THE EFFECTS OF MOTOR VEHICLE WEALTH TAXES ON HOUSEHOLDS' VEHICLE PURCHASE DECISIONS

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ABSTRACT

Wealth taxes on motor vehicles, in the form of personal property or privilege taxes, are utilized in nearly half of the states in the U.S. The taxing methodologies implemented in these states result in effective tax rates that are a declining function of vehicle age. Under such tax structures, consumers would be expected to make adjustments in their consumption portfolios in favor of older vehicles since they receive preferential tax treatment. As a result, vehicle taxes may have unintended environmental consequences since they provide households with the incentive to keep or purchase older vehicles with higher emissions. This analysis examines the effects of these taxes on households' vehicle purchases using data from the 2001 National Household Travel Survey. The analysis identifies households that purchased a vehicle in 2001 and models their choice of vehicle age to determine whether the relatively favorable tax treatment encourages the purchase of older vehicles. The results indicate that wealth taxes have a statistically significant negative effect on the probability that a household purchases a vehicle in a given year but have virtually no effect on vehicle age at the time of the purchase.

INTRODUCTION

As of 2001, annual wealth taxes on motor vehicles were used in twenty-eight states in the United States in the form of either an ad valorem personal property tax, a tax in lieu of a property tax or an age-based fee. In recent years, politicians have proposed the reduction or removal of motor vehicle wealth taxes to take advantage of their unpopularity to win votes. Such proposals have been very popular among the electorate but have been difficult to implement since these taxes represent a stable source of revenues for state and local governments. Empirical evidence from Dill et al. (1999) also suggests that motor vehicle wealth taxes are

less regressive than sales and gasoline taxes frequently used by state and local governments.

Despite these positive qualities, these taxes may be inefficient as they may distort household decisions regarding their vehicle fleets, which in turn may have consequences for the environment. Specifically, a high tax on vehicle wealth might encourage a household to keep or purchase an older vehicle, thereby possibly increasing air pollution. The incentive effects provided by annual motor vehicle wealth taxes have received relatively little consideration.[1] The potential unintended consequences of these taxes on vehicle age distributions, emissions and air quality suggest the importance of investigating the effects of these taxes on household vehicle purchase and vehicle age decisions.

Motor vehicle wealth taxes tend to be based on either the age or value of the vehicle which results in a tax liability that decreases with age. Given this structure, consumers have an incentive to make adjustments to their vehicle stocks in favor of older vehicles as they receive preferential tax treatment. Specifically, motor vehicle wealth taxes are expected to affect household vehicle purchase decisions in two ways. First, households that reside in a state with a wealth tax on vehicles are expected to delay the purchase of a newer vehicle. A household can expect to have a higher motor vehicle wealth tax liability when it replaces an older less valuable vehicle with a newer more expensive vehicle or makes an addition to its vehicle stock. All else constant, the higher tax liability may discourage many households from purchasing a vehicle. Second, those households living in wealth tax states that do purchase a vehicle are expected to purchase older vehicles on average, all else constant. Given that a household has decided to purchase a vehicle, the structure of motor vehicle wealth taxes provides an incentive to purchase older vehicles as their absolute tax liabilities, and in some cases their tax liabilities as a percentage of their value, are lower than those of newer vehicles. Thus, the age distribution of vehicles in states with a wealth tax is expected to be skewed towards older vehicles as consumers have the incentive to delay the purchase of a newer vehicle or to enter the used vehicle market.

If motor vehicle wealth taxes have indeed delayed fleet turnover, they might have resulted in additional unintended consequences, namely a decrease in air quality resulting from an increase in emissions from motor vehicles. Older vehicles are likely to emit larger amounts of harmful pollutants due to their less sophisticated emission control systems and the deterioration of these systems over time. Simulations using the Environmental Protection Agency's most recent emissions model (MOBILE6) reveal that a 20 percent age shift to older vehicles yields a 50

percent increase in hydrocarbon and carbon monoxide emissions and a 40 percent increase in nitrogen oxide emissions (Environmental Protection Agency, 2002(b)).[2]

Therefore, to the extent that motor vehicle wealth taxes affect vehicle age distributions, changes to these taxes may be viable options for governments charged with the task of decreasing mobile source emissions. Specifically, states with areas that have air pollution levels that persistently exceed ambient air quality standards and have thus been classified as nonattainment areas by the Environmental Protection Agency might be able to make adjustments to their wealth tax policies to achieve attainment status. As of 2002, nearly 57 percent of states with an ozone nonattainment area and 75 percent of states with a carbon monoxide nonattainment area were wealth tax states (EPA, 2002(a)).

The objective of this analysis is to examine the effects of motor vehicle wealth taxes on households' vehicle purchase and age decisions that might affect emissions and air quality so that policy makers might make more informed decisions regarding the future use and structure of these taxes. The manuscript is divided into five sections. The first section offers a brief review of previous literature on household vehicle purchase decisions followed by a section on the theoretical framework used to model households decisions. The third section presents a discussion of the data and methods used. The fourth section discusses the results of empirical models designed to isolate the effects of motor vehicle wealth taxes on households' vehicle purchase and age decisions. The final section summarizes the main conclusions and suggests directions for future research.

PREVIOUS LITERATURE

This analysis is certainly not the first to propose a relationship between tax structures, vehicle age and emissions. Nor is it the first to suggest that annual ownership taxes based on vehicle age influence the rate of fleet turnover. However, it does represent the first study to examine the effects of motor vehicle wealth taxes on household vehicle purchase and age decisions in the United States as existing research focuses either on the tax structures and vehicle fleets in other countries or aggregate state-level data in the U.S.

Estimation results from Johnstone et al. (2001) suggest that adjustments to consumption taxes in Costa Rica that increase the relative price of used cars by 10 percent would decrease their share of total vehicle sales by 5.6 percent. Further simulations indicate that such a change would have the potential to yield significant environmental gains as nitrogen oxide emissions would decrease by 17 percent,

carbon monoxide emissions by 10 percent, and hydrocarbon emissions by 4 percent after five years.

In recent years, the government of Singapore has recognized that higher registration taxes on newer vehicles may discourage households from replacing their vehicles or encourage them to enter the used vehicle market and has placed an annual tax on vehicles that is in part based on age. Each vehicle registered faces an annual road tax, and a surcharge of 10 percent for each additional year is imposed on vehicles above the age of ten. Thus, the objective of the surcharge is to discourage households from registering older vehicles that pollute more. Chia and Phang (2001) analyze the use of this tax as well as other motor vehicle taxes as environmental management tools. Although their analysis concludes that this age-based registration tax offers a double dividend (i.e. tax revenues and emissions reductions), they also note that it is difficult to isolate the direct impacts of this tax on air quality since it is often used simultaneously with other policy instruments.

