be negative, as when an increased bus ridership increased the number of intermediate stops by the transit vehicle for loading and unloading.

Figure 5
Distribution of Average Predicted Time Savings
From Congestion Toll, by Traffic Zone



each district in favor of the system of tolls in the 2006 election and the percentage of voters in the district who supported one of the parties in the Alliance in the same election. An inverse relationship is clear in the data. Voters who were more likely to favor Alliance candidates (who opposed the system of congestion tolls) were also more likely to oppose the imposition of those tolls. Notwithstanding this relationship, it is also clear that voters who resided inside the cordon were more likely to favor the toll system. Not only did these residents, on average, face lower costs if they commuted to the central core, but also their residence areas also benefited from the reduced throughput of other commuting vehicles.

Figure 6
Distribution of Average Predicted Incremental Costs from Congestion Toll, by Traffic Zone

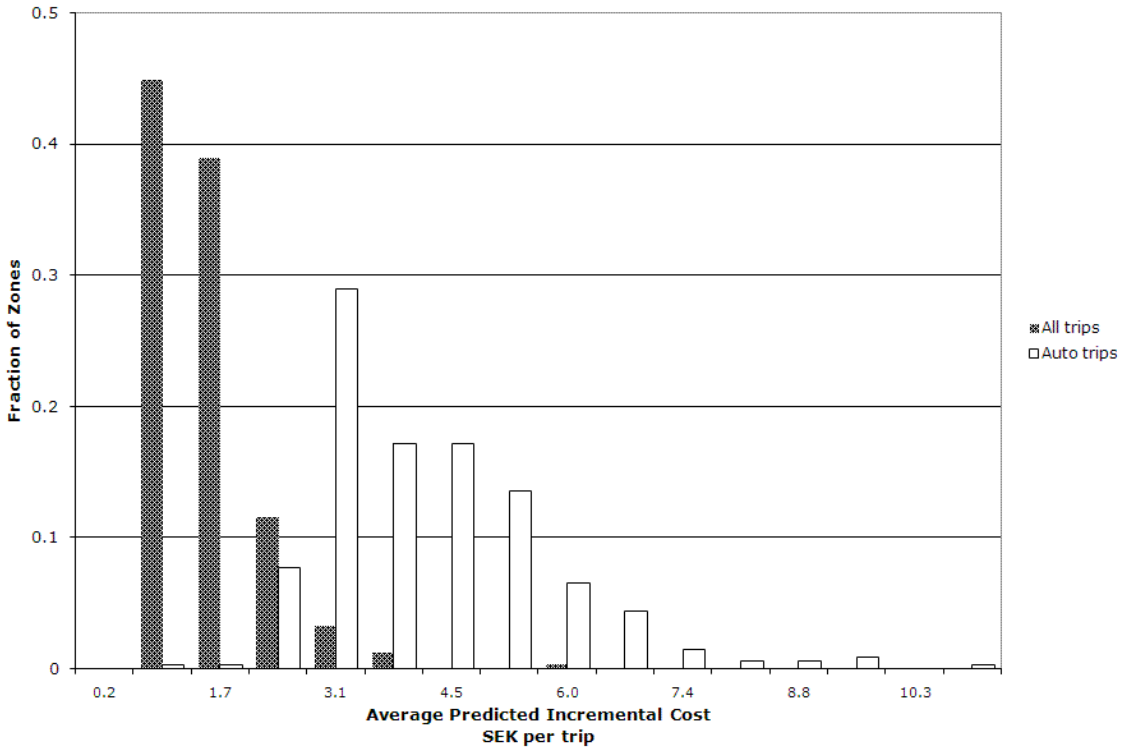


Figure 8 reports the relationship between the time savings arising from the toll system and the propensity to favor the proposal. There is a clear positive relationship between time savings, for all trips and for auto trips, and the propensity to vote in favor of the proposal.

