An Analysis of the Effects of Vehicle Property Taxes on Vehicle Demand

Abstract - Vehicle personal property taxes recently existed in 31 states. Using data collected during the phaseout of the tax in Virginia, we analyze the effect of differing tax rates on the personal vehicle count and value data in 134 locales. We find that each increase in the effective property tax of one percentage point leads to a reduction in vehicular capital of over 5 percent. This result implies that the average dollar of tax revenue caused a deadweight loss of about 25 cents. Our results also provide cost and redistribution lessons for policymakers considering the enactment or elimination of a vehicle property tax.

INTRODUCTION

Person property taxes on vehicles recently existed in 31 states. In some states, there is a uniform rate across all political jurisdictions; in others, the tax rates vary by county, city, town, school, and even fire district (Mackey and Raffool, 1998; personal investigations). Although there exists no single reference identifying total receipts across the country, personal property taxes are an important source of revenue in some states. In the late 1990s, California raised $4 billion a year from the tax, known as a vehicle license fee (California Legislative Analysts’ Office, 1998; Rojas, 1999). Washington State estimated revenue of $1.1 billion during its 1999–2001 biennial budget period (Washington State Office of Financial Management, 1999). South Carolina expected about $0.5 billion in 1999 (Gibson, 1999). Even tiny Rhode Island collected nearly $145 million in 1997 from the tax (Frasier, 1999).

In the fall of 1997, Virginia gubernatorial candidate James Gilmore based his successful campaign on eliminating the unpopular “car tax.” Since then, policy–makers in California and Virginia have reduced, and the government of Rhode Island began phasing out, personal property taxes on vehicles (Rojas, 1999; Rowland, 1999). After the Washington State referendum in 1999 to reduce the 2.2 percent state vehicle tax to a flat $30 was found to be unconstitutional, the Legislature quickly acted to achieve the same result (Washington State Department of Revenue, 2002). In the late 1990s, political leaders in Kansas, Kentucky, Oklahoma, South Carolina, and Utah also proposed reductions in, or elimination of, their vehicular taxes (Sullinger, Petterson, and Dvorak, 1999; Brown, 1999; Jenkins,
Recent state fiscal crises appear to be reversing the earlier trend. Revenue shortfalls in Virginia triggered an automatic moratorium on scheduled reductions for 2002–2004. Governor Gray Davis of California used his administrative authority to reverse the California reductions and triple the vehicle license fee to raise an additional $4.2 billion in fiscal year 2004 (Gledhill, 2003). This unpopular action played an important role in the 2003 recall of Davis, only the second successful recall of a governor in United States history.

Beyond gubernatorial politics, there are at least four direct policy issues related to any reform of the personal property tax on vehicles. First, what are the distributional implications of taxes based on the value of vehicles owned? In other words, what is the incidence of the tax? Evidence that the tax is regressive would be one factor encouraging consideration of its reform.

Second, what are the budget and revenue implications of lowering the personal property tax on vehicles? States often reimburse affected localities for lost revenue when reducing or eliminating the opportunity for local governments to collect revenue from the tax. In Virginia, for example, the revenue reimbursements are based on pre-tax reform rates. Therefore, accurate state budget forecasts require knowledge of the behavioral implications of lowering the effective tax faced by vehicle owners. Since reduction of this tax may cause persons to own larger amounts of vehicular capital, localities whose taxing authority has been reduced may even experience revenue gains. Correspondingly, the cost of the program to the state would rise beyond projections not based on rising purchases. As there is no research on the behavioral effect of vehicle taxes, states and localities have no basis for predicting the revenue effects of any reduction in the tax.

Third, what is the deadweight or efficiency loss associated with revenues from vehicle taxes? Many casual observers claim that the personal property tax on vehicles does not affect buying decisions. If this were true, the “car tax” would be a type of head tax that varies by individual. It would be an efficient means of raising revenue. On the other hand, if the behavioral effects of the “car tax” were large, this revenue source would raise funds with a large deadweight loss. Taxes on vehicles should be evaluated in the context of other revenue sources for state and local governments, which include income taxes, sales taxes, excise taxes, lottery profits, inheritance taxes, other property taxes, and user fees. Absent distributional considerations and other external effects, the distortions from taxation are minimized when the marginal deadweight loss per dollar of revenue across all revenue sources is equalized. The literature estimating or comparing the deadweight loss of these various revenue sources is extremely thin.¹

Fourth, what are the environmental implications of reducing or eliminating vehicle taxes? Since value-based taxes raise the cost of owning more valuable vehicles, any reduction in such taxes can be expected to encourage persons to own more valuable vehicles. This likely will occur in conjunction with increased ownership of newer vehicles. Ceteris paribus, a proportionate decrease in taxes will raise the effective relative price of older cars and induce substitution away from them, and towards newer cars. Newer vehicles generally create smaller quantities of emissions of hydrocarbons, carbon monoxide, carbon dioxide, and nitrogen oxides.

¹ One reason the literature is thin or nonexistent is that many results are not easily generalized beyond a given state or community. For example, increases in sales taxes will have larger deadweight losses in states whose major populations live in close proximity to other states. One exception to this general point is the demand for personalized (vanity) license plates, where each state Department of Motor Vehicles is a monopolist. See Craft (2002).
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(Alberini, Harrington, and McConnell, 1995). One potential effect of the phaseout of the vehicle tax, then, would be to lower emissions per vehicle. Alternatively, if larger vehicles, such as sport utility vehicles, replace older vehicles, emissions per vehicle could rise. The tax phaseout may also affect the number of vehicles owned. Even if the total miles driven do not change, this second factor would change emissions, since even vehicles that are not driven cause pollution through evaporation of fuels. To our knowledge, only Fullerton and West (2002) have published research relating vehicle taxes to vehicle emissions. Their theoretical paper investigates the feasibility of various taxes and combinations of taxes that internalize the external costs of vehicle emissions. We address the second and third questions using unusual Virginia Department of Motor Vehicle data.

Presumably, there are many researchers using the Department of Transportation’s (DOT) 1995 and 2000 National Personal Transportation Surveys (NPTS) to determine the relationships between household characteristics and the number, type, and value of vehicles households owned, as well as the miles and time spent in vehicles. The NPTS is an unusually rich micro level data set including household information on vehicle characteristics, income, demographics, local road characteristics, public transportation, driving patterns, geographical characteristics, population density, and housing status. However, the NPTS does not include information concerning vehicular property taxes. To the extent that the personal property tax rate influences vehicular decisions and that the variables used to estimate demand are correlated with personal property tax variables, those estimates will be biased. A byproduct of our research will be a more complete understanding of the many factors affecting vehicle ownership decisions.