An extensive body of literature has developed over the past several decades on household vehicle purchase and consumption decisions including Manski and Sherman (1980), Mannering and Winston (1983), McCarthy (1985), Hensher and LePlastrier (1985) and Hayashi et al. (2001). Many of these studies include various financial characteristics such as vehicle purchase price, operating costs, transaction-search costs, service and repair costs and sales taxes in multivariate choice models of purchase decisions, ownership levels and vehicle type decisions. However, Hayashi et al. is the only analysis that includes a measure of annual ownership taxes in multivariate models of household vehicle purchase decisions. Their results from an analysis of vehicle registration data from Japan indicate that increases in annual ownership taxes do indeed have a negative effect on fleet turnover.

Two recent studies have analyzed the effects of vehicle wealth taxes on purchase and registration decisions using data from the United States. Ott and Andrus (2000) examine the relative importance of consumer's perceptions of vehicle personal property taxes versus other factors on purchasing decisions. Their analysis is based on a survey of consumers who had recently purchased a new vehicle in a high-tax state (Mississippi or South Carolina) or a low-tax state (North Carolina and Utah). The authors' findings suggest that despite the fact that over 75.6 percent of respondents perceived the property tax to be too high, the tax appears to be of little consequence relative to other factors in the purchase decision process. However, 19.6 percent of respondents claimed that high vehicle property taxes would make them unlikely to buy a replacement vehicle in the next two years. Unfortunately, these results may suffer from selection bias given that the authors made no attempt

to elicit the opinions from individuals who decided not to purchase a new vehicle. Nor do the authors examine the impact of the tax on the age of the vehicle selected.

Beck and Bennett (2003) note that in addition to encouraging households to substitute older vehicles for newer ones, lower vehicle wealth taxes in neighboring states may have a negative effect on the proportion of registered vehicles that are new as consumers attempt to evade taxes by registering vehicles outside their state of residence. The authors use cross-sectional data from 1997 state vehicle registrations to estimate an OLS regression model of the proportion of total vehicle registrations that are new vehicles. The results indicate that taxes and license fees based on the value or age of the vehicle have a statistically significant negative effect on the share of registrations that are new vehicles. However, given that these results are based on state-level data it is impossible to determine the potential consequences these taxes may have on air quality in the consumer's state of residence. If households are purchasing new vehicles but are registering them out of state, there should be no negative environmental impacts. However, if the results are due to consumer's substituting older vehicles for newer vehicles, emissions will be higher in states with vehicle wealth taxes. An analysis of purchasing decisions and vehicle age decisions at the household-level is necessary to make any conclusions regarding the environmental impacts of these taxes.

THEORETICAL FRAMEWORK

The first model of interest in this analysis is that of households' vehicle purchase decisions. The outcome of this decision can only be observed in two states: the household purchases a vehicle or it does not. As a result a basic random utility model can be used to frame this decision. This model assumes that a household will compare the utility it receives from purchasing a vehicle to the utility it would receive if it decided not to purchase a vehicle. The probability that a household buys a vehicle is expressed as:

$$P = P(\text{Utility with vehicle purchase} > \text{Utility without vehicle purchase}) \quad (1)$$

Each household's utility from purchasing a vehicle (U_i) is measured by a latent index, which could be viewed as a "buying index", expressed by the following linear function:

$$U_i = X_i\beta + T_i\beta + W_i\beta + V_i\,\beta + \varepsilon_i \quad (2)$$

where X_i represents a vector of demographic and socioeconomic variables, T_i is a vector of state and local vehicle taxes, W_i is a vector of transportation use patterns including both private and public transportation, and V_i is a vector that includes characteristics of the household's vehicle stock. The betas represent coefficients which measure the magnitude of the impact of each independent variable. Finally, ε_i represents an error term which captures the impact of unobserved variables that impact a household's utility.

The idea of a latent index is that there is an underlying propensity to purchase a vehicle that generates the observed state. Although the value of this index can not be observed directly, at some threshold value a change in the buying index generates a change in the observed state, namely, whether the household purchases a vehicle. Therefore, households with larger values of this index purchase a vehicle, while those with smaller values do not. Thus the latent index is linked to the observed purchase decision (y_i) by the measurement equation:

$$y_i = \{1 \text{ if } U_i > \tau, \text{ or } 0 \text{ if } U_i = \tau\} \quad (3)$$

where τ is the threshold value which is typically normalized to be zero. When $y_i = 1$ the household decides to purchase a vehicle and when $y_i = 0$ the household does not purchase a vehicle. The probability that a household purchases a vehicle can now be expressed as:

$$P(y_i = 1|x) = P(x\beta + \varepsilon > 0 \,|x) \quad (4)$$

where x is the vector of all the independent variables included in the buying index in equation 2.

Although the buying index is a continuous variable, since it is unobserved it can not be estimated with an ordinary least squares technique. Instead a maximum likelihood estimation technique is necessary to estimate the probability of the binary outcome represented in equation 4. This analysis assumes that the error terms are normally distributed and uses a probit model to estimate households' vehicle purchase decisions. For the probit model the cumulative distribution function of the standard normal model provides the probability that the event will occur and one minus this function provides the probability that it will not occur.[3]

The second model of interest in this analysis is that of households' vehicle age decisions. For those household who decide to purchase a vehicle, the age of the vehicle selected is assumed to be a function of household demographics and

socioeconomic variables, vehicle taxes, transportation use patterns, and vehicle stock characteristics as expressed by the following linear function:

$$Age_i = X_i\beta + T_i\beta + W_i\beta + V_i\ \beta + \varepsilon_i \qquad (5)$$

which can be estimated using OLS. The vector of vehicle taxes (T_i) includes a measure of the motor vehicle wealth tax in the household's state of residence, which is expected to have a positive impact on age as households are expected to purchase older vehicles in order to reduce their tax liabilities.

DATA AND METHODS USED

This analysis examines the effects of motor vehicle wealth taxes on household vehicle purchase and age decisions using data from the 2001 National Household Travel Survey (NHTS) conducted by the U.S. Department of Transportation between March 2001 and May 2002. The data contain a wealth of information on the demographics, travel patterns and vehicle stocks for a random sample of approximately 24,000 households living throughout the United States.[4] State and average local vehicle sales tax rates are collected from the 2001 U.S. Master Sales and Use Tax Guide (CCH Incorporated, 2003).

The first column of data in Table 1 provides a distribution of households with complete observations in the NHTS data set across various household demographics and other variables that may affect households' vehicle purchase and age decisions. These other variables include measures of public transportation use and taxes on vehicle transactions in the household's state of residence.[5] Households in the sample are likely to have two or fewer members, an annual income below $50,000 and a home of their own. Households are also likely to reside in a metropolitan statistical area (MSA), drive less than 10 miles to work, and most likely do not use public transportation. Nearly all households live in a state that imposes a tax on the transaction of vehicles, such as a sales, use or excise tax, and roughly 50 percent live in a state where local jurisdictions have the option of taxing the sale of vehicles. Finally, household survey respondents are likely to be white, without a college degree, and younger than the age of 56.