Figure 7
Percent Support for Alliance Candidates and
Percent Support for Congestion Tolls,
By Traffic Zone
2006 Election

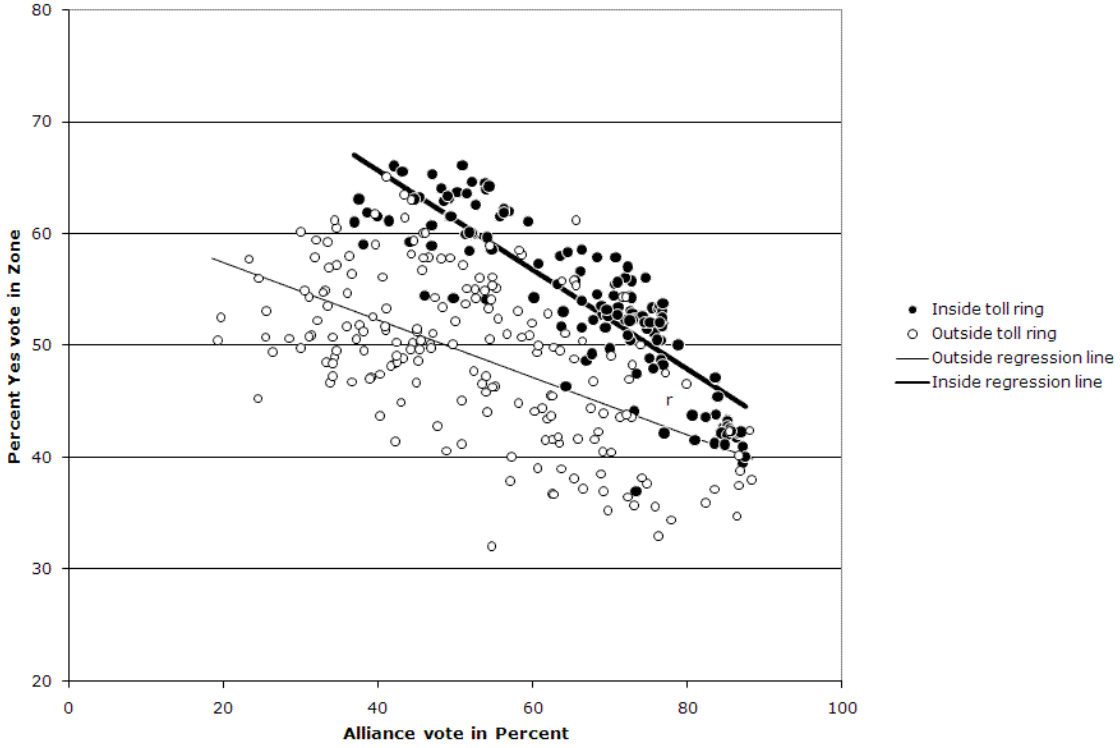
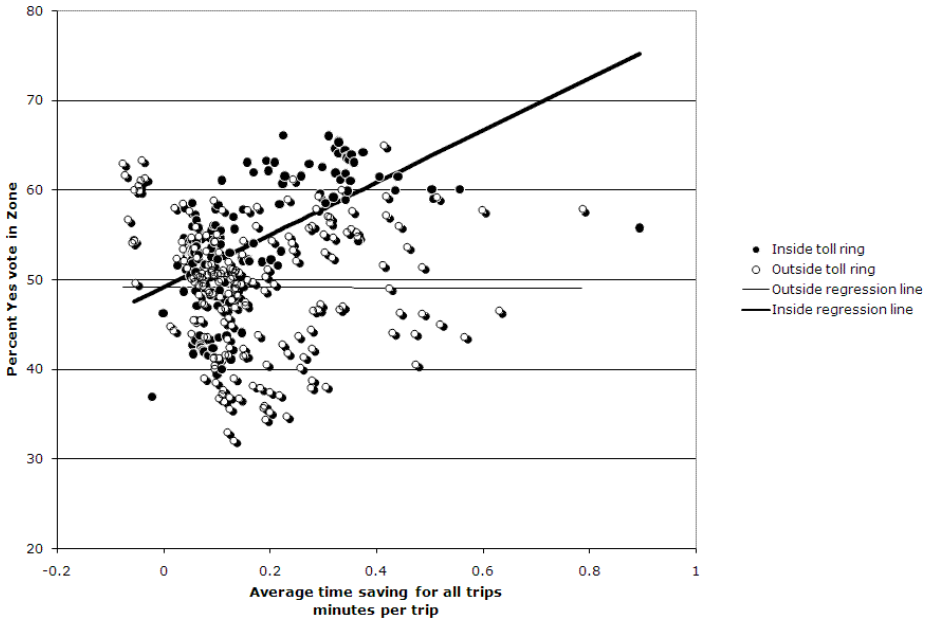