Accurately estimating the income elasticity of demand for vehicles and vehicular capital may even require integrating the effect of personal property taxes. To the extent that previous estimates of the income elasticity of demand for vehicles used micro level data sets in which income was correlated with personal property tax rates, those estimates would be biased.

Five sections follow this introduction. The second section presents a preliminary look at the impact of the vehicle tax phaseout on vehicle sales in Virginia by comparing her with neighboring states over the period 1993–2001. The third section reviews the limited past research on vehicle taxes. The fourth section offers an analysis of Virginia’s 1998 county and city vehicle data and builds an empirical model for the analysis. The fifth section presents our quantitative results and investigates their policy interpretations, with particular emphasis on the deadweight loss implications of the property tax on personal vehicles. Finally, the sixth section summarizes the major conclusions of this paper.

A GLIMPSE AT THE EFFECTS OF VIRGINIA’S CAR TAX PHASEOUT

Virginia began a scheduled phaseout of her personal property tax on the first $20,000 of vehicular value in mid–1998. Tax rates were reduced by 12.5 percent in 1998, 27.5 percent in 1999, 47.5 percent in 2000, and 70 percent in 2001 before stalling due to an economic downturn. Before addressing the major policy issues by analyzing Virginia data at the local level, we ask a very simple question. Did this phaseout affect per capita vehicle sales in Virginia vis-à-vis her neighboring states? Figures 1 and 2 depict, respectively, changes in per capita dealership sales values and new vehicle registrations in Virginia, Maryland, North Carolina, and West Virginia from 1993–94 to 2001–02.

Sales taxes, registration fees, and fuel taxes also affect ownership decisions, but are not included in the NTPS.
Figure 1. Annual Change in Per Capita Sales, Virginia and Three Neighboring States, 1993–94 to 2001–02

Figure 2. Annual Change in Per Capita New Vehicle Registrations, Virginia and Three Neighboring States, 1993–94 to 2001–02
In general, these figures reveal a secular decline through 1997 with Virginia typically faring worse than her neighbors. The turnaround begins in 1998, coincidentally, the same year as the onset of Virginia’s tax phase out. Virginia goes from near worst before the phaseout to near first in 1998, 1999, and 2000.

Is the apparent positive impact of the phaseout statistically significant? We tested this by estimating the following regression model for each series:

\[ \Delta Sales/N_{it} = f(Va1998_{it}, Va1999_{it}, Va2000_{it}, Va2001_{it}, \Delta Y/N_{it}, t, Md_{it}, NC_{it}, WV_{it}), \]

where the dependent variable is the change in either per-capita sales or new vehicle registrations. The four Virginia period binaries track the years of phase out; \( \Delta Y/N_{it} \) controls for change in per-capita personal income; \( t \) controls for any linear time trend; and the three state binaries control for unobserved state fixed effects. Due to its exclusion from the equation, the numeraire for the various state binaries is the period in Virginia prior to the passage of legislation (1993–94 through 1996–97).

The results corroborate the graphs. The Virginia period binaries are positive in all four periods vis–à–vis the pre-phaseout period; however, their coefficients are the largest and significant only in 1999 (at the one percent level for all sales and five percent level for new registrations). This is plausible as households adjust their purchase decisions to a graduated phaseout begun in midyear 1998. They are also encouraging to our more rigorous policy analysis and modeling at the local level in Virginia.

PREVIOUS RESEARCH

Pritchard and DeBoer (1995) estimate the effect of taxes, insurance costs, and other factors on automobile registrations at the state level. Interpretation of their results is limited, however, by the use of either the statewide average or the prevailing tax in a large city to estimate the property tax variable in their study. Our research extends and improves this work by using observed property tax rates at the county and city level and estimating their influence not only on vehicle registrations, but also on new vehicle sales and vehicular capital per capita.

There are only two known studies measuring the tax incidence of the personal property tax on vehicles. Dill, Goldman, and Wachs (2002) conclude that the California vehicle license fee is regressive using data found in the 1995 NPTS. Bremer (2001) confirmed the regressivity of vehicle property taxes by estimating the tax burden of 904 Virginia, Connecticut, and Rhode Island families also surveyed in the 1995 NPTS.

We extend this literature by using a unique data set to address a range of issues concerning the vehicle property tax in a reduced-form supply-demand model. We base that model on an extensive literature that estimates price and income elasticities of demand for automobiles. To our knowledge, none of those studies takes into account the influence of personal property taxes on automobile demand. Most studies distinguish only coarsely or not at all among the different types (and values) of vehicles, estimate demand by vehicle type or model (not aggregate vehicular demand), or are based on new car buyers or households that own vehicles (Chow,
1957 and 1960; Cragg and Uhler, 1970; Dyckman, 1965; Hess, 1977; Hymans, 1970; Johnson, 1978a and 1978b; Levinsohn, 1988; Nerlove, 1957; Smith 1975; Suits, 1958 and 1971; Trandel, 1991; Wetzel and Hoffer, 1982). More recent research by Goldberg (1995) and Berry, Levinsohn, and Pakes (1995) employs sophisticated discrete–choice models that take into account product differentiation in the context of a market equilibrium. That research is focused more on the demand for, and supply of, individual makes of vehicles or classes of vehicles and the corresponding implications for trade policy, as opposed to estimating the income elasticity of demand for vehicles in general. Goldberg’s (1995) demand model adopts a transactions rather than a holdings approach, and Berry et al. (1995) employ an aggregated time series model that pays particular attention to vehicle attributes when estimating demand for differentiated vehicles. While none of these models addresses the tax aspects, they do provide a framework for assessing the influence of the personal property tax on purchase decisions.

DATA AND HYPOTHESES FOR ANALYSIS OF THE EFFECTS OF VEHICLE TAXES

In Virginia the effective personal property tax rate on retail vehicular value averaged 2.08 percent and ranged from 0.15 to 3.48 percent in 1998 (Weldon Cooper Center for Public Service (1998) adjusted for assessment ratio; the use of retail, trade-in, or loan value; town rates; and federal tax deductibility). Figure 3’s map illustrates the distribution of 1998 tax rates across locales in the state of Virginia. As can be seen, tax rate categories tend to cluster regionally. While there are exceptions, the highest rates tend to be in northern and southeastern Virginia. By contrast, the western portion of the state tends to have had lower rates. A large swathe of locales in the central and southeastern areas imposed high rates.

Fulfilling a campaign pledge of the newly elected governor, the Virginia General Assembly passed a law in April of 1998 (Senate Bill No. 4005) to begin the phaseout of taxation on the first $20,000 of market value of all personal vehicles. How might that phaseout be expected to impact vehicular ownership? Consider the economic significance of vehicle property taxes in the decision to purchase a new $20,000 vehicle. Assume that the vehicle depreciates 20 percent per year. Using the average property tax rate in Virginia (2.1 percent) and a four percent discount rate, a vehicle lasting 15 years will have a tax bill in present–value terms of $1,784, or nearly nine percent of the vehicle purchase price. Do such calculations affect the decisions by households? The Virginia “experiment” and a well–articulated model of vehicular demand can help answer this question.

