E-ZTax: Tax Salience and Tax Rates

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Online Appendix

Appendix A: Survey of Toll Awareness

I conducted a survey in May 2007 of toll awareness of 214 individuals who were attending a large, open-air antiques show in Brimfield Massachusetts.[1] The venue was chosen to ensure easy access to a large number of people who were likely to have driven on a toll road (in this case, I-90, otherwise known as the Mass Pike) to reach the venue.

Individuals at the antique show were approached and asked if they had driven on the Mass Pike that day to get to the antiques show. If they answered yes, they were asked if they would take 1 to 2 minutes to answer some survey questions for MIT researchers. They were informed that the survey was entirely voluntary and they did not have to answer any questions that they did not want to answer. Only the driver was surveyed and other passengers were asked not to participate in helping to answer the questions.

The survey was designed to collect information on drivers' awareness of the toll that they had paid during their drive. Specifically drivers were asked "What is your best guess of how much you paid in tolls today on the Mass Pike on your drive here?" The survey also collected data on the entrance and exit that they had taken (so that the actual toll paid could be computed and compared to their estimated toll).[2] Finally, I collected basic demographic information on the respondents. The survey instrument is shown at the end of Appendix A.

One-third of drivers reported paying using ETC. This is broadly consistent with data from the Massachusetts Turnpike Authority indicating that, in 2005, 55 percent of tolls on the Mass Pike were paid for using ETC. Note that the survey data is weighted by drivers while the Authority's data is weighed by transactions. It is likely that the transaction-weighted number from my sample would look quite similar to the Authority's estimate, as individuals in my sample who reported paying with ETC were over twice as likely to report that they "regularly drive through a toll plaza on a commute to work."

Appendix Table A reports the demographic characteristics of the sample overall, and separately for ETC and cash drivers. About two-thirds of survey respondents were from Massachusetts; another 23 percent are roughly evenly drawn from CT, NH, NY and RI (not shown). On average the sample population is slightly richer than the general population. For example, for the Massachusetts respondents (about two-thirds of the sample), average median household income of their zip code was $60,157 compared to $54,143 for Massachusetts residents overall in the 2000 Census (not shown).

Reassuringly, where comparisons are feasible, the statistics on drivers who use ETC relative to those who use cash are similar to those found in other studies. Consistent with other survey evidence (Amromin et al., 2005, Pietrzyk and Mierzejewsli 1993), Appendix Table A shows that individuals who drive frequently on toll facilities are more likely to adopt ETC, and that drivers who adopt ETC are of

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[1] Brimfield, in Western Massachusetts, is easily reached from Exit 8 or 9 on I-90. It hosts what it bills as the "largest outdoor antiques show in the world" three times a year; it estimates over 130,000 visitors per show.

[2] About 9 percent of both drivers who paid with cash and those who paid electronically drove on a portion of the Mass Pike in which the toll is lower if paid electronically. For these drivers, the actual toll paid based on their payment method was used in calculating the error in toll estimation. None of the results of the survey are affected either qualitatively or quantitatively by omitting this sub-sample of individuals for whom the toll varied by method of payment (not shown). The toll schedules for passenger cars on the Mass Pike can be found here: http://www.masspike.com/pdf/tolls/toll_class1.pdf (cash schedule) and here http://www.masspike.com/pdf/tolls/toll_class1FL.pdf (ETC schedule).

higher socio-economic status (as measured by zip code-level income, educational attainment, or the value of their car) than those who do not. The two types of drivers are quite similar in terms of age and gender, as well as in terms of the average cash toll for the trip taken on the day of the survey. In the analysis of differences in awareness of toll rates between these two types of drivers in the main paper, I show that these differences in awareness are not affected by controlling for these observable differences in demographic characteristics (see Table I).

MIT TRANSPORTATION STUDY

1.	What is your best guess of how much you paid in tolls today on the Mass Pike on your drive here?	$ ___ . ___
	TICK HERE IF FIRST RESPONSE WAS some version of "I don't know" and respondent had to be prompted to give an answer.[*]	___
2.	Where did you get on the Mass Pike today? **SHOW LIST OF ENTRANCES. RECORD ENTRANCE NUMBER.**	___
3.	Where did you get off the Mass Pike today? **SHOW LIST OF EXITS. RECORD EXIT NUMBER.**	___
4.	Did you pay cash for the toll today or did you use Fast-Lane / EZ-Pass?	1 Cash 2 Fast lane / EZ Pass 9 Don't know
5.	Do you regularly drive through a toll plaza on a commute to work?	1 Yes 2 No 6 Don't work / not applicable
6.	What is your zip code?	___
7.	What is the make, model and year of the car you drove here today?	
7a.	Make:	___
7b.	Model:	___
7c.	Year:	___
8.	What is the highest grade of school you completed, or the highest degree you received?	1. Grade: ___ 2. High school 3. College 4. Post-college
9.	How old are you?	___
10.	**SURVEYOR NOTE GENDER.**	1 Male 2 Female

[*] Surveyors were instructed to allow a pause for individuals to volunteer a guess on their own, and to only mark the respondent as saying "I don't know" if the respondent did not volunteer any guess, but stopped at this point and had to be urged (prompted) to please make their best guess. In the end, all but one of the surveyed individuals made a guess.