Figure 8
Average Predicted Time Savings and Percent Support for Congestion Tolls, By Traffic Zone
2006 Election
A. All Trips



B. Auto Trips

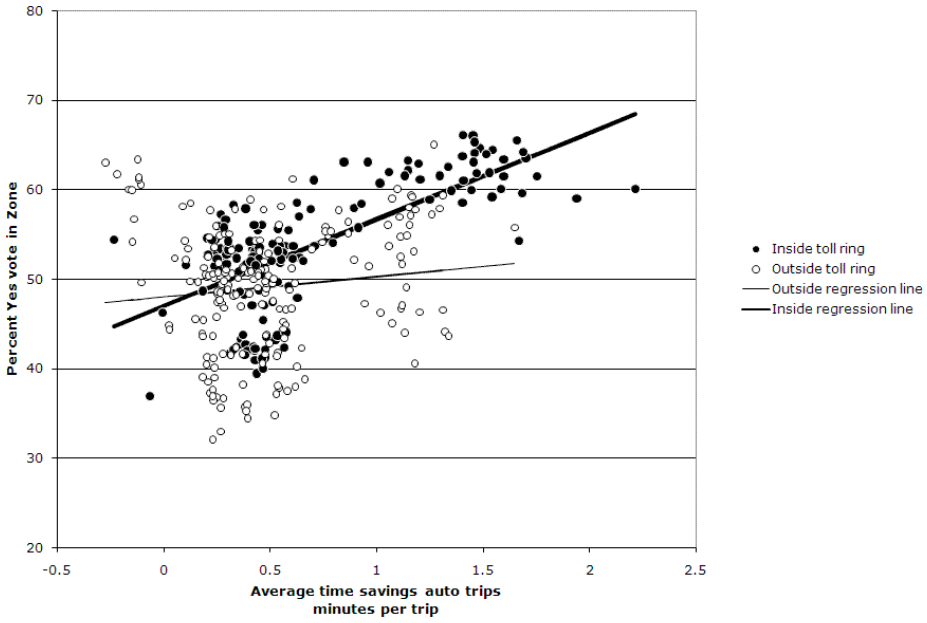
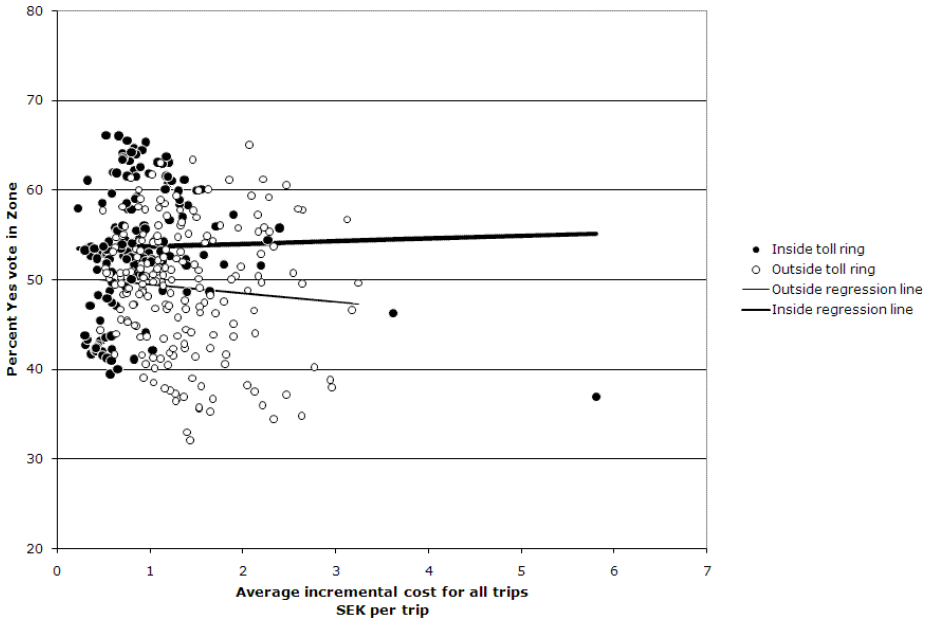
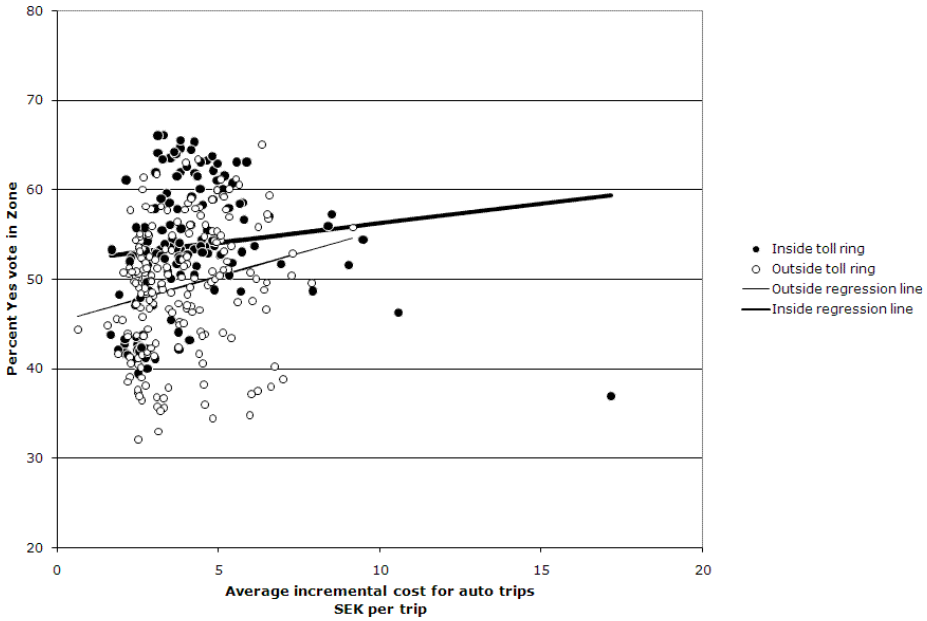