We are fortunate that this policy experiment occurred in Virginia for two reasons. First, Virginia has a unique organization of local government. Governmental jurisdictions conform to county and city jurisdictions, and 40 cities maintained local governments independent of any county government in 1998 (Morris and Sabato, 1990, 282–304). Furthermore, these non–overlapping jurisdictions bear responsibility for all services from water and sewer to roads to fire and police protection to education, and they have the taxing authority to pay for these services. Combining counties and independent cities, there are 135 potential observations of vehicular capital, vehicles purchased, vehicles owned per capita, effective property tax rates, and other factors affecting vehicle demand. As a result of this

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4 The number of licensed drivers in Falls Church exceeds its total population because its address extends beyond the independent city of Falls Church and into neighboring Fairfax County. We have resolved the resulting anomaly in DMV data by combining Falls Church and Fairfax County.
Figure 3. 1998 Annual Personal Vehicle Effective Tax Rates in Virginia (by county and city)

Source: See Text.
structure, locality classifications from the Census Bureau and Bureau of Labor Statistics track Virginia’s local government jurisdictions perfectly. Thus, we have been able to download locality-specific data for the socio-economic variables in the model (income, population size and density, and age structure) from their Web sites.

Second, the Virginia Department of Motor Vehicles (DMV) has been most generous in providing all of the locale data necessary for this project for 1998. These data include, by county and city, the assessed value and number of vehicles (as reported to the DMV by counties, cities, and towns for reimbursement of lost tax revenue), the number of new passenger vehicles licensed during the year, and the number of licensed drivers.

With respect to the tax rate, the Weldon Cooper Center for Public Service (WCCPS) at the University of Virginia surveys all counties, independent cities, and incorporated towns in Virginia each year on local government tax rates and fees. For nearly two decades it has recorded the personal property tax on vehicles and the assessment procedures used to calculate their value (WCCPS, 1998). Four adjustments have been made to the recorded tax rate to obtain “effective” tax rates that are defined consistently across localities. First, since locales use varying assessment ratios, the WCCPS multiplied the recorded rate by the assessment ratio. Second, locales use different valuations (loan, trade-in, or retail) from the National Automobile Dealers Association (NADA) Official Used Car Guide in making their assessments. We based our adjustment to the WCCPS tax rate from loan and trade-in values to retail values on a sample of 1,011 Virginia vehicles in the 1995 NPTS. Third, since some counties contain towns that also tax vehicles, we have adjusted the average county tax rates to account for town taxes. Fourth, since the personal property tax is deductible for Federal income taxes, a locale’s effective rate is reduced by the marginal tax rate for the next deduction for the average individual in the locale.

Across all locales, that marginal Federal tax rate averages 0.078 and ranges from 0.022 to 0.171.

As noted above, our quantitative approach is a reduced-form, supply-demand model. We believe our contribution lies in the careful analysis of a unique data set. Our data are not completely disaggregated, yet we do capture heterogeneity in tax and insurance attributes that, for example, no micro data set does. Not

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5 There is a difference in coverage due to the data sources for total vehicular value and total number of vehicles versus the number of new vehicles. The totals refer to “personal” vehicles reported for reimbursement of foregone “personal” property tax. Thus, they do not include business vehicles, but do include small trucks and motorcycles. By contrast, new vehicles refer to “passenger” vehicles, which do include business vehicles. Thus, we would not anticipate new vehicles to be as responsive to the tax rate since they are not all affected by the tax.

6 The ratio of retail value to trade-in value varies more for older, low-value models. To the extent that this variance occurs in the least valuable cars, the problems it poses are vitiated. Further, to the extent that the distributions of vehicles across communities are similar, this variation in valuation will wash out across communities.

7 If the effect of these taxes is linear, then knowing the numbers and values of vehicles in each town that levies additional taxes is sufficient to calculate an adjusted effective tax rate in the county. In any case, both the tax rates in taxing towns and the proportions of vehicles taxed by towns in counties with taxing towns are quite small.

8 Necessary data for these calculations were downloaded from the U.S. Department of the Treasury Internal Revenue Service (IRS) Web site (IRS Master File Data, found in the March 2001 Statistics of Income) for the 1998 tax year. The IRS data provide summary information by FIPS code for all individual returns as well as for returns in four adjusted gross income (AGI) categories. The “marginal tax rate for the next deduction” (MTRD) is calculated as a weighted average of the proportion of returns in the AGI category that itemize times that category’s 1998 marginal tax rate. Specifically, MTRD = (0.15 * “# under $10,000 that itemize” + 0.15 * “# $10,000 under $25,000 that itemize” + 0.23 * “# $25,000 under $50,000 that itemize” + 0.33 * “# $50,000 or more that itemize”) / “# of returns in the locale”. 
only do we seek to estimate the behavioral effects of the personal property tax, we also attempt to provide a more intuitive interpretation of the income elasticity of demand for vehicles in a world with extreme product heterogeneity.

Table 1 lists the variables used to model personal vehicular capital ($Capital$), new

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>VARIABLE DEFINITIONS AND DESCRIPTIVE STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part 1: Dependent Variables</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Mean (Std Dev)</strong></td>
</tr>
<tr>
<td>$Capital$</td>
<td>$13,207 (3,991)$</td>
</tr>
<tr>
<td>$New$</td>
<td>0.100 (0.034)</td>
</tr>
<tr>
<td>$Vehicles$</td>
<td>1.938 (0.364)</td>
</tr>
<tr>
<td><strong>Part 2: Independent Variables</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Mean (Std Dev)</strong></td>
</tr>
<tr>
<td>Tax Rate</td>
<td>2.075 (0.658)</td>
</tr>
<tr>
<td>Prorate</td>
<td>0.336 (0.474)</td>
</tr>
<tr>
<td>Tax Rate * Prorate</td>
<td>0.834 (1.206)</td>
</tr>
<tr>
<td>HHY</td>
<td>$39,228 (11,763)$</td>
</tr>
<tr>
<td>% $75K+</td>
<td>17.559 (10.189)</td>
</tr>
<tr>
<td>Density</td>
<td>0.757 (1.347)</td>
</tr>
<tr>
<td>Drivers</td>
<td>1.843 (0.179)</td>
</tr>
<tr>
<td>% 35–44</td>
<td>15.953 (2.317)</td>
</tr>
<tr>
<td>% 45–64</td>
<td>24.351 (3.464)</td>
</tr>
<tr>
<td>Insurance</td>
<td>5.686 (0.578)</td>
</tr>
</tbody>
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Notes: See text for sources. The $H_a$ column reports our null hypothesis of the effect the independent variable has on the three dependent variables.
passenger vehicles purchased (\textit{New}), and personal vehicles owned (\textit{Vehicles}). Table 1 also provides summary statistics as well as the expected signs in the model. Where \textit{DepVar} represents one of these three dependent variables and an \textit{i} subscript denotes the \textit{i}th locale, the estimation model can be written as follows:

\begin{equation}
\ln(\text{DepVar}) = f(\text{Tax Rate}_i, \text{Prorate}_i, \\
\text{(Tax Rate} \times \text{Prorate})_i, \ln(\text{HHY}), \\
\%$75K, \ln(\text{Density}), \ln(\text{Drivers}), \\
\%25–34, \%35–44, \%45–64, \%65+, \ln(\text{Insurance})_i).
\end{equation}