Table 1: Distribution of NHTS Households Across Various Characteristics					
		All HHs Percent	HHs without a purchase	HHs with a purchase	Average vehicle purchase age
Household size	1	20.00	23.13	11.39	5.04
	2	39.19	40.17	36.49	4.65
	3	16.50	15.09	20.40	5.27
	4	14.92	13.53	18.72	5.82
	5 or more	9.39	8.08	12.99	6.82
Race of HH respondent	Black	5.84	6.01	5.37	6.72
	White	82.79	82.83	82.69	5.08
	Other	11.36	11.16	11.93	6.38
Household income	0 - $9,999	5.26	5.78	3.84	10.06
	$10,000 - $19,999	10.85	11.77	8.40	8.28
	$20,000 - $29,999	13.83	14.75	11.36	7.00
	$30,000 - $39,999	14.00	14.27	13.26	6.53
	$40,000 - $49,999	11.76	11.64	12.07	5.44
	$50,000 - $59,999	10.07	9.92	10.47	4.82
	$60,000 - $69,999	7.36	7.09	8.10	4.16
	$70,000 - $79,999	6.36	5.95	7.46	4.33

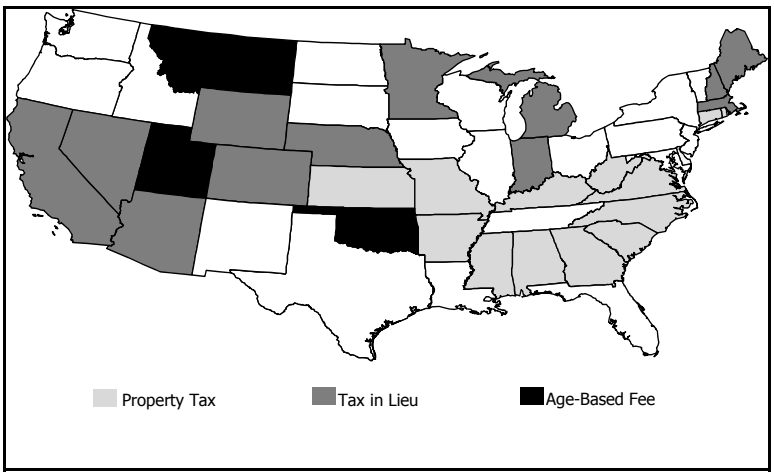
Table 1: Distribution of NHTS Households Across Various Characteristics					
		All HHs Percent	HHs without a purchase	HHs with a purchase	Average vehicle purchase age
	$80,000 or more	20.51	18.82	25.04	3.37
College Degree	Yes	39.18	39.33	38.76	4.03
	No	60.82	60.67	61.24	6.14
Age of household respondent	17-25	6.03	5.02	8.80	6.71
	26-35	15.35	14.24	18.41	5.88
	36-45	21.52	20.13	25.34	5.79
	46-55	20.99	20.63	21.99	5.16
	56-65	15.63	16.30	13.77	4.40
	66 or older	20.49	23.68	11.69	3.78
Household life cycle	No children	34.59	35.31	32.60	4.87
	Youngest child 15 or younger	32.23	29.61	39.44	6.01
	Youngest child 21 or younger	5.87	4.60	9.37	6.05
	Retired adults	27.31	30.48	18.58	4.29
Home ownership	Yes	81.26	81.25	81.29	4.87
	No	18.74	18.75	18.71	7.27
Driver count	0	0.29	0.39	0.00	0.00
	1	28.32	32.24	17.50	5.90
	2	57.66	56.51	60.84	4.94

Table 1: Distribution of NHTS Households Across Various Characteristics					
		All HHs Percent	HHs without a purchase	HHs with a purchase	Average vehicle purchase age
	3 or more	13.72	10.86	5.95	5.94
Worker count	0	21.35	24.46	12.77	4.70
	1	33.12	34.57	29.14	5.63
	2	37.20	34.60	44.38	5.05
	3 or more	8.32	6.36	13.72	6.13
State vehicle transaction tax	Yes	98.24	98.20	98.36	5.30
	No	1.76	1.80	1.64	6.87
Local option transaction tax	Yes	63.29	63.44	62.87	5.48
	No	36.71	36.56	37.13	5.06
MSA category	More than 1 mil, heavy transit	14.17	14.84	12.34	3.96
	More than 1 mil, no transit	41.12	41.10	41.16	4.78
	Less than 1 mil	24.15	23.90	24.84	5.75
	Not in MSA	20.56	20.16	21.66	6.64
Public transportation use	Yes	18.12	18.05	18.33	5.15
	No	81.88	81.95	81.67	5.36
Average distance to work	Less than 5 miles	52.43	55.06	45.17	5.62
	5 - 9 miles	17.63	16.91	19.61	5.23
	10 -19 miles	18.17	17.09	21.13	4.95
	20 or more miles	11.78	10.94	14.09	5.05
Note: The number of observations is 21,253 for the first column of data, 15,597 for the second and 5,656 for the third.					

The survey data also include information on the year, make, model, and the length of current ownership for over 45,500 vehicles owned by households in the survey.[6] Thus, the survey data provide all the information necessary to identify the households that purchased a vehicle in 2001 and the age of each vehicle at the time of purchase. Specifically, the survey date and the length of time the household reports owning each of its vehicles are used to identify households that purchased a vehicle in 2001, while each vehicle's age at the time of purchase is derived using information on the model year of the vehicle, survey date and reported length of ownership.

In order to model the effects of motor vehicle wealth taxes on household vehicle purchase decisions, the survey data are supplemented with motor vehicle wealth tax data collected by various methods including mail surveys, personal interviews, and searches of state tax codes. Figure 1 highlights the twenty-eight states with motor vehicle wealth taxes as of 2001. The taxing methodologies used in these states generally fall into one of three categories: an ad valorem personal property tax, a state or local tax in lieu of a personal property tax or an aged-based fee. However, the taxing methodologies implemented in these states differ by more than just their classification. Specifically, states use different valuation methods, assessment ratios, tax rates and minimum tax thresholds. In some instances assessment ratios and tax rates also vary within a state based on the age of the vehicle.

Figure 1: States with Motor Vehicle Wealth Taxes in 2001



Given the disparities in the taxing methodologies used by states, it is virtually impossible to adequately represent motor vehicle wealth taxes with a simple measure such as a tax rate. Such a measure fails to capture the dynamic structure of the tax that results in a decline in tax liabilities with vehicle age. In theory, households' vehicle purchase and age decisions are expected to be more responsive in situations where the tax liabilities differ more dramatically by vehicle age. Therefore, the tax provisions of each state were used to create two measures of motor vehicle wealth taxes that compare the tax liability of a brand-new vehicle to the tax liability of a used vehicle. The Honda Accord was used as the representative vehicle in these calculations as it has been one of the best selling sedans in the U.S. over the past several years.