Figure 9
Average Predicted Incremental Costs and Percent Support for Congestion Tolls, By Traffic Zone
2006 Election
A. All Trips



B. Auto Trips



Finally, Figure 9 reports the relationship between the increased out-of-pocket costs, for all travelers and for motorists, and the propensity to favor the system of tolls. Those whose out-of-pocket costs increased more were more likely to oppose the system.

The importance of the private benefits to commuters of the tolling system in affecting citizen voting behavior is demonstrated by the regressions reported in Table 2. The table reports the results of four regressions relating the average voting behavior of residents by traffic zone to the benefits of the congestion toll (the average time savings for trips originating in any zone) and the costs imposed by the system (the average cost increase for trips originating in any zone). Regression (1) relates these two measures of the impact of the tolls, as well as the vote for the Alliance candidates, upon the referendum on congestion tolls. It is clear that zones with higher fractions of voters favoring Alliance candidates were much less disposed to favor the system of congestion tolls. Despite this, voters in zones where the average time savings were greater were more likely to favor congestion pricing. *Ceteris paribus*, voters in zones where the average congestion toll payments were larger were less likely to favor the pricing system.[15]

Regression (2) adds four variables measuring the demographic composition of the traffic zones. Districts with a larger fraction of residents with a post-secondary education were more likely to favor the referendum. Similarly, districts containing a larger fraction of working-aged adults (i.e., those between 18 and 64 years of age) were more likely to favor congestion tolls. In contrast, districts with a larger fraction of foreign-born were less likely to favor the referendum, and districts with a larger fraction of males were less

[15] Again, it should be noted that these time and cost variables are model-based and are *not* derived from *ex post* surveys of trip-making behavior. These estimates were, however, available to potential voters for all zones in the city several months before the vote on congestion pricing was held.