Appendix B: Construction of toll data set

B.1 Sample

The target sample is all publicly owned toll facilities in the United States (excluding ferries) that were charging a toll in 1985. I chose the year 1985 to ensure at least 20 years of toll rate history on each facility, as well as data on all roads prior to the first facility's adoption of ETC in the United States (which occurred in 1987).

I identified the target sample as the universe of toll facilities from the 1985 and 1986 volumes of "Highway Statistics" published by the U.S. Department of Transportation (U.S. Department of Transportation, various years). In a few instances, I added facilities to the data that did not appear independently in the "Highway Statistics" volumes but that were disaggregated for us by the operating authority when we contacted them (such as the "Bee Line East Expressway" which is part of the "Florida Turnpike System" in "Highway Statistics").

To construct the necessary data, I contacted each toll operating authority and requested toll rate histories for each of their toll facilities from 1950 or its opening (whichever was later) through 2005. I also requested the date (if any) that ETC was adopted, annual traffic and revenue data, and the annual fraction of traffic and revenue accounted for by ETC. The data collection effort took place mainly in the first six months of 2006. I consider the data usable if it contains the date of ETC adoption and toll rate histories back to at least 1985.

The target sample consists of 183 toll facilities run by 88 operating authorities in 31 states. Of these, I was able to collect the requisite data for 123 facilities run by 49 operating authorities in 22 states. For the acquired facilities, opening dates range from 1924 to 1985, with a median opening date of 1955. All of the facilities in the sample started charging tolls on the opening date. About sixty percent of the facilities are bridges or tunnels; the remainder consists of roads.

Appendix Table B1 provides some summary statistics on the 123 facilities in the sample. Specifically, it lists for each state and operating authority, the facilities for which I collected data, the date the facility started charging tolls, the date my toll data start (if later than the toll start date), the date (if any) at which the facility adopted Electronic Toll Collection (ETC), and whether the facility ever offered a discounted toll rate to ETC users. For purposes of the analysis, I defined two additional "states" ("New Jersey – Pennsylvania" and New York – New Jersey") to reflect the fact that certain operating authorities – specifically, the Port Authority of New York and New Jersey, the Delaware River Joint Toll Bridge Commission, and the Delaware River Port Authority – are under the purview of two states (NY and NJ, and NJ and PA, respectively). The sample for analysis therefore consists of 24 state-like entities, as reflected in Table B1.

Appendix Table B2 provides a list of the 60 facilities in the target sample for which I was unable to find data. Not surprisingly, a factor that is strongly predictive of a lack of success in getting toll data is that the facility is no longer charging a toll toward the end of our sample period. Only half of the facilities that I was unable to collect data for were still charging tolls in 2003, compared to over 90 percent of the facilities for which I was able to collect data. Of the 9 states in which I was unable to collect data on any target facilities, 4 (CT, IA, MN, and WA) were no longer charging tolls on any of the sample facilities in 2003**.** For facilities that were no longer charging tolls by the end of out sample period, I was usually unable to find any contact information, particularly if the operating authority that managed that facility no longer had any toll charging facilities. (Indeed, 8 out of the 13 facilities that were not charging a toll in 2003 that I was able to collect data for were managed by operating authorities that still had other facilities charging tolls). For the vast majority of facilities for which I am missing data that were still charging tolls at the end of my sample period, I contacted the relevant operating authority repeatedly but was unable to obtain the necessary data; in a very few of these cases, I was unable to even find the relevant contact information.[3] Another noticeable pattern in success in data collection is that I am missing data on all 12 target facilities in TX (even though all but 1 of the 10 operating authorities were still running facilities charging tolls by the end of the sample period). The TX operating authorities either did not respond to inquiries or did not provide sufficient data (despite multiple requests) to be included in the analysis.

The missing facilities raise questions about the validity of analyzing the impact of ETC on only a sub-sample of toll facilities. To the extent that the missing data is related to systematic geographic characteristics – such as the lack of any data on TX – we may wish to interpret the results as applicable only in certain states. A potentially more major concern is the selection on the dependent variable. As noted, facilities that are no longer charging tolls are much less likely to be in the sample. However, this likely biases my analysis against finding an effect of ETC on toll increases as facilities that are no longer charging tolls (and are therefore not experiencing any toll increases by definition) are much less likely to have adopted ETC. Indeed, only 1 of the 15 facilities in the acquired sample that had stopped charging a toll by 2005 had ever adopted ETC.

B.2 Variable definitions

ETC Penetration: I define the ETC Penetration rate as the fraction of toll transactions or the fraction of toll revenue collected by ETC. The definition of ETC penetration varies across (but not within) facilities depending on whether I could obtain more years of data for the fraction of toll transactions or the fraction of toll revenue paid for by ETC. These measures may differ because of ETC discounts. Where I observe both, the correlation is 0.90. Since all of the analysis is within-facility, this slight variation in definition across facilities should not pose any problems.