The anticipated sign of \textit{Tax Rate}, the effective personal property tax rate on vehicles, varies across equations. Since the tax is levied on vehicular value, we expect a negative sign in the \textit{Capital} equation. Since new vehicles have high capital values, we also anticipate an inverse relationship with the purchase of \textit{New Vehicles}. The relationship with the total number of \textit{Vehicles} is more complex. People in high tax–rate locales might lower their vehicle ownership or merely substitute lower–valued against higher–valued vehicles. Conceivably, they might even substitute for quantity from quality resulting in a higher number of lower–valued vehicles. Accordingly, we do not predict a sign for this relationship.

Additional detail on the implications of the tax is provided by the \textit{Prorate} dummy variable and its interaction with the \textit{Tax Rate}. In Virginia, 45 localities prorate annual personal property taxes for vehicles purchased during the tax year, while 89 localities do not. Those that do not, charge the annual fee according to ownership of vehicles on a specific assessment date (typically January 1)\footnote{In 1998, 57 of the 89 nonprorating localities made their assessment on January 1, 5 more on a date near the middle of the year (e.g., May 1 or July 1), and the remaining 27 did not list an assessment date (Weldon Cooper Center for Public Service, 1998).} and do not tax vehicles purchased between assessments until the following tax year. Prorating the tax has at least three possible effects within the model. The first is an artifact of data collection for the vehicle count (\textit{Vehicles}) and vehicular capital per household (\textit{Capital}). Since these data are based on values reported by localities for state reimbursement, the \textit{Capital} and \textit{Vehicles} variables will miss all vehicles purchased after the assessment date in a locality that does not prorate. In the same vein, these variables will miss additional vehicles resulting from households moving into a non–prorate locality between assessment dates. By contrast, both the \textit{Capital} and \textit{Vehicles} variables will include these vehicles for prorating localities. Note that this anomaly does not exist for \textit{New} since these data were provided by the Virginia DMV and are based on new vehicle registrations over the calendar year. We include a binary for \textit{Prorate} localities to control for this anomaly and predict a positive coefficient for both \textit{Capital} and \textit{Vehicles}, but no effect for \textit{New}.

The second effect is economic. Individuals in prorating localities pay, on average, an extra half year’s tax during the first year of ownership, assuming purchases spread evenly throughout the year. This raises the effective cost of the vehicle, discouraging vehicle purchases, especially new and

\footnote{Property tax relief in Virginia is only available on the first $20,000 of market value for a personal vehicle. For that reason, nine out of the 135 locales neglected to provide values in excess of $20,000 when reporting vehicular value. We completed those series by using locales with complete data in a regression of the ratio of total vehicular value to the first $20,000 in vehicle value on the locale’s income and age distribution. Predicted ratios were then applied to the nine locales with truncated vehicular values. We tested the sensitivity of this procedure in two ways: (1) by dropping the nine locales altogether and (2) by using a dummy variable for the locales. In neither case does the estimate of the tax rate coefficient change in any quantitatively significant manner.}
high–valued vehicle purchases. To control for these economic effects of prorating, we include an interaction term between the Prorate binary and the Tax Rate, since the influence on effective vehicular cost is higher in the high–tax prorating locales. We predict a negative impact for all three dependent variables.

The third effect ameliorates the second effect. Legislation to phase out the vehicle tax was enacted on April 24, 1998 and this plausibly affected vehicular purchases for the remainder of 1998 (and to a lesser extent, pre–legislation purchases in anticipation of the phase out). Given the manner in which our data were collected, this influence will be included in the Capital and Vehicles variables for prorating localities and for the New variable in all localities. We find it unlikely that either the legislation or its anticipation affected Capital and Vehicles in nonprorating localities. In nearly all cases these assessments were made prior to the legislation and households could avoid a full year’s taxes by waiting to purchase a vehicle until after the next assessment date (in most cases January 1, 1998). To the extent that passage of the legislation affected vehicular decisions in prorating localities during 1998, the magnitude of the interaction’s coefficient will be reduced, but its negative impact should not be eliminated. We continue to predict a negative sign in all three equations.

With the inclusion of the Prorate binary as well as its interaction with the Tax Rate, the Tax Rate variable has a cleaner ceteris paribus interpretation. Recognizing that these rates remained quite stable over time, it is the pre–legislation, long–run impact of a one–percentage–point change in the vehicular tax rate in a nonprorating locality (such locales comprise 89 of the 134 data points). We should note, however, that given the significant correlation between Prorate binary and its interaction with the effective tax rate, estimates of these two coefficients must be treated with care. Our sensitivity analysis provides results for the subset of nonprorating locales.

Consider the remaining control variables within the model. We anticipate a positive relationship between the natural log of median household income, ln(HHY), and all ownership measures. We include an additional measure, the percentage of all households exceeding $75,000 in personal income (% $75K+), to capture potential non–linearity at the upper end of the income distribution. We predict a positive sign for % $75K+ in the Capital and New equations, but remain agnostic for the Vehicles equation. Higher–income households might own more vehicles than their income would suggest. On the other hand, such households might substitute quality for quantity and own fewer. Both series are from the 2000 Census and downloaded from the United States Census Bureau’s Web site. We used census values from 2000 for our income control variables because we believe the increased accuracy of census data outweighs variation across locales from changes between 1998 and 2000.