Table 2
Determinants of Voting in Support of Congestion Tolls
Dependent Variable: Percent Yes Vote
Ordinary Least Squares Estimates

	1	2	3	4
Average Time Saving: all trips	12.005 (3.35)**	6.350 (3.56)**	5.296 (2.86)**	5.521 (3.40)**
Average Cost Increase: all trips	-1.792 (3.11)**	-2.149 (8.46)**	-1.630 (3.65)**	-1.712 (5.61)**
inside ring (1 = yes)			2.606 (3.80)**	2.217 (3.03)**
Fraction				
public transit commuters				-5.574 (0.86)
Alliance	-19.231 (7.77)**	-49.417 (18.93)**	-50.418 (20.97)**	-50.675 (24.58)**
college-educated		39.994 (9.14)**	34.607 (7.73)**	34.813 (11.55)**
foreign-born		-15.752 (8.99)**	-15.649 (9.12)**	-15.571 (9.47)**
male		-55.170 (4.92)**	-42.581 (4.33)**	-41.772 (4.83)**
working age		40.709 (11.19)**	34.584 (9.40)**	33.974 (10.57)**
Constant	62.720 (36.05)**	71.066 (12.82)**	69.833 (14.33)**	70.966 (18.46)**
R^2	0.28	0.80	0.81	0.81

Notes:

t statistics in parentheses;

observations are weighted by the number of voters in each of 339 zones;

* significant at 5%; ** significant at 1%

likely to vote in favor of the tolls. Note that when these demographic variables are included, the explained variance of the statistical models increases from 28 percent to 80 percent.

Regression (3) adds a dummy variable for those zones located inside the tolling cordon. Holding time and money, demographics and politics constant, those zones inside the perimeter were about two-and-a-half percent more likely to favor the system of congestion tolls. Presumably this reflects some of the other benefits enjoyed by residents in neighborhoods where fewer autos passed through – reduced pollution, traffic, noise, and so forth.

Finally, regression (4) adds a variable measuring the fraction of commutes taken by public transit in the zone before the congestion tolls were imposed. The coefficient of this variable is insignificantly different from zero. The voting outcome did *not* simply reflect a tendency of transit users to favor tolls on cars and auto users to oppose tolls and higher costs for cars; rather the vote reflected a more subtle relationship between the time savings and the cost increases associated with the tolling system as they affected commuters living in different neighborhoods who had different travel demands.

A major limitation in interpreting the regressions reported in Table 2 is the endogenous nature of the votes for or against the Alliance candidates. Voters in the election registered their preferences simultaneously in favor of certain political parties and for or against the proposed tolling system. It is quite likely that these choices were determined jointly. In Table 3, we address this simultaneity issue by re-estimating the vote on the referendum using instrumental variables (IV). As an instrument for the aggregate vote in favor of the Alliance candidates, we use the vote in the national

Table 3
Determinants of Voting in Support of Congestion Tolls
Dependent Variable: Percent Yes Vote
Two Stage Least Squares Estimates

	1	2	3	4
Average Time Saving: all trips	13.332 (3.59)**	8.741 (4.33)**	6.965 (3.43)**	7.094 (3.51)**
Average Cost Increase: all trips	-1.892 (3.04)**	-2.117 (7.08)**	-1.636 (3.48)**	-1.687 (3.53)**
inside ring (1 = yes)			2.466 (3.58)**	2.224 (2.48)*
Fraction				
public transit commuters				-3.481 (0.47)
Alliance	-14.430 (5.32)**	-42.696 (12.50)**	-45.830 (14.64)**	-46.022 (14.43)**
college-educated		34.015 (7.23)**	30.864 (6.55)**	31.018 (6.50)**
foreign-born		-12.738 (6.82)**	-13.621 (7.49)**	-13.587 (7.49)**
male		-60.657 (5.30)**	-46.960 (4.70)**	-46.424 (4.67)**
working age		44.040 (11.96)**	37.161 (10.12)**	36.762 (9.87)**
Constant	59.928 (33.44)**	68.339 (12.57)**	68.060 (14.01)**	68.780 (13.23)**
R^2	0.27	0.80	0.81	0.81