The present value of a ten-year stream of tax liabilities for a new 2001 Accord and a used 1998 Accord were calculated using the tax provisions of each respective state.[7] The 1998 Accord represents a reasonable substitute to the 2001 Accord as it is young enough to be driven for ten additional years, yet it has aged enough such that its associated wealth tax liability is lower than that of a new vehicle. Table 2 provides a list of the resulting tax liabilities by state. The average present value of a ten-year stream of tax liabilities was $1,417 for a new 2001 Accord across states with a wealth tax in 2001 and was $825 for a used 1998 Accord.[8]

Table 2: Motor Vehicle Wealth Tax Liabilities ($)

	2001 Honda Accord	1998 Honda Accord	Difference	Ratio
Alabama	$704	$510	$194	1.38
Arizona	1,738	1,073	665	1.62
Arkansas	1,011	733	278	1.38
California	724	519	205	1.39
Colorado	1,374	585	789	2.35
Connecticut	2,083	1,509	574	1.38
Georgia	1,450	1,050	400	1.38
Indiana	1,080	444	636	2.43
Kansas	1,365	613	752	2.23
Kentucky	1,713	1,241	472	1.38
Maine	1,850	971	879	1.91

Table 2: Motor Vehicle Wealth Tax Liabilities ($)				
	2001 Honda Accord	**1998 Honda Accord**	**Difference**	**Ratio**
Massachusetts	1,419	572	847	2.48
Michigan	627	477	150	1.31
Minnesota	1,043	629	414	1.66
Mississippi	1,909	636	1,273	3.00
Missouri	2,368	1,716	652	1.38
Montana	1,011	537	474	1.88
Nebraska	1,662	975	687	1.70
Nevada	1,267	604	663	2.10
New Hampshire	1,518	790	728	1.92
North Carolina	1,258	911	347	1.38
Oklahoma	668	583	85	1.15
South Carolina	3,372	2,443	929	1.38
Utah	823	547	276	1.50
West Virginia	1,876	1,359	517	1.38
Wyoming	1,640	1,010	630	1.62
Note: Tax liabilities represent a 10 year present value stream of tax liabilities.				

Two measures of the wealth tax were created using the respective tax liabilities for the new 2001 Accord and the used 1998 Accord in each state. The first of these variables is the absolute difference, which is the 2001 Accord tax liability minus the 1998 Accord tax liability. Column three of Table 2 shows the result of this calculation by state. The average difference between these tax liabilities across states is $551. Mississippi has the largest difference ($1,273) while Oklahoma has the smallest ($85). The second measure of the wealth tax is the relative difference in the tax liabilities of a new versus used vehicle, which is the ratio of the 2001 Accord tax liability to the 1998 Accord tax liability. The average wealth tax ratio across states is 1.72, indicating that on average the present value of a ten-year stream of tax liabilities for a brand new vehicle is 72 percent larger than that for a three-year-old vehicle. Both measures reflect the degree to which older vehicles receive favorable tax treatment relative to new vehicles under the motor

vehicle wealth tax provisions in each state. Larger values of both measures suggest that older vehicles receive more favorable tax treatment.

The maximum difference between the present value of a ten-year stream of tax liabilities in Table 2 ($1,273) represents roughly 5.6 percent of the manufacturer's suggested retail price (MSRP) of the 2001 Honda Accord, while the minimum difference ($85) represents only 0.37 percent of the Accord's suggested price. Absent further analysis, it is difficult to project whether these differences are large enough to affect households' decisions. Wheeler (1998) claims that motor vehicle wealth tax liabilities are such a small percentage of a vehicle's value that most individuals do not take the tax into consideration when purchasing a vehicle; however no prior empirical analysis has been conducted to support or refute this claim.

Roughly half of the households in the data set resided in a state that had a wealth tax on motor vehicles in 2001. From the final sample of 21,253 households, roughly 27 percent purchased at least one vehicle in 2001. Households living in states with a motor vehicle wealth tax were just as likely to purchase a vehicle in 2001 as households living in states without a motor vehicle wealth tax. Specifically, 26.49 percent of households living in states with a wealth tax purchased at least one vehicle, while 26.73 percent of households living in states without a motor vehicle wealth tax purchased a vehicle. However this simple comparison fails to control for the effects other variables may have on vehicle purchase decisions, such as household demographics, household composition, travel patterns, public transportation use and transaction taxes.

Columns two and three of Table 1 show the distribution of households across various characteristics by vehicle purchase status. Households that purchased a vehicle in 2001 were more likely to be larger in size, had higher annual incomes, and had a larger number of drivers and workers. Households that purchased a vehicle were also more likely to drive further distances to work. Of course, to isolate the effect wealth taxes have on vehicle purchase decisions from the effects of these other variables a multivariate strategy is required.

Households that decide to purchase a vehicle may be further influenced by the presence of motor vehicle wealth taxes in their choice of vehicle age since lower tax liabilities are associated with older vehicles. The summary statistics presented in Table 3 indicate that nearly half of the households that purchased a vehicle in 2001 lived in a wealth tax state. On average, households faced a relative difference in the present value of a ten-year stream of tax liabilities of a new and used vehicle

of 1.28 and an absolute difference of $207.37. These variables take on a value of one and zero respectively for households living in non-wealth-tax states.

Table 3: Summary Statistics of Wealth Tax Measures for NHTS Households That Purchased A Vehicle

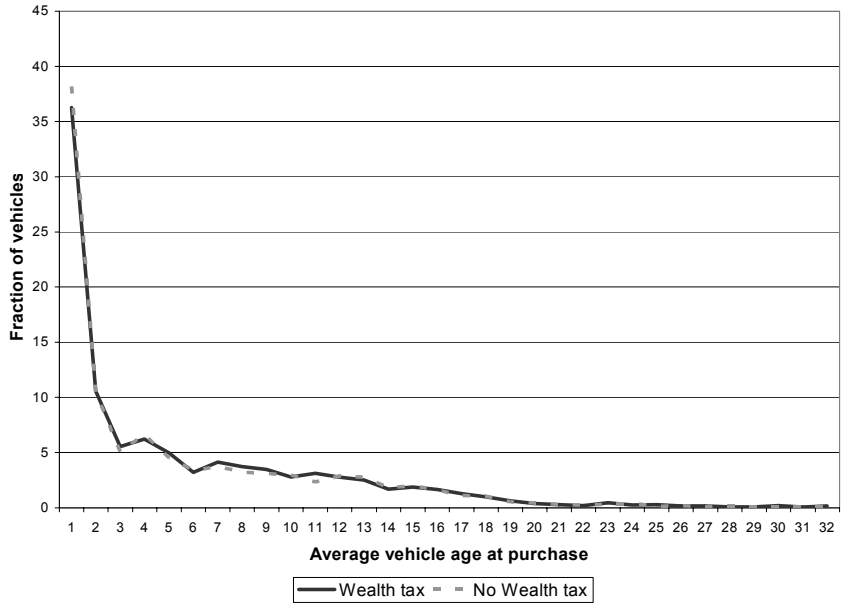
Variable	Mean	Standard deviation	Minimum	Maximum
Motor vehicle wealth tax dummy	0.48	0.50	0	1
2001 Honda Accord tax liability	596.28	761.7	0	3,372
1998 Honda Accord tax liability	388.91	519.33	0	2,443
Ratio (01/98)	1.28	0.41	1	3
Difference (01-98)	207.37	281.33	0	1,273
Note: Number of observations = 5,656				

Figure 2 shows the distribution of vehicle age at the time of purchase by the wealth tax status in the household's state of residence. The differences in these distributions are very minor. In fact, the average vehicle age at the time of purchase for households in wealth tax states is 5.42 years compared to 5.23 years for households in non-wealth-tax states, and these values are not statistically different. A Kolmogorov-Smirnov test applied to these distributions generates a corrected p-value of 0.158, suggesting that these distributions are not statistically different at the ten-percent level.