For over 95 percent of facilities, ETC penetration is defined based on all toll revenue (or transactions); in a few cases it refers to just passenger car revenue (or transactions). For about two-thirds of facilities ETC penetration was reported separately for each facility. For the others, it was reported for the entire operating authority; for these, I impute to each facility-year the operating authority - year average. Since, as discussed, adoption of ETC is almost always simultaneous on facilities within an operating authority, this should be a reasonable approximation.

Tolls: Tolls are defined as the nominal toll rate for passenger cars; high frequency discounts (i.e. commuter discounts) are not coded. None of the facilities offer time-of-day varying prices. I collected data on both the "manual" (i.e. cash) toll rate and the discounted electronic toll rate, if offered. I define the toll on bridges, tunnels, or causeways as the round-trip cost on that facility; I use the round-trip rate because 40 of the 79 bridges and tunnels changed from collecting a toll on both ends of the bridge to only collecting it on one end during the sample period. I define the toll rate on a road as the cost of a full length trip on this road. Where the road has several potential branches (such as the PA turnpike), I code a full length trip as the length on the mainline; where a road forks at one end (such as the New Jersey Turnpike), I code the full length trip as the longer fork. One potential concern with this definition is that it may fail to capture some toll changes on a road. Specifically, toll changes will be missed if they occur on uncoded branches (such as branches of the PA turnpike other than the mainline), on exit or entrance ramps along the road, or on non full-length routes within a ticket system (such as the New Jersey turnpike). In practice, I determined that this is unlikely to have any effect on my analysis. I constructed an indicator variable "any toll increase" that is coded if the road has a toll change on the coded toll *or* an unrecorded toll change for any of the reasons just discussed. I find that the analysis of the impact of ETC

[3] These were: the White County Bridge Commission, the Indiana Transportation Finance Authority, the Bellevue Bridge Commission, and the Roma International Toll Bridge.

on the probability of a toll increase yields literally the same point estimates and standard errors when this "any toll increase" binary variable is used instead of a binary variable for a recorded toll increase (these latter results are shown in Table VII column 2); this is not surprising, given that the correlation between "any toll increase" and the standard binary variable for a recorded toll increase is 0.98 on roads.

In 2005, the average (manual) toll was $5.41 for a full length trip on a road (implying an average per-mile toll of $0.063)[4] and $3.03 for a round-trip on a bridge or tunnel.

As noted in the text, 15 of the 123 toll facilities that are charging a toll in 1985 subsequently set the toll to zero. These facilities (and the date that the toll is set to zero) are as follows: Astoria-Pt. Ellice Bridge (1993), Bluegrass Parkway (1991), Coronado Bridge (2002), Cumberland Bridge (2003), Daniel Boone Parkway (2003), Jackson Purchase Parkway (1992), Mt. Hope Bridge (1998), Murray Road Toll Bridge (2000), Navarre Bridge (2004), Norfolk-Virginia Beach Toll Road (1995), Pennyrile Parkway (1992), Rock Island Centennial Bridge (2003), Torras Causeway (2004), Vincent Thomas Bridge (2001), and Western Kentucky Parkway (1986). All of these facilities keep the toll at zero through 2005. However, it does not appear that a toll set to zero is always an absorbing state. Two facilities that set tolls to zero prior to 1985 subsequently reintroduced positive tolls: Antioch Bridge (reintroduced a toll in 1978) and Carquinez Bridge (reintroduced a toll in 1957). I treat all facility-years with zero tolls as censored in the analysis. As noted in the text, this may bias the estimated effect of ETC downward, as facilities are less likely to set tolls to zero when they have ETC; indeed of the 15 facilities that set their tolls to zero, only the Navarre Bridge adopted ETC and subsequently set the toll rate to zero.

Traffic and revenue: I considered data on toll revenue or toll traffic usable if I was able to get at least 10 years of facility-level data. For a facility with usable data, on average I collected 34 years of data. For over 95 percent of facilities, the data pertain to all toll revenue or toll traffic; in a few cases they pertain only to passenger cars. Traffic and revenue data are all reported at the facility level, except for the three facilities in the New Hampshire Department of Transportation and for the three facilities in the Illinois State Toll Highway Authority for which they are reported at the level of the operating authority. For these, I assign the operating authority value to each facility within it.

Over the sample, traffic on a facility grew on average by 4.9 percent per year and (nominal) facility revenue by 7.7 percent.

[4] Mileage data for a full length trip were taken from U.S. Department of Transportation (2003) or information from the operating authority's web site.

Appendix C: Effect of lower compliance costs on toll rates.

Section 7.4 discussed the possibility that lower personal compliance costs of paying tolls under ETC might provide an alternative explanation for the observed increase in toll rates under ETC. Mitigating against this explanation, it described two pieces of empirical evidence that suggest that toll authorities do not increase tolls in response to reductions in compliance cost. This online appendix section C provides more detail on each of these pieces of evidence.

The first piece of evidence comes from variation across roads in the number of times an individual must make a toll transaction; this produces variation in the compliance costs savings from ETC. For example, in 1985 an individual made 11 toll transactions while driving the length of the Garden State Parkway, compared to only two on the New Jersey Turnpike. If tolls are increased under ETC in response to the reductions in compliance costs, we would expect greater toll increases on roads with a greater number of toll transactions. In fact, there is weak evidence of the opposite.