The natural log of population density, ln(Density), is included to model a number of phenomena. First, a high population density provides the opportunity for some to live near work and shopping locations. Second, public transportation, a substitute for the ownership of personal vehicles, might be expected to be more available in dense than less–dense locales. In the absence of good estimates of the level of public transportation in localities, we include ln(Density) as a proxy for its availability. Third, some counties and cities in northern Virginia require vehicles to pass emissions tests each year due to air pollution regulations. Not surprisingly, the requirement that vehicles pass an emissions test each year due to air pollution regulations. Not surprisingly, the requirement that vehicles pass an emissions test is highly correlated with Density. Fourth, and possibly most important, the Bureau of Labor Statistics does not collect pricing information at the locality level.
While vehicle prices might be considered to be requisite in any demand equation, they are not available at this level of disaggregation. On the other hand, Density and the two income measures are certainly correlated with vehicular prices. To the extent they are, they serve as useful instrumental variables for vehicle prices. Regardless of the rationale for the inclusion of \( \ln(\text{Density}) \), we expect a negative impact on vehicle purchases and ownership. Density was calculated using 2000 Census data for population and the Virginia Department of Transportation’s 1993 County Road Map Atlas for square mileage.

Several demographic variables are included in the model. The natural log of the number of licensed drivers per household, \( \ln(\text{Drivers}) \), is included to capture the demand for vehicles within households. We expect vehicular purchase and ownership per household to rise as the \( \ln(\text{Drivers}) \) rises. We expect that there may be some additional life-cycle effects influencing vehicle ownership and purchases as well, and include the population age distribution to model those effects. We exclude the percentage under age 25, implying that other age coefficients must be interpreted relative to this cohort. The 25–34 and 35–44 age groups include many persons who are single, are establishing households, and/or have young children. People in these groups may use vehicles to acquire prestige or reputational capital, attract mates, and protect children. We expect a positive effect on new vehicle purchases and vehicular capital.\(^{11}\) The 45–64 age group includes individuals in their highest income ages with children in the process of moving out of the household. We anticipate increased discretionary income with a positive impact on vehicle ownership and purchases. Finally, the 65+ age cohort is in its retirement years, perhaps with accumulated wealth, but less interested in vehicle purchases. The effect on the stock of vehicles and vehicular capital is uncertain.

The cost of insurance varies across localities in Virginia. A national insurance company has provided locality-specific 1998 costs for standard collision, liability, and comprehensive insurance policies for a 1995 Honda Accord. The rates are quoted for an adult with no accidents or violations during the past three years. We expect higher insurance costs to discourage the ownership of vehicular capital, all other factors held constant.

**EMPIRICAL RESULTS**

The interpretation of the following analysis is clearest and most appropriate when we assume that each county or city is in a long-term steady state. In other words, residents have had time to adjust their ownership decisions to any changes in the effective tax rate due to residents changing tax jurisdictions or to tax jurisdictions modifying tax rates. Such an assumption is plausible since an inspection of property tax rates indicates few changes by jurisdiction over time. To the extent that the tax rates change or households change localities, the estimated behavioral effect is biased downward.\(^{12}\)

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\(^{11}\) These hypotheses are supported by evidence in Craft (2002) that a higher proportion of the population aged 25–34 significantly increases the demand for personalized license plates.

\(^{12}\) While the steady-state argument is plausible pre-legislation, the phaseout began in 1998. To the extent that households began adjusting their behavior, the tax-rate coefficients for the full undifferentiated data set will be understated. However, we believe those adjustments to be muted because (1) the rebate was only 12.5 percent of the tax on the first $20,000 of value; (2) the stock variables (capital and number of vehicles) are dominated by vehicles purchased prior to 1998; (3) the legislation was not passed until several months into 1998; (4) vehicle purchases after the new law was enacted will be captured by the Prorate dummy and its interaction with the tax rate; and (5) neither house of the Virginia General Assembly in 1997 was controlled by the party of the gubernatorial candidate James Gilmore, thereby vitiating expectation effects. Most fundamentally though,
**Overall Fit and the Influence of Tax Rates on Household Vehicle Decisions**

Table 2 presents ordinary least-squares regressions of the factors determining the level of vehicular capital, new vehicles purchased, and vehicles owned per capita.\(^{13}\) The dependent variables are specified as logs, as are most of the independent variables. Coefficients for these variables may, thus, be interpreted as elasticities. On the other hand, those variables expressed as percentages (the effective tax rate, the percent of households with incomes exceeding $75,000, and the age distribution) are kept in percentage terms. Their estimated coefficients may be interpreted similarly to elasticities, that is, a one percentage point change in the variable results in a coefficient \((\times 100)\) percent change in the dependent variable.

R\(^2\)'s in these regressions are relatively high for cross-sectional data (0.86, 0.76, and 0.79 for the capital, new purchases, and total vehicle equations, respectively) with strong t-values and no inexplicable signs on significant coefficients. With this backdrop, consider the influence of the effective *Tax Rate* on household vehicular decisions in a nonprorating locale. At the one percent significance level, each percentage point increase in the effective tax rate *lowers* the value of vehicular capital per household by 5.2 percent, *lowers* the per-household purchase of new vehicles by 12.3 percent, but *increases* the number of vehicles owned per household by 5.5 percent, *ceteris paribus*. The policy implications are interesting. Holding other model influences constant, high effective property tax rates encourage households to substitute more low-value for fewer high-value vehicles, including the purchase of fewer new vehicles. The capital value of vehicles depreciates faster than their ability to transport persons, and households react accordingly when faced with higher tax rates on vehicular value. On the other hand, while retaining their utilitarian value, the older vehicles characteristically produce higher emissions, of concern to policymakers.

Not only is the *Tax Rate* statistically significant, it is quantitatively important as well. As noted previously, each percentage point increase in the effective tax rate implies 5.2 percent lower vehicular capital and 12.3 percent fewer new vehicles per household, while increasing the total number of vehicles per household by 5.5 percent. Thus, holding other factors constant, a nonprorating locality imposing the average tax rate of 2.1 percent would be predicted to have 10.3 percent lower vehicular capital, 22.5 percent fewer new vehicles, but 12.1 percent more vehicles per household than a locality without a personal property tax on vehicles. (Note that these calculations differ slightly from the simple product of the tax rate times the coefficient estimates because of the regressions' semilog specification. See note 16.) One can frame these behavioral responses to the tax as price elasticities as well. If one assumes a vehicle depreciates by 20 percent per year and a four percent interest rate, the present discounted value of the tax in the average locale equals nine percent of the purchase price of the vehicle. This implies corresponding price elasticities of \(-1.2\) for vehicular capital, \(-2.9\) for new vehicle purchases, and \(+1.3\) for vehicles per household. We note a qualification to our results. To the extent that population density and our income measures do not adequately control for

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13 We note that Park tests found no significant evidence of heteroskedasticity against a locality's population size \((p\text{-values of} \ 0.40, 0.92, \text{and} \ 0.51, \text{respectively})\). Since that is the most likely source of heteroskedasticity with per capita data, we have made no correction for heteroskedasticity.
vehicle, fuel, or maintenance prices, and to the extent that these prices are positively correlated with tax rates, these impacts will be overstated.