These results suggest that motor vehicle wealth taxes do not significantly influence the age of vehicles purchased. However, simply comparing the vehicle age distribution by wealth tax status fails to control for the effects of other variables may have on a household's vehicle age decision. As reported in Table 1, a household with a survey respondent that is white, older and has a college degree tends to purchase newer vehicles. Households that live in a metropolitan statistical area, have higher annual incomes and drive further distances to work also tend to purchase newer vehicles.

Again, to isolate the effects of motor vehicle wealth taxes from the effects of these other variables, a multivariate strategy is required.

Figure 2; Vehicle Age at Purchase by Motor Vehicle Wealth Tax Status



EMPIRICAL ANALYSIS OF HOUSEHOLDS' VEHICLE PURCHASE DECISIONS

Three separate probit models using different measures of the motor vehicle wealth tax: a dummy variable indicating the presence of a wealth tax in the household's state of residence, the ratio of tax liabilities and the absolute difference in tax liabilities, were estimated to analyze the effects of motor vehicle wealth taxes on households' 2001 vehicle purchase decisions. In each of the models the dependent variable takes a value of one for households that purchased at least one vehicle in 2001. The models also include measures of household demographics, household composition, public transportation use and transaction tax rates as controls.

The wealth tax variable has a negative and statistically significant marginal effect on the probability that a household purchases a vehicle in two of the three models using a two-tailed test as reported in Table 4. The results from model 1 indicate that if a household lives in a state with a wealth tax on motor vehicles, its probability of purchasing a vehicle is 1.23 percentage points less than that for a

household living in a state without such a tax, all else constant. The baseline proportion of households in this sample that actually purchased a vehicle is 26.61 percent; therefore, this change represents a 4.62 percent decrease in the likelihood that a vehicle is purchased.

Table 4: Marginal Effects for the 2001 Vehicle Purchase Decision			
	Model		
Variable	1	2	3
Wealth tax dummy	-0.0123**		
	0.0062		
Wealth tax ratio		-0.0214***	
		0.0074	
Wealth tax difference (in $100s)			-0.0017
			0.0011
HH black	-0.0012	-0.0022	-0.0012
	0.0134	0.0133	0.0134
HH other	-0.0013	-0.0020	-0.0022
	0.0099	0.0099	0.0098
Household Income (in $1,000s)	0.0007***	0.0007***	0.0007***
	0.0001	0.0001	0.0001
College degree	-0.0274***	-0.0274***	-0.0274***
	0.0067	0.0067	0.0067
Age of respondent	-0.0030***	-0.003***	-0.003***
	0.0003	0.0003	0.0003
Life cycle 1 - no kids	-0.0569***	-0.0571***	-0.0569***
	0.0136	0.0136	0.0135
Life cycle 2 - youngest less than 16	-0.0561***	-0.0561***	-0.056***
	0.0147	0.0147	0.0145
Life cycle 4 - retired	-0.0264*	-0.0268*	-0.0267*
	0.0160	0.0160	0.0160
Home ownership	-0.0337***	-0.0337***	-0.0335***
	0.0090	0.0090	0.0091

Table 4: Marginal Effects for the 2001 Vehicle Purchase Decision			
	Model		
Variable	**1**	**2**	**3**
Household size	0.0113**	0.0112**	0.0112**
	0.0048	0.0048	0.0047
Worker count	0.0127**	0.0129**	0.0128**
	0.0054	0.0054	0.0054
Ratio vehicles to drivers	0.0983***	0.098***	0.0979***
	0.0063	0.0063	0.0058
State transaction tax rate	0.0020	0.0013	0.0021
	0.0025	0.0025	0.0025
Ave. local transaction tax rate	-0.0027	-0.0037	-0.0029
	0.0029	0.0029	0.0029
MSA 1 mil +, no heavy trans.	0.0307***	0.03***	0.0303***
	0.0098	0.0098	0.0098
MSA smaller than 1 mil	0.0429***		0.0433***
	0.0112	0.0112	0.0113
Not in MSA	0.0432***		0.0434***
	0.0119	0.0119	0.0119
Public transportation use	-0.0127	-0.0121	-0.0124
	0.0083	0.0082	0.0082
Ave. distance to work (in 10s of miles)	0.0075***		0.0075***
	0.0030	0.0030	0.0030
Driver Count	0.0688***	0.0687***	0.0687***
	0.0071	0.0071	0.0070
Number of observations	21,253	21,253	21,253
Pseudo R-squared	0.0596	0.0598	0.0595
Predicted probability	0.2531	0.2530	0.2531

Notes: Marginal effects that are statistically significantly different from zero at the 1, 5, and 10 percent levels are indicated with a ***, ** and * respectively.
Standard errors have been corrected for heteroskedasticity and are reported in parentheses.

The marginal effect of the ratio of tax liabilities is highly statistically significant in model 2. However, the small marginal effect results in an elasticity of only -0.10. Thus the model predicts that a one-percent increase in the ratio of tax liabilities would decrease the predicted probability that a vehicle is purchased by only 0.10 percent, all else constant. The marginal effect on the difference in tax liabilities is statistically significantly different from zero in model 3 when a one-tailed test is used. A $100 difference in wealth tax liabilities between new and used vehicles results in a very modest 0.17 percentage point decrease in the likelihood that a vehicle is purchased.

A majority of the marginal effects on the additional explanatory variables in these models are statistically significant and robust across the various specifications of the wealth tax. In most cases, the marginal effects of these explanatory variables are of the expected sign or are consistent with the trends presented in Table 1. For example, increasing a household's income would increase the probability that it purchases a vehicle, all else constant. Households with a youngest child between the ages of 16 and 21 are more likely to purchase a vehicle than are households in other stages of the life cycle. Homeowners are less likely to purchase a vehicle in 2001, which might reflect the effects of the liquidity constraints often faced by households with mortgage payments. Households that reside in an MSA with a population of at least one million and a heavy transit system are less likely to purchase a vehicle, perhaps due to a lack of need or availability of other transportation options. However, the marginal effect of the public transportation variable indicating whether a member of the household used some form of public transportation in the past two months is not statistically significant. Increasing the household size, worker count or average distance to work would increase the probability that a vehicle is purchased. Households with younger respondents and those with respondents without a college degree are less likely to purchase a vehicle.