Table C1 shows the results. Column 1 shows that the baseline result of an increase in tolls associated with ETC persists when I re-estimate equation (17) [see main text] on the sub-sample of facilities that are roads. In columns 2 through 4 I enrich equation (17) to include interactions of both $ETCAdopt_{it}$ and ETC_{it} with three different measures of the compliance costs associated with toll collection on the facility in 1985; I also include the main effect for the measure of compliance costs. The measures of compliance costs are the number of separate toll transactions involved in a full length trip on the road (column 2), the number of transactions per dollar of toll (column 3), and the number of transactions per mile of toll (column 4). For all three measures, the results suggest that the increase in tolls associated with ETC is, if anything, *lower* on roads with higher compliance costs. Of course, roads with different compliance costs of toll paying may differ for other reasons in their responsiveness to tax salience; the evidence therefore, while reassuring, is of course not without its limitations.

The second piece of suggestive evidence comes from about half of the bridges and tunnels (40 out of 79) switching from collecting tolls at both ends of the facility to collecting tolls at only one end. This switch occurred at different times for different facilities (see Finkelstein [2007] for more detail on the timing of these switches). Table C2 shows the impact on tolls. Column 1 shows the baseline results limited to the sub-sample of facilities that are bridges and tunnels. In column 2, I add an additional right hand side indicator variable for whether it is the year in which the facility switched from two-way to one-way tolling ($OneWayAdopt_{it}$).[5] Unlike ETC whose use diffuses over time and whose effects on toll rates is therefore expected to occur incrementally over time, the switch to one-way tolling is instantaneous, and therefore any effect on toll rates might also be expected to be instantaneous. The coefficient on $OneWayAdopt_{it}$ is 0.041 (s.e. = 0.035) which suggests that the change from both-way to one-way tolling is associated with a statistically insignificant 4.1 percent increase in tolls. By contrast, the coefficients on $ETCAdopt_{it}$ and ETC_{it} in column 2 together imply that after ETC has diffused to its steady state level, it is associated with a statistically significant increase in toll rates of 36 percent (~exp($\beta_{ETCAdopt}$ + 14*$\beta_{\Delta ETC}$)). I can reject that the implied steady state effect of ETC is the same as that from the switch to one-way tolling at the 90% confidence level.

To allow for possible lags in the effect of a change to one-way tolling – and to make the specification of the effect of this change identical to that used to gauge the effects of ETC – in column 3 I add an indicator variable for whether the facility switched to one way tolling that year or a previous year ($OneWay_{it}$).The coefficient on $OneWay_{it}$ is statistically insignificant while the (corresponding) coefficient on ETC_{it} is unaffected in magnitude or statistical significance; I do not, however, have enough power to reject that the coefficients on ETC_{it} and $OneWay_{it}$ are statistically distinguishable.

[5] Recall that the tolls on bridges and tunnels are defined as the tolls on a round trip, so that there is no mechanical effect on tolls from changing from two-way to one-way tolling.

Appendix Table A: Demographic Characteristics of MA survey respondents, by payment method

	Entire Sample (1)	ETC Drivers (2)	Cash Drivers ((3)	Difference btwn ETC and Cash Drivers (4)
Average Age	46.7	45.3	47.3	-2.00
	(12.01)	(11.4)	(12.3)	(1.74)
Fraction Male	0.581	0.567	0.587	-0.020
	(0.495)	(0.500)	(0.494)	(0.074)
Fraction "usually pay toll on commute to work"	0.169	0.265	0.124	0.141**
	(0.376)	(0.444)	(0.331)	(0.060)
Average median hh income of zip code	$ 56,865	$62,199	$54,368	$7,830**
	(21,110)	($25,312)	($18,400)	(3,473)
Avg Retail Price of Car	$11,310	$13,357	$10,302	$3,055***
	(6,600)	(7,222)	(6,050)	(1,054)
Fraction Highest Degree Received				
HS Degree or Less	0.201	0.176	0.212	-0.036
	(0.402)	(0.384)	(0.410)	(0.058)
College Degree	0.509	0.441	0.541	-0.100
	(0.501)	(0.500)	(0.500)	(0.073)
Post-College Degree	0.290	0.382	0.247	0.136**
	(0.455)	(0.490)	(0.433)	(0.069)
Average cash toll for drive	$1.14	$1.09	$1.16	-0.070
	($1.05)	($0.905)	($1.11)	(0.143)
Fraction from MA	0.682	0.765	0.644	0.121*
	(0.466)	(0.424)	(0.479	(0.065)
N	214	68	146	

Notes: Standard deviations are in parentheses, except in column 4 where robust standard errors are reported instead. In column 4, ***, **, * denote statistical significance at the 1%, 5% and 10% levels respectively.