Consider next the deadweight loss of the tax, which we estimate to be 26 percent of the revenue raised. Imagine a demand for vehicle capital units. We assume a perfectly elastic supply curve for vehicle units. Such an elasticity assumption is not unreasonable, as there are no obvious limits (rising input costs) to the long-run production of vehicles. Assume the price per unit of vehicular capital to be one dollar. With this normalization, across all locales in Virginia, households hold on average 13,207 units of vehicular capital in equilibrium. The average effec-

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Notes: * denotes 5% significance; ** denotes 1% significance; 1– or 2–tailed tests have been used consistent with hypothesized signs in Table 1; and t–statistics are in parentheses. The Park Test found no heteroskedasticity against population size. Consequently, unweighted linear regressions were employed.
tive vehicular tax rate was 2.1 percent in Virginia before the implementation of the property tax relief. This implies a reduction in vehicular capital of 10.3 percent. In other words, in the absence of the tax, a household in an average locale would own 14,722 units of capital. The annual revenue collected on 13,207 units of vehicular capital equals $277. In order to calculate the deadweight loss, the increase in effective price per unit of capital must be estimated. If a vehicle depreciates by 20 percent per year, the present value of the lifetime tax incidence of the vehicle is about nine percent of the vehicle’s initial value when using the average tax rate of 2.1 percent. The average personal property tax in Virginia raises the effective price of owning a vehicle from one dollar per unit of capital to $1.09. The tax reduces the equilibrium level of capital by $1,515. The implied Harberger triangle has an area of $68.18 (calculated as 1,515 × 0.09 × 0.5). The deadweight loss, therefore, is approximately 25 percent of the revenue raised. The social cost of this method of revenue enhancement is slightly greater when considering the loss in Federal tax revenue due to deductibility of these local tax payments.14

Although welfare loss estimates per dollar of revenue at the state level are rare, our ratio of deadweight loss to revenue dollar for the personal property tax on vehicles is comparable with other taxes estimated in several well-known studies. Jorgenson and Yun (1990 and 1991) present an average deadweight loss of 16 cents for each dollar of revenue from real property taxes. Hawkins (2002) finds the excess burden (reduction in economic welfare beyond the revenue raised) to be between 17 percent and 39 percent for the general sales tax. Jorgenson and Yun (1991) present their own and other researchers’ estimates of the deadweight loss per dollar of revenue from the overall tax system as well as from labor taxes. The five estimates from both partial and general equilibrium approaches yield efficiency losses between 18 and 30 percent.

Results for the Control Variables

Household Income

As a byproduct to our investigation of the behavioral effects of the property taxes on vehicle ownership, this research also offers an estimate of the income elasticity of demand for vehicles. Given the durable nature of vehicles and the extreme heterogeneity of vehicle types, it is often difficult to interpret the meaning of a standard estimate of the income elasticity of demand in many studies. We have included both the natural log of median household income ($\ln(\text{HHY})$) and the percentage of households with incomes exceeding $75,000 ($\%75K+$) to capture the influence of both mean and high-end income in explaining vehicle ownership decisions. The two measures are jointly significant at the one percent level in all three equations; $\%75K+$ is significant in the capital equation at the one percent level; while $\ln(\text{HHY})$ is significant at the one percent level in the vehicles equation. Interestingly, high income households appear to substitute for quality from quantity as they tend to own more vehicular capital and purchase more new vehicles, but own fewer vehicles overall than the median household.

The income elasticity of demand for household vehicular capital is 0.52, for

14 Using 1998 data on the number of households itemizing and the taxable income distribution, the average across all locales of the marginal value of a Federal tax deduction is eight percent. Reducing the true increase in government revenue by eight percent increases the social cost per dollar revenue to 26.7 percent (U.S. Department of the Treasury, 2001).
new vehicles, 0.46, and for all vehicles, 0.21. How do these results compare with those from household studies? They do fall within the range of estimates (0.26 to 4.18) from a wide variety of micro-studies cited by Bordley and McDonald (1993) and McCarthy (1996). Nevertheless, our estimates are on the low end, and many of the studies do find automobile demand to be income elastic. Although we note that the estimation of income elasticities is not the focus of this research, we also note that their relative magnitudes are quite plausible. Our results indicate that vehicular capital and new vehicle purchases are much more income elastic than is the demand for the number of vehicles in a household. These results are consistent with our earlier findings that new purchases and vehicular capital respond to the effective tax rate on personal vehicles, while the number of vehicles does not.

The Prorate Dummy and Tax Rate Interaction

Recall that we have included a Prorate dummy and prorate–tax rate interaction for two distinct reasons. We included the Prorate binary to control for a data anomaly. Since our values for vehicular capital and numbers of vehicles are those reported to the state for tax reimbursement, they will include additions to the vehicular stock throughout the year in a prorating locale, but not in one that does not prorate vehicle taxes. This anomaly exerts a positive impact on the Prorate coefficient in the vehicular capital and total vehicle equations, but not on new vehicle purchases since these numbers come directly from titling records. Our results corroborate this. Prorate is positive and significant at the one percent level in the Capital and Vehicles equations, but insignificant at the ten percent level in the New Vehicles equation.

We included an interaction term between the prorate binary and the tax rate since the lifetime tax incidence of a vehicle is higher in a prorate than in a non–prorate locale, and higher still in a high–tax than in a low–tax prorating locality. Although this higher incidence was ameliorated a bit during the year because of passage of the tax phaseout legislation in April 1998, we predicted negative signs for these coefficients. This is true for the Vehicles equation where the interaction term is both negative and significant at the one percent level. Indeed, the negative interaction coefficient more than offsets the positive tax rate coefficient for prorating localities. The interaction is also negative in the Capital equation but positive in the New equation. Neither of these coefficients is significant at the five percent level.

Density

At the one percent significance level, households in high–density locales purchase more new vehicles, but own fewer vehicles in total. At first blush, these appear to be contradictory results, but upon further reflection they are consistent with the quantity–quality choices households appear to make with respect to varying tax rates and household incomes. Households in more dense localities have a reduced desire for vehicles because of shorter distances between destinations as well as possible mass transportation alternatives. Having a reduced desire for numbers of vehicles, households in more urban areas have the ability to purchase newer vehicles for a given income level and tax rate. On the other hand, drivers in more rural households have a greater desire

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15 The coefficients on the ln(HHY) cannot be used directly as an income elasticity because of the inclusion of a second income measure, % $75K+, in the equation. Accordingly, we approximated these elasticities two different ways. First we re-estimated the model using only ln(HHY). Second, we regressed the ln(HHY) on % $75K+ (R² of 0.88), multiplied that coefficient (34.65) times the coefficient for % $75K+ from these regressions, and added the result to the coefficient for ln(HHY). The alternatives provided coefficient estimates within 0.02 of each other.
for individual vehicles, purchasing fewer new vehicles in consequence.