Notes:

t statistics in parentheses;

Vote in the 2003 Swedish referendum on joining the European Monetary Union is used as an instrument for the Alliance vote;

Observations are weighted by the number of voters in each of 339 zones;

* significant at 5%; ** significant at 1%

referendum about the adoption of the Euro in Sweden. The referendum about Sweden's entry into the European Monetary Union was rejected in a national vote in 2003 by a margin of 47 to 53 percent. We distributed the 2003 vote on adoption of the Euro in the 461 precincts in Stockholm to the 339 traffic zones using GIS techniques identical to those described earlier.

Table 3 reports the results when the 2003 vote on the adoption of the Euro is used as an instrument for the 2006 vote in favor of the Alliance candidates. As indicated in the table, the magnitudes and statistical significance of the coefficients are quite similar. The Alliance sympathizers were substantially less likely to favor the system of congestion tolls. Districts in which time savings were greater were more likely to favor the system of tolls, and districts in which incremental costs were larger were more likely to oppose the referendum. The importance of the other demographic variables is quite similar. College-educated working-age adults were more likely to approve the system of tolls; immigrants and males were less likely to favor congestion pricing. *Ceteris paribus*, those living inside the ring were marginally more likely to favor the system of tolls. Holding other things constant, there is no evidence that the voting decisions of prior transit riders or auto users merely reflected their modal preferences.

The results in columns 3 and 4 suggest, for example, that an average saving of one minute in commuting time per trip (i.e., 8.3 hours of commuting per year) is associated with an increase of about seven percentage points in the propensity to favor the system of congestion tolls. An increase of one SEK in out-of-pocket costs per trip (i.e., 500 SEK per year) is associated with a decrease of about 1.7 percentage points in

the propensity to favor the system of tolls. Holding other things constant, those residing inside the ring were about two percentage points more likely to favor the system of tolls.

Table 4 presents estimates when the average time savings and cost increases facing motorists are used instead of the costs and benefits facing all voters. Results are presented for the IV estimates (and the OLS estimates are reported in Appendix Table A1). When the more volatile variations in the time savings and additional costs borne by motorists are included, there is no improvement in the model. In fact, the significance of the out-of-pocket costs is less when the analysis recognizes only the costs and benefits of auto commuters.

IV. Conclusions

This paper presents an empirical analysis of the only referendum in which congestion pricing was freely adopted in a popular vote. The analysis shows that voters were predisposed for or against the measure by their more general political preferences. Those more likely to vote for certain political parties were also more likely to reflect that party's view on the issue of congestion tolls. The propensity to favor the system of congestion tolls also varied with the demographic characteristics of voters, with better educated voters and working-age voters tending to favor the tolls and immigrants and male workers tending to oppose the levies. As suggested by Frey (2003), the Stockholm experiment may be an example of the use of referenda to resolve long-standing political deadlocks.

But the results clearly document the importance of the private costs and benefits – the time savings in commuting and the tariffs paid by motorists arising from the tolls – in conditioning the acceptance of the system and in affecting voting behavior. The empirical

Table 4
Determinants of Voting in Support of Congestion Tolls
Dependent Variable: Percent Yes Vote
Two Stage Least Squares Estimates

	13	14	15	16
Average Time Saving: auto trips	7.037 (7.03)**	3.940 (7.36)**	2.949 (4.90)**	2.946 (4.84)**
Average Cost Increase: auto trips	0.432 (1.14)	-0.405 (2.25)*	-0.358 (1.60)	-0.357 (1.57)
inside ring (1 = yes)			2.421 (3.57)**	2.438 (2.89)**
Fraction				
public transit commuters				0.262 (0.04)
Alliance	-13.889 (5.63)**	-39.756 (12.10)**	-43.885 (14.29)**	-43.872 (14.10)**
college-educated		32.583 (7.10)**	30.151 (6.52)**	30.142 (6.47)**
foreign-born		-9.623 (5.36)**	-11.514 (6.61)**	-11.520 (6.60)**
male		-64.887 (5.94)**	-50.595 (5.05)**	-50.630 (5.08)**
working age		44.563 (12.55)**	37.772 (10.05)**	37.802 (9.93)**
Constant	53.593 (25.24)**	66.279 (12.50)**	66.928 (13.76)**	66.874 (12.76)**
R^2	0.40	0.80	0.81	0.81