Appendix Table B1: Facilities in Sample and the Data Available for them

State	Operating Authority	Facility	Year First Toll	Toll data start date	Traffic Data	Revenue Data	ETC start date	ETC Penetration Data
CA	California Transportation Commission	Antioch Bridge	1926	1950	1993-2004	1993-2004	2001	2002-2005
		Bay Bridge	1936	1950	1993-2004	1993-2004	2001	2002-2005
		Benicia-Martinez Bridge	1962	1962	1993-2004	1993-2004	2001	2002-2005
		Carquinez Bridge	1927	1950	1993-2004	1993-2004	2001	2002-2005
		Coronado Bridge	1969	1969			--	--
		Dumbarton Bridge	1927	1959	1993-2004	1993-2004	2001	2002-2005
		Richmond San Rafael Bridge	1956	1956	1993-2004	1993-2004	2001	2002-2005
		San Mateo Bridge	1929	1959	1993-2004	1993-2004	2001	2002-2005
		Vincent Thomas Bridge	1963	1963			--	--
	City of Oceanside	Murray Road Toll Bridge	1984	1984			--	--
	Golden Gate Bridge and Highway District	Golden Gate Bridge	1937	1950	1974-2004		**2000**	2001-2005
DE	Delaware Transportation Authority	John F. Kennedy Memorial Highway (I-95) -- Delaware	1963	1963	1963-2005	1963-2005	**1998**	1999-2005
	Delaware River and Bay Authority	Delaware Memorial Bridge		1970			2001	2002 - 2005
FL	City of Treasure Island	Treasure Island Causeway		1950	1971-2005	1996-2005	--	--
	Florida Department of Transportation	Bee Line East Expressway	1974	1974	1994-2005		2001	2004 - 2005
		Everglades Parkway (Alligator Alley)	1969	1969	1994-2005		1999	2003 – 2005
		Navarre Bridge	1961	1961	1994-2005		2000	
		Pinellas Bayway System	1962	1962	1994-2005		2000	2003 – 2005
		Selmon Crosstown Expressway	1976	1976	1994-2005		2000	2003 – 2005
		Sunshine Skyway Bridge	1954	1954	1994-2005		**2000**	2003 – 2005
	Lee County	Lee County Toll Bridges -- Sanibel Bridge and Causeway	1963	1963	1965-1978 1980-1998 2000-2005		1987	2001-2005
	Monroe County	Card Sound Toll Bridge	1965	1965		1991-2005	--	--
	Town of Bay Harbor Islands	Broad Causeway	1951	1951	1952-2004	1952-2004	**1989**	2001-2005
GA	Georgia State Tollway Authority	Torras Causeway	1981	1981			--	--
IL	City of Chicago	Calumet Skyway Toll Bridge (Chicago Skyway)	1959	1959	1983-2003	1983-2003	2005	--

	City of Rock Island	Rock Island Centennial Bridge	1940	1950	1971, 1973, 1975, 1977, 1979, 1981, 1983, 1985 1987-1995 1999, 2001, 2003, 2005		--	--
	Illinois State Toll Highway Authority	Northwest Tollway	1958	1959			**1993**	1998-2005
		Ronald Reagan Memorial Tollway	1958	1959			**1993**	1998-2005
		Tri-State Tollway	1958	1959			**1993**	1998-2005
IN	Indiana Toll Finance Authority	Indiana Toll Road	1956	1956	1957-2004	1957-2004	--	--
		Wabash Memorial Toll Bridge	1956	1956	1977-1981 1983-2004	1957-2004	--	--
KS	Kansas Turnpike Authority	Kansas Turnpike System	1956	1956	1956-2005	1956-2005	**1995**	1995-2005
KY	The Turnpike Authority of Kentucky	Audubon Parkway	1970	1970		1972-2005	--	--
		Bluegrass Parkway	1965	1965			--	--
		Cumberland Parkway	1973	1973		1974-2004	--	--
		Daniel Boone Parkway	1971	1971		1973-2004	--	--
		Jackson Purchase Parkway	1968	1968			--	--
		Pennyrile Parkway	1969	1969			--	--
		Western Kentucky Parkway	1963	1963			--	--
		William H Natcher Parkway	1972	1972		1974-2005	--	--
MA	Massachusetts Turnpike Authority	Massachusetts Turnpike	1957	1980			**1998**	1998-2005
		Sumner Tunnel	1934	1934	1966-1998		**1998**	1998-2005
MD	Maryland Transportation Authority	Chesapeake Bay Bridge	1952	1952	1969-1992 2000-2005		2001	2002-2005
		Fort McHenry Tunnel	1985	1985	1986-1992 2000-2005		1999	2000-2005
		John F. Kennedy Memorial Highway	1963	1963	1969-1992 2000-2005		2001	2002-2005
		Key Bridge	1977	1977	1978 1980-1992 2000-2005		1999	2001-2005
		Patapsco Tunnel	1957	1957	1969-1978 1980-1992 2001-2005		1999	2000-2005