Intuition would suggest that transaction taxes such as sales, use or excise taxes on motor vehicles would discourage households from purchasing a vehicle as they increase the overall cost of the purchase. However, neither state nor local transaction tax rates in the household's state of residence significantly affect the purchase decision in these models. These results are consistent with the findings of Beck and Bennett (2003) who suggest that a one-time charge such as a sales tax is less likely to affect a purchase decisions than is an annual cost such as a wealth tax.

The robustness of these results is tested by estimating several alternative specifications of the model. The findings suggests that the results of the baseline

model are robust to the exclusion of households with one or no vehicles who may be less sensitive to motor vehicle wealth taxes given their need for transportation. The baseline results are also robust to the use of motor vehicle wealth tax measures created using the Ford Taurus as the representative vehicle.[9]

However, slight changes in the results occur after controlling for the timing of the households' survey interview. Table 5 presents the results of models that include a dummy variable that indicates whether or not the household was interviewed in the fourth quarter of 2001. This variable serves two purposes. First, it captures the effects of special promotions, such as low interest rates and low down payments, that are frequently offered during this time of the year as auto-dealers attempt to clear their lots of current year models. Secondly, it serves as a control for the influence that the events of September 11th may have had on household vehicle purchase decisions. After controlling for the possibility of a fourth quarter purchase, the marginal effect on the wealth tax dummy variable is no longer statically significant. However, the marginal effect on the wealth tax ratio variable remains statistically significant and is of the same order of magnitude as in the baseline model.

Table 5: Marginal Effects for the 2001 Vehicle Purchase Decision After Controlling for a 4th Quarter Purchase

	Model		
Variable	**1**	**2**	**3**
Wealth tax dummy	-0.0089		
	0.0062		
Wealth tax ratio		-0.0201***	
		0.0074	
Wealth tax difference (in $100s)			-0.0015
			0.0011
HH black	-0.0073	-0.0082	-0.0073
	0.0132	0.0131	0.0132
HH other	-0.0048	-0.0053	-0.0055
	0.0099	0.0098	0.0098
Household Income (in $1,000s)	0.0006***	0.0006***	0.0006***
	0.0001	0.0001	0.0001

Table 5: Marginal Effects for the 2001 Vehicle Purchase Decision After Controlling for a 4th Quarter Purchase			
	Model		
Variable	**1**	**2**	**3**
College degree	-0.0284***	-0.0284***	-0.0284***
	0.0067	0.0067	0.0067
Age of respondent	-0.0029***	-0.0029***	-0.0029***
	0.0003	0.0003	0.0003
Life cycle 1 - no kids	-0.0639***	-0.0642***	-0.064***
	0.0134	0.0134	0.0134
Life cycle 2 - youngest less than 16	-0.0609***	-0.061***	-0.0608***
	0.0145	0.0145	0.0145
Life cycle 4 - retired	-0.0293*	-0.0297*	-0.0295*
	0.0159	0.0159	0.0159
Home ownership	-0.0354***	-0.0354***	-0.0352***
	0.0091	0.0091	0.0090
Household size	0.0122***	0.0121***	0.0121***
	0.0048	0.0048	0.0048
Worker count	0.0146***	0.0148***	0.0147***
	0.0054	0.0054	0.0054
Ratio vehicles to drivers	0.0984***	0.0982***	0.0981***
	0.0064	0.0064	0.0064
State transaction tax rate	0.0031	0.0022	0.0030
	0.0025	0.0025	0.0025
Ave. local transaction tax rate	-0.0022	-0.0032	-0.0024
	0.0029	0.0029	0.0029
MSA 1 mil +, no heavy trans.	0.0269***	0.0264***	0.0267***
	0.0098	0.0098	0.0098
MSA smaller than 1 mil	0.0398***	0.0394***	0.0402***
	0.0112	0.0112	0.0112

Table 5: Marginal Effects for the 2001 Vehicle Purchase Decision After Controlling for a 4th Quarter Purchase			
	Model		
Variable	**1**	**2**	**3**
Not in MSA	0.0416***	0.0414***	0.0418***
	0.0120	0.0119	0.0120
Public transportation use	-0.0103	-0.0099	-0.0101
	0.0083	0.0083	0.0083
Ave. distance to work (in 10s of miles)	0.0075***	0.0074***	0.0074***
	0.0030	0.0030	0.0030
Driver Count	0.0694***	0.0693***	0.0693***
	0.0070	0.0070	0.0070
4th Quarter Purchase	0.1800***	0.1801***	0.1801***
	0.0057	0.0057	0.0057
Number of observations	21,253	21,253	21,253
Pseudo R-squared	0.0948	0.0951	0.0948
Predicted probability	0.2438	0.2438	0.2439

Notes: Marginal effects that are statistically significantly different from zero at the 1, 5, and 10 percent levels are indicated with a ***, ** and * respectively.
Standard errors have been corrected for heteroskedasticity and are reported in parentheses.

These results suggest that after controlling for a fourth quarter interview households' vehicle purchase decisions are not affected by the mere presence of a motor vehicle wealth tax but are still responsive to the relative differences in tax liabilities for new versus used vehicles. The positive and statistically significant marginal effect on the fourth quarter dummy variable indicates that households interviewed during this time of the year are more likely to have purchased a vehicle. The significance patterns and the magnitudes of the effects of the remaining control variables are robust.[10]

EMPIRICAL ANALYSIS OF HOUSEHOLDS' VEHICLE AGE DECISIONS

After analyzing households' vehicle purchase decisions, the next step is to examine the effects of motor vehicle wealth taxes on households' vehicle age decisions. The sample used to model vehicle age includes the 5,656 households that purchased at least one vehicle in 2001. Table 6 presents the results of multivariate OLS regression models of vehicle age. In each model, the dependent variable is the average age of vehicles purchased by the household in 2001; however, each model includes a different measure of the motor vehicle wealth tax as before.[11] The control variables again include measures of household demographics and composition, public transportation use and transaction tax rates.

