

How Rational Are Consumers?
An Examination of Automobile Sales in Greater Saint Louis*

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Abstract

The concept of modeling consumer rationality in behavior is at the heart of any microeconomics textbook, lecture, or research. This study presents an empirical investigation into the rational choices made by automobile consumers by utilizing data on a relatively homogenous population in the Saint Louis metropolitan area to discern differences across purchasing choices when a portion of that population is subjected to a tax while the remainder is completely exempt. The results indicate that the presence of this tax nearly doubles the typical downward trend in sales each winter.

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1. Introduction

In 1950's, the city of Saint Louis reached a peak population of nearly 900,000 people, making it the eighth-most populous city in the United States. Since then the population has dropped to fewer than 320,000 according to the 2010 US Census. At first, most of the population that had left the city moved Westward to the emerging suburban neighborhoods in the outlying region, however, more recently there has been a lot of growth in the Eastern neighborhoods as well, nicknamed Metro East. While the population of Metro East is about half of the population of the suburban Western metropolitan area, it contains some of the fastest growing towns in the region, and has grown much more diverse over the last decade (Doug Moore, 2011). Today, the nearly three-million-person Greater Saint Louis metropolitan area is comprised of fifteen counties and one city-county spread relatively evenly around the Mississippi River in the states of Illinois and Missouri.¹ Due to this suburban dispersion, Saint Louis features a webbing of major US highways, including four national interstates and three regional interstates. However, among other major metropolitan areas, Greater Saint Louis consistently ranks among the lowest in terms of public transportation use and accessibility; hence for working families, cars are essential.

Residents of the regional Missouri counties are subject to a personal property tax which applies to any vehicles they own that are registered in the state of Missouri. No such tax exists for residents of the Illinois counties in the region. Traditional economic theory (i.e. the Life Cycle Hypothesis or LCH) states that unless consumers are liquidity-constrained, and expect to be unconstrained in the future, changes in tax policy will be ineffective in changing consumption

¹ For the purposes of this study, only the core metropolitan area will be examined which excludes the four most rural counties in the region. Note that the core region comprises nearly 97% of the overall population and covers Franklin, Jefferson, Lincoln, St. Charles, St. Louis, St. Louis City, and Warren Counties in Missouri, and Clinton, Jersey, Madison, Monroe, and St. Clair Counties in Illinois.

behavior (Albert Ando and Franco Modigliani, 1963). John Y. Campbell and N. Gregory Mankiw (1989) showed that changes in disposable income will be dealt with rationally, with consumers dedicating a percentage of any income increase or decrease towards a similar change in consumption. Similarly, Matthew D. Shapiro and Joel Slemrod (1995) examined President George H.W. Bush's reduction of the federal withholding rates in 1992 to indicate that even unconstrained consumers will spend a tax cut quickly. One can use their same methodology to see similar results under President Obama's 2009 withholding rate reductions. Essentially, when given additional income, people will spend more, and likewise, when a tax is levied causing disposable income to decrease, people will spend less.

Therefore, according to the LCH and subsequent studies, one would suspect there to be a difference in the purchasing habits of Greater Saint Louis residents on either side of the Mississippi River, because the presence of the personal property tax represents a permanent shift downward in disposable income for the Missouri residents. This study examines the impact of this personal property tax on the consumption habits of consumers across the metropolitan area, using sales reported by automobile dealerships in the Eastern counties as the control group, and sales reported by dealerships in the Western counties as the treatment group to assess the impact that eliminating the personal property tax currently has on automobile purchases in the Missouri-side of Greater Saint Louis.

2. Background on the Personal Property Tax

Whereas income taxes are 5% in Illinois and 6% in Missouri, and sales taxes range around 7% to 8% across the entire region; the main difference in taxation across the two sets of counties comes from property taxes. Personal property is not taxed in Illinois, but it is taxed in

Missouri. Missouri residents are taxed on the assessed value of all vehicles they owned as of January 1st of each tax year. The personal property tax rate is assessed on 33 1/3% of the value of a vehicle. The tax rate is a combination of a 0.03% state tax plus local taxes which sum to an average tax rate of 6.45%. Thus, the effective tax rate averages 2.15% of the full value of the vehicle. Table 1 lists the various rates across each of the seven Missouri counties included in this study, with data obtained from the St. Louis Regional Chamber & Growth Association:²

Table 1: Personal Property Taxes in Selected Missouri Counties

County	Nominal Rate	Effective Rate
Franklin County	5.7529%	1.9176%
Jefferson County	6.9741%	2.3247%
Lincoln County	5.9111%	1.9704%
St. Charles County	6.3787%	2.1262%
St. Louis County	7.4861%	2.4954%
St. Louis City County	6.9187%	2.3062%
Warren County	5.7446%	1.9149%
Average County	6.4523%	2.1508%

For example, suppose an individual decides to purchase a new vehicle worth \$20,000 to replace a current vehicle valued at \$10,000. Should that individual make the purchase prior to January 1st, the vehicle will be subject to a tax burden of \$430.15 in an average Missouri county. On the other hand, should the consumer hold onto the \$10,000 vehicle until January 2nd, the tax burden for that year will be \$215.08. In each case, the new vehicle will be treated as a one-year old vehicle the following year and thus will face the same tax burden from that point onward. The overall difference in taxation is felt immediately; and in this example would be a savings of \$215.07, or just over 1.075% of the purchase price of the vehicle (or one-half of the 2.15% effective rate without a trade-in vehicle).