		Potamac River Bridge	1940	1950	1969-1978 1980-1992 2000-2005		2001	2002-2005
		Susquehanna River Bridge	1940	1950	1969-1978 1980-1992 2000-2005		2002	2002-2005
ME	Maine Turnpike Authority	Maine Turnpike	1947	1950	1980-2000		**1997**	2000, 2002, 2005
MI	Mackinac Bridge Authority	Mackinac Bridge	1957	1957	1957-2005		2001	2001-2005
NH	New Hampshire Department of Public Works and Highways	Blue Star Turnpike	1950	1950	1950-2004	1950-2004	**2005**	2005
		Central Turnpike	1955	1955	1955-2004	1955-2004	**2005**	2005
		Spaulding Turnpike	1956	1956	1956-2004	1956-2004	**2005**	2005
NJ	Burlington County Bridge Commission	Burlington-Bristol Bridge	1929	1950			2003	2004-2005
		Tacony-Palmyra Bridge	1929	1950			2003	2004-2005
	Cape May Bridge Commission	Corsons Inlet Bridge	1948	1950			NA	--
		Grassy Sound Bridge	1940	1950			NA	--
		Middle Thorofare Bridge	1940	1950			NA	--
		Ocean City Longport Bridge	1946	1950			NA	--
		Townsends Inlet Bridge	1941	1950			NA	--
	New Jersey Highway Authority	Garden State Parkway	1954	1954	1955 - 2004		**1999**	2001-2005
	New Jersey Turnpike Authority	New Jersey Turnpike^	1951	1967	1967-2003		**2000**	2001-2005
	New Jersey Expressway Authority	Atlantic City Expressway	1965	1965	1965-2004	1965-2004	**1998**	1998-2004
NJPA	Delaware River Joint Toll Bridge Commission	Easton-Phillipsburg Bridge		1983			**2002**	2003-2005
		Interstate 80 Delaware Water Gap		1983			**2002**	2003-2005
		Milford-Montague Bridge		1983			**2002**	2003-2005
		New Hope-Lambertville Bridge		1983			**2002**	2003-2005
		Portland-Columbia Bridge		1983			**2002**	2003-2005
		Trenton-Morrisville Bridge		1983			**2002**	2003-2005
	Delaware River Port Authority	Ben Franklin Bridge	1926	1950	1993 – 2005		**1999**	2000-2005
		Betsy Ross Bridge	1976	1976	1993-2005		**1999**	2000-2005
		Commodore Barry Bridge	1974	1974	1993-2005		**1999**	2000-2005
		Walt Whitman Bridge	1957	1957	1993-2005		**1999**	2000-2005

NY	Buffalo and Ft. Erie Public Bridge Authority	Peace Bridge	1927	1956	1995-2004	1995-2004	**2002**	2002-2004
	Nassau County Bridge Authority	Atlantic Beach Bridge		1967			--	--
	New York State Bridge Authority	Bear Mountain Bridge	1940	1950			1998	’98, ’02, ’05
		Kingston-Rhinecliff Bridge	1957	1957			1998	’98, ’02, ’05
		Mid-Hudson Bridge	1933	1950			1998	’98, ’02, ’05
		Newburgh-Beacon Bridge	1963	1963			1998	’98, ’02, ’05
		Rip Van Winkle Bridge	1935	1950			1998	’98, ’02, ’05
	New York State Thruway Authority	New York State Thruway^	1954	1954	1970-2004	1970-2004	**1993**	1993-2005
		Tappan Zee Bridge	1955	1955	1956-1961 1963-1964 1969-1970 1972-2004	1956-2004	**1993**	1999-2005
	Niagara Falls Bridge Commission	Lewiston-Queenston Bridge	1962	1969			--	--
		Rainbow Bridge	1941	1969			--	--
		Whirlpool Bridge	1959	1969			--	--
	Ogdensburg Bridge and Port Authority	Ogdensburg-Prescott Bridge	1960	1960			--	--
	Thousand Islands Bridge Authority	Thousand Island Bridges	1938	1950	1950-2005	1950-2005	--	--
	Triborough Bridge and Tunnel Authority	Bronx-Whitestone Bridge	1939	1969	1969-2004	1969-2004	**1996**	1996-2004
		Brooklyn-Battery Tunnel	1950	1969	1969-2004	1969-2004	**1996**	1996-2004
		Cross Bay Veterans Memorial Bridge	1939	1969	1969-2004	1969-2004	**1996**	1996-2004
		Henry Hudson Bridge	1936	1969	1969-2004	1969-2004	**1996**	1996-2004
		Marine Parkway-Gil Hodges Memorial Bridge	1937	1969	1969-2004	1969-2004	**1996**	1996-2004
		Queens Midtown Tunnel	1940	1969	1969-2004	1969-2004	**1996**	1996-2004
		Throgs Neck Bridge	1961	1969	1969-2004	1969-2004	**1996**	1996-2004
		Triborough Bridge	1936	1969	1969-2004	1969-2004	**1996**	1996-2004
		Verrazano Narrows Bridge	1964	1969	1969-2004	1969-2004	**1995**	1995-2004
NYNJ	Port Authority of New York and New Jersey	Bayonne Bridge	1931	1950	1950-2004		**1997**	2005
		George Washington Bridge	1931	1950	1950-2004		**1997**	2005
		Goethals Bridge	1928	1950	1950-2004		**1997**	2005
		Holland Tunnel	1927	1950	1950-2004		**1997**	2005
		Lincoln Tunnel	1937	1950	1950-2004		**1997**	2005