Notes:

t statistics in parentheses;

Vote in the 2003 Swedish referendum on joining the European Monetary Union is used as an instrument for the Alliance vote;

Observations are weighted by the number of voters in each of 339 zones;

* significant at 5%; ** significant at 1%

results suggest that a ten percent decrease in the amount of time required for commuting could be expected to increase the propensity to favor the tolling system by an average of two percentage points. A ten percent increase in the incremental costs of commuting is associated with a decline of four percent in the approval rate of congestion tolls. Consumers who have experienced first-hand to implications of a specific toll scheme are clearly willing to trade money for time to reduce congestion and to gain other environmental benefits.

The tradeoff between time savings and out-of-pocket costs in the voting calculus also says something about consumers' valuation of commuting time. For example, if the average cost paid by commuters were increased by one SEK, the average payment by auto commuters would be about 3.70 SEK. (Recall, transit commuters pay nothing.) From the regression results in column 4 of Table 3 (Table 2), this would suggest that one hour of aggregate travel saving would be valued at 53 SEK (69 SEK). This valuation of commute time is a bit higher than the value of time for private trips (42 SEK per hour) assumed in national benefit-cost calculations by the Swedish National Road Administration. But this valuation is quite close to the private value of commute time assumed for the higher-income Stockholm metropolitan region (65 SEK per hour) in contemporaneous cost-benefit calculations for Stockholm (e.g., Eliasson, 2009, as described above). The estimates of travel time valuation, revealed by the referendum, 31 to 40 percent of the pretax wage rate[16] or 39 to 59 percent of the after-tax wage, are

[16] In 2006, average monthly income in Stockholm County was 28,500 SEK. For the country as a whole it was 25,000 SEK.

roughly comparable to time valuations derived from the modal choice decisions made by commuters in Western Europe and North America.[17]

Consumers behave as if they value commute time highly. When they have experienced first-hand the out-of-pocket costs and the time-savings benefits of a specific pricing scheme, they are prepared to adopt freely policies which reduce congestion on scarce urban motorways. Well-designed experimental policies of charging commuters to reduce congestion may help citizens to recognize the practical benefits of Pigovian taxes. This will improve economic efficiency in the use of urban infrastructure.

[17] See, for example, Van Ommeren and Fosgerau, 2009, and Small, 1992.

Appendix Table A1
Determinants of Voting in Support of Congestion Tolls
Dependent Variable: Percent Yes Vote
Ordinary Least Squares Estimates

	9	10	11	12
Average Time Saving: auto trips	6.699 (6.85)**	3.313 (7.02)**	2.433 (4.44)**	2.448 (4.87)**
Average Cost Increase: auto trips	0.472 (1.25)	-0.443 (2.74)**	-0.376 (1.73)	-0.379 (3.53)**
inside ring (1 = yes)			2.703 (4.02)**	2.631 (3.72)**
Fraction				
public transit commuters				-1.089 (0.17)
Alliance	-18.160 (8.40)**	-45.672 (18.40)**	-48.150 (20.52)**	-48.191 (22.32)**
college-educated		38.146 (9.02)**	33.428 (7.66)**	33.457 (11.04)**
foreign-born		-12.113 (7.49)**	-13.326 (8.19)**	-13.294 (8.24)**
male		-62.527 (5.74)**	-47.425 (4.84)**	-47.290 (5.47)**
working age		42.743 (12.27)**	35.818 (9.71)**	35.698 (11.11)**
Constant	56.026 (28.43)**	69.114 (12.67)**	68.817 (14.01)**	69.032 (17.67)**
R^2	0.41	0.80	0.81	0.81

Notes:

t statistics in parentheses;

Observations are weighted by the number of voters in each of 339 zones;

* significant at 5%; ** significant at 1%

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