Licensed Drivers

As might be expected, the number of licensed drivers per household exerts a strong influence in vehicular demand. Households increase vehicular ownership for all three of our measures in response to an increase in the number of licensed drivers. New vehicle purchases are most sensitive (1.56 elasticity, significant at the one percent level), followed by vehicular capital (0.47 elasticity, significant at one percent), and the total number of vehicles (0.18 elasticity and insignificant). In short, households purchase a disproportionate number of new vehicles among the additional vehicles they purchase as more drivers enter the household.

Age Distribution

The locality’s age profile tells an interesting and plausible story. Recall two points to put these results into context. First, the percent of the population aged 0–24 are included in the intercept, i.e., the remaining age coefficients must be interpreted relative to their impact on household vehicular decisions. We take this age cohort to consist largely of dependents of the household; that is, individuals who influence but do not make vehicular decisions. Second, we control for the number of licensed drivers in the household and, therefore, the age variables must be interpreted accordingly. With these in mind, consider the various age cohorts. The 25–34 age cohort is near the beginning of working lives and household formation, either as singles or as young couples. They purchase more new vehicles (3.9 percent rise for each percentage point increase in population share) but own fewer vehicles (1.4 percent drop), ceteris paribus, with no significant impact on vehicular capital. By contrast, 35–to–44–year–olds are the primary cohort with young children and nearly complete family sizes. They own more vehicular capital (1.7 percent more for each percentage point increase in population share) and more vehicles (2.0 percent rise), but purchase fewer new vehicles (3.1 percent decline) for their young family. Households in the 45–64 age bracket are typically at peak earnings and enjoy their highest discretionary earnings as their children leave the household. Unsurprisingly, they also own more vehicular capital (1.4 percent increase for each percentage point increase in population share) and more vehicles (1.7 percent rise), with no sacrifice in new vehicle purchases (1.1 percent rise, but insignificant in a two–tailed test). Lastly, the percent of the population of retirement age has no quantitative or statistical significance in any equation.

Insurance Rates

Finally, higher insurance costs are shown to discourage the ownership of vehicular capital with an elasticity of –0.2, significant at the one percent level. While negative, the coefficients for insurance rates are small and statistically insignificant for new vehicle purchases or the number of vehicles owned.

Robustness of the Key Results

Our key results with respect to the influence of the “car tax” and other controlling variables are reasonably robust to a number of possible qualifications to the data and the modeling effort. In this section we summarize several of those issues together with the sensitivity experiment we have performed to address them. Table 3 summarizes the effects of these alternative specifications by presenting for each experiment the tax rate coefficient and its t–value together with the deadweight loss of the tax implied by that coefficient for vehicular capital. The full set of regression results from these analyses is available on the Web at www.richmond.edu/~schmidt/2005ntj.pdf.
Tax Avoidance by "Gaming" the System

A potential exists for households in high-tax locales to reduce their exposure to this unpopular tax by registering their vehicles in low-tax localities. The effect of such tax avoidance would be to bias our tax rate coefficients upwards. An obvious trick would be to illegally register the vehicle in a friend’s or relative’s name in a lower-tax locality. Households run clear risks engaging in such a practice, and we have no way of determining the prevalence of such activity. On the other hand, we can and have tested for the impacts of three alternative possibilities, and find no impact on our basic results. Households that own a second home, say a vacation home, might very well choose to register one or more of their vehicles in the locale with the lower tax rate. To test this, we have added a variable that interacts the portion of housing units that are classified seasonal, recreational, or occasional use with the locale’s tax rate difference from Virginia’s highest tax rate. If tax avoidance through garaging is occurring on a wide scale, we expect to observe a statistically significant positive coefficient. We find no such evidence of garaging vehicles in low-tax localities to avoid taxation. The interaction terms are very small in magnitude (less than 0.002) and statistically insignificant, and as can be seen in Table 3, the tax rate coefficients are only slightly affected.

In a similar vein, military personnel may opt to register their vehicles in the locale in which they are stationed or in the locality of their permanent address, and households with college students might choose to register the student’s vehicle in the college locality. We tested for these influences by including census measures of the percent of the population in college and the percent of the adult population in the military. In all cases, these coefficients were quantitatively small (less than 0.005) and insignificant, and their inclusion changed other coefficients negligibly.

Further Considerations for Locales That Prorate Taxes

We have noted previously that both data and behavioral effects must be considered when mixing localities that pro-
rate taxes for vehicles owned only part of a year with those that solely tax vehicles garaged in the locality on January 1. We have tested the sensitivity of our results to two additional issues in this regard. The first is another data anomaly. If a vehicle’s garage address is moved from one locale to a second locale that prorates taxes, the vehicle and its value will be counted twice in the data set, both in the original locale and the subsequent locale. The 2000 Census provides data on the percentage of persons who lived in a different county in 1995. By interacting this measure of mobility with prorating locales, we test for evidence that this data anomaly affects the results of the basic model. Perhaps the combination of high taxes with high mobility due to federal government in northern Virginia locales bias our tax rate coefficients downward. The results from this sensitivity experiment find no such evidence. The mobility interaction terms are all quantitatively negligible (less than 0.002) and insignificant at the ten percent level.

Regressions on Nonprorating Subsample

We have run our model on all cities and counties in Virginia, pooling the 89 nonprorating and 45 prorating localities into a single sample. We have controlled for the impacts of prorating by including both a Prorate binary and its interaction with the tax rate. We have concentrated our analysis of the tax implications on the Tax Rate variable. That is, we believe the cleanest long–run interpretations for elasticity and burden of the tax is for a nonprorating locality when holding other influences constant. Some readers might prefer that analysis to have been performed directly on the 89 nonprorating locales. We have also done that. As can be seen in Table 3, the tax rate coefficient becomes quantitatively smaller in the subsample and remains significant in each regression (albeit with a drop to five percent significance in the Vehicles equation). The burden of the tax declines from 25 cents per dollar revenue in the pooled sample to 19 cents in the subsample.

Although not shown in Table 3, there are notable changes to both coefficient estimates and statistical significance for some of the control variables.Apparently differences exist between prorating and nonprorating localities that are not fully captured by the control variables in our model. It is instructive to note in this regard that prorating appears to be a phenomenon of the major population centers. Prorating localities cluster in the north around Washington DC, in the west around Roanoke and Lynchburg, in the central area around Richmond, and in the east in the Tidewater area. Indeed, although they comprise 34 percent of the localities, prorating locales include 71 percent of Virginia’s population. We think it important, therefore, to include their experience in our estimation sample. Having done that, however, we must also qualify our interpretation of both the Prorate binary and its interaction. In addition to the effects previously discussed, their coefficients will also include the effects of these unobserved differences. For that reason, we have downplayed their analysis.