		Outerbridge Crossing	1928	1950	1950-2004		**1997**	2005
OH	Ohio Turnpike Commission	Ohio Turnpike	1955	1955	1961-2004	1961-2004	--	--
OK	Oklahoma Transportation Authority	Cimarron Turnpike	1975	1975	1982-2005	1975-2005	**1991**	1991-2005
		H.E. Bailey Turnpike	1964	1964	1982-2005	1964-2005	**1991**	1991-2005
		Indian Nation Turnpike	1966	1966	1982-2005	1966-2005	**1991**	1991-2005
		Muskogee Turnpike	1969	1969	1982-2005	1969-2005	**1991**	1991-2005
		Turner Turnpike	1953	1953	1982-2005	1982-2005	**1991**	1991-2005
		Will Rogers Turnpike	1957	1957	1982-2005	1957-2005	**1991**	1991-2005
OR	Oregon State Highway Div.	Astoria-Pt. Ellice Bridge	1966	1966			--	--
	Port of Cascade Locks Commission	Cascade Locks Bridge	1926	1950			--	--
	Port of Hood River Commission	Hood River-White Salmon Bridge	1924	1950	1994-2005	1994-2005	--	--
PA	Pennsylvania Turnpike Commission	Pennsylvania Turnpike^	1940	1950	1950-2005		2000	
RI	RI Turnpike & Bridge Authority	Jamestown-Newport Bridge	1969	1969			--	--
		Mt. Hope Bridge	1955	1955			--	--
VA	Richmond Metropolitan Authority	Boulevard Bridge	1969	1969	1972-2004		1999	2000-2005
		Downtown Expressway	1976	1976	1976-2004		**1999**	2000-2005
		Powhite Parkway	1973	1973	1973-2004		**1999**	2000-2005
	VA Department of Highways	Norfolk-Virginia Beach Toll Road	1967	1967			--	--
		Dulles Toll Road	1984	1984	1985-2005		1996	2000-2005
WV	City of Parkersburg	Parkersburg Bridge	1955	1974			--	--
	WV Turnpike Commission	West Virginia Turnpike	1954	1954	1991-2005		2000	

Notes: Blank cells indicate missing data. All toll data go through 2005. "ETC start date" is coded "--" to indicate "not applicable" if facility never instated ETC and is **bolded** if the facility ever offered a discounted rate to ETC users. Toll, Traffic and Revenue data denote the years after 1950 for which we have these data. "ETC Penetration" records years in which a facility has ETC for which we have ETC Penetration data; it is coded "--" to indicate "not applicable" for facilities that did not adopt ETC by 2005. "Year first toll" is missing for the few facilities for which I was not able to obtain this information. ^ denotes that this road has multiple branches; for the purposes of this study, we defined the road as the mainline branch (where relevant) or the longest possible path from the end of one branch to the end of another. Operating Authority names are based on the Operating Authority that controlled the facility in 1985, according to the U.S. Department of Transportation (1985, 1986).

Appendix Table B2: Target facilities lacking requisite data for analysis

State	Operating Authority	Facility	Toll in 2003?
CO	City of Colorado Springs	Pikes Peak Toll Highway	1
CT	Connecticut Department of Transportation	Charter Oak Bridge	0
		Connecticut Turnpike	0
		John Bissell Bridge	0
		Merritt Parkway	0
		Thames River Bridge	0
		Wilbur Cross Parkway	0
		William H. Putnam Bridge	0
FL	City of Clearwater	Clearwater Toll Bridge	0
	Dade County Port Authority	Biscayne Key (Rickenbacker) Causeway	1
		Venetian Causeway	1
	Escambia County	Pensacola Beach Bridge	1
	Florida Department of Transportation	Central Florida Expressway	1
		Florida Turnpike System*	1
		Miami-Dade County Expressways	1
		St. George Island (Bryant Patton) Bridge	0
		Tampa-Hillsborough County (South Crosstown) Expressway	1
	Jacksonville Transportation Authority	Jacksonville Expressway System	0
	Ocean Highway and Port Authority	Buccaneer Trail Road	0
IA	City of Burlington	MacArthur (Burlington) Bridge	0
	City of Keokuk	Keokuk Municipal Bridge	0
	Iowa Department of Transportation	Clinton Toll Bridge	0
		Dubuque Toll Bridge	0
		Muscatine Bridge	0
		Savanna-Sabula Toll Bridge	0
IL	City of Chester	Chester (Mississippi River) Bridge	0
	City of East St. Louis	Martin Luther King (Veterans Memorial) Bridge	0
	City of Venice	McKinley Bridge	0
	White County Bridge Commission	New Harmony Bridge	1
IN	Indiana Toll Finance Authority	Hawesville-Cannelton Bridge	0
	Indiana Transportation Finance Authority	Brandenburg-Maukport Bridge	1
LA	Greater New Orleans Expressway Commission	Greater New Orleans Expressway	1
MA	Massachusetts Port Authority	Maurice J. Tobin (Mystic River) Bridge	1
MI	International Bridge Authority of MI	Sault Sainte Marie Bridge	1
	Michigan Department of Transportation	Blue Water Bridge	1
MN	Village of Baudette	Baudette-Rainy River International Bridge	0
MO	City of Kansas City	Broadway Bridge	0
	Platte County	Platte Purchase Bridge	0
	Wayland Special Road District	St. Francisville Bridge	1
NE	Bellevue Bridge Commission	Bellevue Bridge	1
	Burt County Bridge Commission	Burt County Missouri River (Decatur) Bridge	1
NY	Lake Champlain Bridge Commission	Crown Point Bridge	0
		Rouses Point Bridge	0