Table 6: OLS Regression Results for Household's Vehicle Age Decisions

	Model		
Variable	**1**	**2**	**3**
Wealth tax dummy	0.1458		
	0.1388		
Wealth tax ratio		0.1049	
		0.1621	
Wealth tax difference (in $100s)			0.0004
			0.0002
HH black	0.8463***	0.8533***	0.8401***
	0.3400	0.3398	0.3399
HH other	0.3903*	0.3970*	0.401*
	0.2143	0.2144	0.2144
Income (in $1,000s)	-0.0388***	-0.0387***	-0.0388***
	0.0025	0.0025	0.0025
College degree	-0.9649***	-0.9658***	-0.9668***
	0.1407	0.1407	0.1406
Age	-0.0249***	-0.025***	-0.0251***
	0.0060	0.0060	0.0060

Table 6: OLS Regression Results for Household's Vehicle Age Decisions			
	Model		
Variable	**1**	**2**	**3**
Life cycle 1 - no kids	-1.0593***	-1.058***	-1.0537***
	0.2650	0.2648	0.2650
Life cycle 2 - youngest less than 16	-1.0437***	-1.0454***	-1.0415***
	0.2790	0.2788	0.2791
Life cycle 4 - retired	-1.5253***	-1.5206***	-1.5123***
	0.3365	0.3366	0.3367
Own home	-1.5116***	-1.5108***	-1.511***
	0.2075	0.2075	0.2075
HH size	0.5969***	0.5981***	0.5984***
	0.0920	0.0920	0.0920
Worker count	-0.0133	-0.0134	-0.0143
	0.1046	0.1047	0.1047
Ratio vehicles to drivers	1.5661***	1.5679***	1.5703***
	0.1496	0.1496	0.1496
State transaction tax rate	0.0420	0.0376	0.0492
	0.0630	0.0631	0.0633
Ave. local transaction tax rate	0.0978	0.0990	0.1018
	0.0641	0.6475	0.0642
MSA 1 mil +, no heavy trans.	0.7677***	0.7807***	0.7696***
	0.1892	0.1880	0.1883
MSA smaller than 1 mil	1.3457***	1.3509***	1.3386***
	0.2151	0.2153	0.2153
Not in MSA	1.9501***	1.9606***	1.9454***
	0.2399	0.2398	0.2397
Public transportation	0.4567***	0.4511***	0.4576***
	0.1794	0.1792	0.1792

Table 6: OLS Regression Results for Household's Vehicle Age Decisions			
	Model		
Variable	**1**	**2**	**3**
Other than auto	-0.8078***	-0.8056***	-0.8095***
	0.1406	0.1406	0.1405
Ave. distance to work (in 10s of miles)	-0.1312**	-0.1308**	-0.1307**
	0.0627	0.0627	0.0626
Constant	6.4044***	6.346***	6.356***
	0.6525	0.7072	0.6534
Number of observations	5,656	5,656	5,656
R-squared	0.1706	0.1705	0.1707
Notes: Coefficients that are statistically significantly different from zero at the 1, 5, and 10 percent levels are indicated with a ***, ** and * respectively. Standard errors have been corrected for heteroskedasticity and are reported in parentheses.			

Households living in wealth tax states are expected to purchase older vehicles, all else constant, in order to avoid paying higher taxes. They are also expected to be more responsive to larger relative and absolute differences in tax liabilities for new and used vehicles. The positive coefficients on all three tax measures is consistent with this hypothesis; however, the coefficients fail to be statistically significantly different from zero, suggesting that wealth taxes do not affect households' vehicle age decisions. These results are perhaps unsurprising given the vehicle age distribution in Figure 2.

Instead, households' decisions are more likely to be affected by specific household characteristics and location. The remaining variables in the model are capable of explaining over 17 percent of the variation in average vehicle age, which is respectable considering that detailed information on the specifics of the vehicle transaction is not available. In fact a large majority of the coefficients are statistically significantly different from zero in each of the models and the results are robust across the various specifications of the wealth tax.

The largest effects on age in each of these models stem from the life cycle and MSA dummy variables. For example, households that have reached the retirement phase of life purchase vehicles that are roughly one and a half years

younger than the vehicles purchased by households whose youngest child is of driving age. Households with no children or with a youngest child below the age of 16 also purchase vehicles that are younger than those purchased by households with a youngest child between the ages of 16 and 21. Households not living in an MSA purchase vehicles that are approximately two years older than the vehicles purchased by households in the largest MSAs with a heavy transit system, all else constant. Households living in smaller MSAs also purchase older vehicles. Households that own their own homes, have higher incomes, drive further distances to work, do not use public transportation or have fewer members tend to purchase newer vehicles on average.

Intuitively, vehicle age decisions for households with more than one vehicle may be more sensitive to motor vehicle wealth taxes than those for households who own only one vehicle. Households with only one vehicle may rely solely on this vehicle for all of their transportation needs; therefore, they are probably more likely to purchase a more reliable, newer vehicle. Thus the status of motor vehicle wealth taxes in their state of residence may be less of a factor in their vehicle age decisions. This hypothesis was tested by estimating the vehicle age models using only the households that report owning more than one vehicle. The results of these models are similar to those of the baseline models, suggesting that vehicle ownership levels do not affect households' responses to wealth taxes.

The exclusion of households that failed to purchase a vehicle in 2001 in the vehicle age model may bias the coefficients of the ordinary least squares regression model. Specifically, households that failed to purchase a vehicle in 2001 may have been more likely to purchase vehicles in certain age groups. Potential sample selection bias in the vehicle age regression is investigated by estimating a Heckman selection model using the purchase decision as the selection equation.[12] The lack of statistical significance for the coefficient on the inverse mills ratio suggests that sample selection bias is not a concern in these models.

Figure 2 reveals that vehicles purchased by households in 2001 are more likely to be new in states without a wealth tax than in states with a tax. Households in non-wealth- tax states are 1.05 times more likely to purchase a new vehicle than households in wealth tax states; however, the remainder of the vehicle age distribution is very similar across wealth tax status. Thus the results of the linear regression model of vehicle age may fail to reveal the complete effects of motor vehicle wealth taxes on the decision to purchase a new vehicle. Therefore, the analysis estimates a probit model of households' decisions to purchase a new versus used vehicle. After controlling for the effects of the other explanatory variables, the

motor vehicle wealth tax measures fail to affect the probability that a household chooses to purchase a new vehicle versus a used vehicle. The results of a Heckman probit model suggest that these results are again robust to controls for sample selection bias.[13]

CONCLUSIONS

This analysis is perhaps the first to recognize the potential unintended consequences of motor vehicle wealth taxes as they are used in the United States on household vehicle purchases and age decisions that may lead to detrimental environmental effects. As hypothesized, motor vehicle wealth taxes have a statistically significant negative effect on the probability that a household purchases a vehicle in a given year. Marginal effects from probit models of households' 2001 vehicle purchase decisions indicate that households are not only responsive to the presence of a motor vehicle wealth tax but also respond to the relative tax treatments of new versus used vehicles. However, the hypothesis that households in motor vehicle wealth tax states purchase older vehicles to avoid higher tax liabilities is not supported by the results. All three wealth tax measures fail to be statistically significant in multivariate regression models of vehicle age. Thus, once a household has decided to purchase a vehicle neither the presence of a motor vehicle wealth tax nor the relative tax treatments of new versus used vehicles affects its choice of vehicle age.

Although the results presented in this analysis indicate that motor vehicle wealth taxes do not have a direct effect on household vehicle age decisions, these taxes may have an indirect effect on state vehicle age distributions as a result of their effect on household vehicle purchase decisions. Even modest delays in the purchase of a newer vehicle may impact average fleet age when summed over time and across households living in a state.