SUMMARY AND CONCLUSION

Vehicle property taxes existed in 31 states in 1998. This study has applied an unusual data set to inform our understanding of vehicle ownership decisions and how they are affected by value–based taxes. The data set, originating from the implementation of tax relief in Virginia, combines locality–specific information on vehicular stocks (vehicular capital and the numbers of vehicles) and flows (new vehicle purchases) with socio–economic and demographic information covering identical jurisdictional boundaries. The result is a rich data set with remarkable
detail for this level of aggregation—134 cities and counties in Virginia. In particular, we exploited the variation in tax rates across locales while controlling for differences in income, population density, and other factors.

The picture that emerges is of households making plausible quantity–quality tradeoffs in meeting their transportation desires. That story is consistent across numerous control variables. By considering the three vehicular measures in concert, we observe that median income households sacrifice new and expensive vehicles while maintaining reasonably steady per–household vehicle ownership. By contrast, higher–income households own the same number of vehicles, but ones that are newer and of higher total value. Households in urban locales with shorter travel distances and more transportation alternatives own fewer vehicles, but of equivalent total value, than do households in rural localities. And households make different quantity–quality decisions during different eras of their life cycle—from early household formation to family formation to highest discretionary income and, finally, to retirement.

Rationality in household vehicular decisions extends to responses to vehicular personal property tax rates that vary across localities. Since these taxes are levied on value rather than numbers of vehicles, it is not surprising to find that property taxes on vehicles lower both vehicular capital and new vehicle purchases per household. And apparently taxes on vehicular value do not discourage car ownership since the tax rate coefficient is positive and significant for vehicle ownership per household. Households in high–tax localities substitute fewer high–value vehicles for more low–value, older vehicles. Our results imply that a one percentage point increase in the effective tax rate would result in a long–run, steady–state reduction of 5.2 percent in vehicular capital and 12.3 percent in new vehicle purchases, with a 5.5 percent rise in total vehicles owned per household.

From a policy standpoint, the results from this study provide one consideration and two notes of caution for legislators as they consider the elimination of a personal property tax on vehicular value. First, the personal property tax on vehicles, at the levels found in Virginia, appears to be approximately as inefficient as other state tax sources. Our estimates indicate the deadweight loss of the tax to be approximately 25 percent of the revenue raised at the average tax rate of 2.1 percent, with a range between 19 percent (non–prorate locales data subset) and 25 percent according to our sensitivity analysis. Furthermore, recall from public finance theory that the deadweight loss increases at the square of the rate of increase of the tax rate. Thus, for the highest observed effective tax rate of 3.5 percent, the deadweight loss rises to 42 percent. By comparison, estimates of the deadweight loss from real property taxes, general sales taxes, and income taxes range from 16 to 39 percent. It was beyond the scope of this research to identify if sensitivity to taxes on vehicular capital depends on income, in which case the deadweight cost of this revenue source might be lower for high–income households. Recall that this tax is regressive. If policy–makers decide this revenue source is necessary, they could balance the competing goals of equity and revenue requirements by limiting taxation to vehicle values in excess of specific levels.

Second, the cost of the tax relief cannot be estimated by a simple application of tax rates to an existing tax base or even to a tax base predicted to grow at the population growth rate. As noted above, every percentage point reduction in the tax rate implies a long–run 5.2 percent rise in vehicular capital per household. Realistic cost estimates of the tax relief program must reflect growth in the number of households as well as this rise in vehicular capital per household. (Conversely, legis-
lators must consider long–run declines in vehicular capital in estimating revenue gains from tax rate increases.)

Third, one irony of such state–mandated tax relief when combined with compensation to local governments is a disproportionate amount of local tax relief from state general funds for locales that had opted for high vehicular tax rates. In Virginia, for example, localities have several methods of taxation, including the real estate tax, the personal property tax (primarily on vehicles), a business tax, and add–ons to the general sales tax for restaurants and hotels. Imagine two non–prorating localities that are average in all respects except for their method for raising taxes. One places less emphasis on the car tax (employing the lowest observed rate of 0.15 percent) and a correspondingly greater emphasis on other methods. The other locality places a much greater emphasis on the car tax (employing the highest observed rate of 3.48 percent) and a lesser emphasis on alternatives. If the state reimbursed localities fully for lost revenue from the elimination of the car tax, taxpayers in the low–tax locality would be relieved immediately of about $0.66 million in local taxes, while its high–tax counterpart would be relieved of about $8.60 million initially. Recall that our model indicates that vehicular capital will grow with the elimination of this tax. Once this takes place, state relief of local tax bills will rise to only $0.67 million in the low–tax locality, but to $10.32 million in its high–tax equivalent. To the extent that localities with high car tax rates are also high–income (simple correlation of 0.47), the redistribution tends to favor high–income localities.

The policy implications for the environment of tax relief are less clear. On the one hand, our results indicate that tax relief would encourage new vehicle purchases without raising the overall number of vehicles. Presumably new vehicles with better emissions controls would replace older vehicles. On the other hand, recent trends in new vehicle purchases are toward larger, less fuel–efficient vehicles. Identifying the net impact on the environment is beyond the scope of our aggregated data set.

Finally, this study extends the literature on the economics of vehicle ownership in two aspects. First, our results indicate that personal property tax rates do affect vehicle ownership decisions. As a result, past research neglecting the sometimes large ownership costs caused by personal property taxes on vehicles may have produced biased estimates of the influence of variables correlated with the level of the tax. Second, many past income elasticity demand estimates either ignore the heterogeneity across vehicles or are not well–suited to answering the basic question of how income affects the stock of vehicles or vehicular capital.

Acknowledgments

We wish to thank the Virginia Department of Motor Vehicles for sharing data collected during the administration of the property tax reform in the Commonwealth of Virginia. Rebecca Bremer, Karen

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16 The anti–log of the product of the tax rate coefficient (−0.052) and the mean effective tax rate (2.075) provides an estimate of the ratio of vehicular capital in a locality with the average tax rate to a locality without the tax. Dividing mean vehicular capital ($13,207) by this ratio (0.897) indicates that the average locale would have had $14,722 of vehicular capital in 1998 in the absence of the car tax. (Note that this is also the number to which vehicular capital per household would grow in these two localities after the elimination of the car tax.) This number declines to $14,605 in the low–tax locale and to $12,269 in its high–tax counterpart when considering the impact of the car tax. Multiplying each of these values by the average number of households (19,690) and the locality’s own tax rate (this time without the adjustment for the impact of federal tax itemization for the average locality—0.231 and 3.562 percent, respectively) results in the values in the text.
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