TX	Cameron County	Cameron County International Toll Bridge	1
	City of Del Rio	Del Rio International Bridge	1
	City of Eagle Pass	Eagle Pass-Piedras Negras International Bridge	1
	City of El Paso	El Paso International Bridge	0
	City of Laredo	Laredo-Nuevo Laredo International Bridge	1
	City of McAllen	McAllen International Toll Bridge	1
	Galveston County	San Luis Pass-Vacek Bridge	1
	Harris County Toll Road Authority	Harris County Toll Road	1
	Starr County	Roma International Toll Bridge	1
	Texas Turnpike Authority	Dallas North Tollway	1
		Houston Ship Channel Bridge	0
		Mountain Creek Lake Bridge	0
VA	Chesapeake Bay Bridge and Tunnel District	Chesapeake Bay Bridge and Tunnel System	1
	City of Chesapeake	Jordan Bridge	1
	Virginia Department of Highways	Elizabeth River Bridge and Tunnels	0
		Richmond-Petersburg Turnpike	0
WA	Washington Toll Bridge Authority	Maple Street Bridge	0

Note: Last column indicates whether or not facility is still charging toll in 2003; this is based on data from U.S. Department of Transportation (2003, 2004). These were the latest available data as of August 2006. * Denotes that facility provided dates of toll changes, but not actual toll rates.

Table C1: The impact of ETC-induced reductions in compliance costs on toll rates

Measure of compliance costs	(1)	Number of transactions (2)	Number of trans-actions per $ toll (3)	Number of transactions per mile (4)
ETC_{it}	0.015	0.023	0.024	0.029
	[0.008]	(0.011)	(0.011)	(0.013)
	(0.067]	[0.043]	[0.048]	[0.046]
ETC_{it}		-0.004	-0.008	-0.132
*(Measure of compliance costs)		(0.002)	(0.004)	[0.047]
		[0.122]	[0.057]	[0.013]
$ETCAdopt_{it}$	-0.023	-0.047	0.016	0.009
	(0.063)	(0.083)	(0.044)	(0.078)
	[0.719]	[0.575]	[0.716]	[0.905]
$ETCAdopt_{it}$		0.010	-0.024	-0.360
*(Measure of compliance costs)		(0.010)	(0.025)	(0.153)
		[0.323]	[0.340]	[0.033]

Note: Table reports results from estimating variants of equation (17) by OLS. Dependent variable is the change in the log minimum toll rate. Sample is limited to roads (N = 1,692; number of facilities = 44; number of operating authorities = 24; number of states = 18; mean of dependent variable = 0.021). In addition to the covariates shown in the table, all regressions include year fixed effects and (in columns 2 through 4) the main effect for "Measure of compliance costs". $ETCAdopt_{it}$ is an indicator variable for whether facility *i* adopted ETC in year *t*. ETC_{it} is an indicator variable for whether the facility has ETC; it is 1 in the year that ETC is adopted and in all subsequent years. The "Measure of compliance costs" variable is defined as of 1985 according to the definition in the column headings. In column 2 it is the number of separate toll transactions on a full length trip on the road. In column 3 it is the number of separate toll transactions divided by the monetary toll for a full length trip. In column 4 it is the number of separate toll transactions divided by the mileage for a full length trip. Data on the number of toll transactions come from toll operating authority websites, which include not only current information but histories of additions or removals of toll plazas. Mileage data are from U.S. Department of Transportation (2003) or information from the operating authority's web site. Each operating authority receives equal weight. Standard errors (in parentheses) are clustered by state. P-values are reported [in square brackets].

Table C2: Impact of Changing from Two-Way to One-Way Tolling on Tolls

	(1)	(2)	(3)
ETC_{it}	0.028	0.028	0.025
	(0.010)	(0.010)	(0.011)
	[0.015]	[0.012]	[0.039]
$OneWayAdopt_{it}$		0.041	0.032
		(0.035)	(0.042)
		[0.258]	[0.454]
$OneWay_{it}$			0.010
			(0.009)
			[0.291]
$ETCAdopt_{it}$	-0.086	-0.086	-0.086
	(0.017)	(0.017)	(0.017)
	[0.000]	[0.000]	[0.000]

Notes: Table reports results from estimating variants of equation (17) by OLS. The dependent variable is always the change in the log minimum toll rate. Sample is limited to bridges and tunnels (N=3,387; number of facilities = 79; number of operating authorities = 31; number of states = 16; mean of dependent variable = 0.020). In addition to the covariates shown in the table, all regressions include year fixed effects. $ETCAdopt_{it}$ is an indicator variable for whether facility *i* adopted ETC in year *t*. ETC_{it} is an indicator variable for whether the facility has ETC; it is 1 in the year that ETC is adopted and in all subsequent years. $OneWayAdopt_{it}$ and $OneWay_{it}$ are indicator variables for, respectively, whether the facility switched to one-way tolling in that year and whether the facility switched to one-way tolling that year or in a previous year. Each operating authority receives equal weight. Standard errors (in parentheses) are clustered by state. P-values are reported [in square brackets].

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