The potential unintended consequences of motor vehicle wealth taxes on fleet turnover, emissions and air quality certainly justify further research on household's responses to these taxes. Future research should test the robustness of the results reported in this analysis by examining household vehicle holdings over time and attempting to quantify the effects of the delay in vehicle purchase associated with motor vehicle wealth taxes on state vehicle age distributions. Efforts should also be made to translate any identified effects on vehicle age distributions into effects on emissions levels to determine whether adjustments to

the use and structure of motor vehicle wealth taxes could be used to improve air quality.

ENDNOTES

[1] The impact of taxes on individual behavior has received much attention over the past several decades. Researchers have shown that individuals can be quite responsive to tax rates in deciding how much to work [Ziliak & Kniesner (1999), Feldstein (1995), and Hausman (1985)], how much to save [Pence (2002), Bernheim (2002), and Poterba et al. (1996)] and whether or not to purchase a house [Poterba (1992), Rosen & Rosen (1980), and Rosen (1979)], among many other decisions.

[2] The EPA conducted this simulation by adjusted vehicle age distributions, increasing the fraction of vehicles with ages greater than 13 years old and subtracting the same fraction from vehicles that were younger than 13 years old.

[3] For additional details on the probit model see chapter 2 of Long (1997).

[4] Although the original NHTS sample included over 26,000, the state of residence could not be identified for households living in states with small populations to protect the confidentiality of survey participants. These households were dropped from this analysis because the corresponding state motor vehicle wealth tax data could not be matched to individual households' states of residence.

[5] Definitions of the variables used in the analysis appear in the Appendix table.

[6] Vehicles not owned by the household, such as leased or company vehicles, are excluded from this analysis as it is not clear whether the household is responsible for paying the wealth tax. Recreational vehicles, motorcycles and vehicles classified as something other than an automobile, van, SUV or truck are excluded because they are usually employed in leisure activities which represent a different choice decision facing the household. Finally, vehicles over the age of 39 are excluded as they are lumped into the same model year category and thus their actual age cannot be determined.

[7] The calculation of these tax liabilities required the creation of a depreciation schedule for the Honda Accord to generate tax liabilities in states that use the blue book valuation method. This depreciation schedule that was generated by using the manufacturer's suggested retail price (MSRP) and resale value data for various model years of Accords. The first step in the calculation was to create a measure

that represented the total percentage change in value for vehicles of each age. The final step was to create annual depreciation rates over a thirteen year period by comparing the total percentage change in value for vehicles of consecutive ages. This analysis used a discount rate of five percent in the present value calculations.

[8] Virginia and Rhode Island are excluded from the analysis due to a lack of sufficient detail on their wealth tax provisions. Motor vehicle wealth tax rates, which vary by jurisdiction in both states, are not available for 2001, thus prohibiting the calculation of wealth tax liabilities.

[9] Although the Honda Accord has been one of the top selling vehicles over the past several years, its depreciation schedule may not be representative of the average vehicle since it tends to retain its value over a longer period time. The more rapid depreciation of the Taurus' value leads to larger relative and absolute differences between the tax liabilities of a new and used vehicle.

[10] This analysis does not consider the supply side of this market, but a few features such as online sales and special ordering opportunities increase the scope of the market making this a less critical issue.

[11] The analysis uses the average age of vehicles purchased by the household in 2001 as the dependent variable to account for the 13 percent of households that purchased more than one vehicle. However, results from models that use the vehicle as the unit of analysis and allow for possible heterogeneity across households were similar to those of the baseline model.

[12] This analysis uses the count of drivers in the household was used to identify the selection model. This variable is expected to affect vehicle purchase decisions as a larger number of drivers leads to the need for more vehicles; however, it is unlikely to affect household vehicle age decisions after controlling for the age of drivers in the household. This variable proves to be a sufficient instrument as it is highly statistically significant in the probit model. The results from the Heckman selection model are available from the author upon request.

[13] This analysis also estimated several other alternative specifications of the model were estimated to test the robustness of the baseline vehicle age results. Specifically, the results on the wealth tax measures were found to be robust to controls for a fourth quarter purchase, using vehicles as the unit of analysis and the use of wealth tax measures that were created using the Ford Taurus as an alternative representative vehicle.

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Table A.1: Variable Definitions	
Variable	**Definition**
Age of respondent	Age of the household respondent in years
Ave. distance to work	Average distance to work for household workers (in 10s of miles)
Ave. local transaction tax rate	Average value of the local transaction tax rates imposed on vehicles by local taxing jurisdictions in the household's state of residence
College degree	Dummy variable indicating that the household respondent received a college degree
Driver count	Count of drivers in the household
HH black	Dummy variable indicating that the household respondent is black
HH other	Dummy variable indicating that the household respondent is not black or white
Home ownership	Dummy variable indicating that the household owned its place of residence
Household size	Count of all household members
Household income	Income is reported in the NHTS files as a categorical variable. Households were assigned an income equal to the midpoint of their respective category
Life cycle 1	Dummy variable indicating that the household members are not retired and have no kids
Life cycle 2	Dummy variable indicating that the household has a youngest child younger than 16
Life cycle 3	Dummy variable indicating that the household has a youngest child between the ages of 16 and 21 (Used as the reference group in the multivariate analyses)
Life cycle 4	Dummy variable indicating that the household is retired
MSA 1mil +, heavy trans	Dummy variable indicating that the household lives in an MSA with a population greater than one million and a heavy transit system (such as a metro line) (Used as the reference group in the multivariate analyses)
MSA 1mil +, no heavy trans	Dummy variable indicating that the household lives in an MSA with a population greater than one million but without a heavy transit system

Table A.1: Variable Definitions	
Variable	**Definition**
MSA smaller than 1mil.	Dummy variable indicating that the household lives in an MSA with a population that is less than one million
Not in MSA	Dummy variable indicating that the household does not live in an MSA
Other than auto	Dummy variable indicating that at least one of the vehicles the household purchased in 2001 was something other than an automobile (such as a sports utility vehicle or truck)
Public transportation use	Dummy variable indicating that at least one member of the household used public transportation at least once in the the two months prior to the survey
Ratio vehicles to drivers	Ratio of vehicles owned or leased by the household to the number of drivers in the household
State transaction tax rate	2001 vehicle transaction tax rate in the household's state of residence (i.e. sales or excise tax rate on vehicles)
Wealth tax	Dummy variable indicating that the household lived in a state that imposed a wealth tax on motor vehicles in 2001
Wealth tax difference	Present value of the ten-year stream of tax liabilities for a new 2001 Accord minus the present value of the ten-year stream of tax liabilities for a used 1998 Accord (in $100s)
Wealth tax ratio	Present value of the ten-year stream of tax liabilities for a new 2001 Accord divided by the present value of the ten-year stream of tax liabilities for a used 1998 Accord
Worker count	Count of household members with jobs