² St. Louis Regional Chamber & Growth Association, <http://www.stlrcga.org>.

One of the dealerships included in this study reported under anonymity that they have occasionally had to provide additional price cuts above and beyond the manufacturer suggested incentives and promotions to consumers in December who are interested in a vehicle but request for that vehicle to be held until January in order to meet their monthly sales quotas which is something they almost never are able to do. They went on to indicate that expectations for sales in December are often far lower than in the rest of the year regardless of the incentive package being offered.

3. Data

The data utilized in this study are monthly and comprise measures of vehicle sales, employment levels, and unemployment rates in each of the twelve counties of the sample. Table 2 lists the descriptive statistics of this data in total and by state:

Table 2: Descriptive Statistics for Greater Saint Louis (2006-2010)

	n*t	Mean	Standard Deviation
Unemployment Rate			
Total:	604	7.0720	2.4833
Missouri:	364	7.3890	2.7293
Illinois:	240	6.5913	1.9648
Total Car Sales per 1,000 Workers			
Total:	604	26.2605	6.9761
Missouri:	364	24.2603	7.6150
Illinois:	240	29.2942	4.4016
New Car Sales per 1,000 Workers			
Total:	604	18.3728	5.3704
Missouri:	364	15.8252	4.6367
Illinois:	240	22.2365	3.9037
Used Car Sales per 1,000 Workers			
Total:	604	7.8878	3.3072
Missouri:	364	8.4351	3.8878
Illinois:	240	7.0577	1.8684

As can be seen, the Illinois counties have a lower mean unemployment rate and a tighter distribution. Likewise, when controlled for the number of workers in each county, in the Illinois counties workers purchase more new cars than in the Missouri counties. In the Missouri counties, more used cars are sold, but the overall totals still lean toward the workers in the Illinois counties.

County-level vehicle sales data are collected by the department of revenue of each state when the dealerships report sales numbers and taxable values at the end of each month. Sales data for the Illinois counties run from January 2006 through December 2009, and for the Missouri counties, the data run from January 2006 through April 2010.

Furthermore, since the lack of public transportation in the Greater Saint Louis region implies that workers must have a personal vehicle, it is important to consider data from the labor market as well.³ Unfortunately, corresponding wage data was not available monthly, and was thus passed over for unemployment data as the labor market measure. The unemployment data were obtained from the Bureau of Labor Statistics: Local Area Unemployment Statistics⁴ (LAU) spanning those same periods of time.

Finally, employment values were taken from the Current Population Survey⁵ (CPS) to control for the size of consumer base in each county. Employment numbers were chosen rather than the number of households, because in an area with poor public transportation, such as in Greater Saint Louis, each worker of the household will have a need for a vehicle.

³ Greater Saint Louis consistently ranks at the bottom of comparable sized regions in terms of accessibility and usage of its public transportation system, which consists of bussing and light rail. The light rail system, MetroLink, has two lines covering 46 miles of track and transport an average of roughly 60,000 passengers per day (just over 2% of the regional population) within St. Louis County and St. Louis City County in Missouri, and St. Clair County in Illinois.

⁴ Bureau of Labor Statistics: Local Area Unemployment Statistics, <http://www.bls.gov/lau/>.

⁵ Current Population Survey, <http://www.bls.gov/cps/>.

4. Econometric Model

In order to estimate the impact of the personal property tax on consumer behavior in the automobile market, we must first consider that each individual county in the sample will have unique features about it that are time invariant, and it is important to consider these characteristics in any econometric approach. This study, therefore, will utilize a fixed effects technique to isolate and control for such characteristics. Furthermore, I will account for clustering of the standard errors within each county using cluster-robust standard errors. When estimated, the model will be used for three independent measures of sales: new, used, and total sales. Thus the model takes the following form:

$$\ln TS_{it} = \alpha_i + \beta_1 U_{it} + \beta_2 (\tau_i * Dec) + \beta_3 (\tau_i * Jan) + \beta_4 Dec + \beta_5 Jan \quad (1)$$

$$\ln NS_{it} = \alpha_i + \beta_1 U_{it} + \beta_2 (\tau_i * Dec) + \beta_3 (\tau_i * Jan) + \beta_4 Dec + \beta_5 Jan \quad (2)$$

$$\ln US_{it} = \alpha_i + \beta_1 U_{it} + \beta_2 (\tau_i * Dec) + \beta_3 (\tau_i * Jan) + \beta_4 Dec + \beta_5 Jan \quad (3)$$

TS , NS , and US reflect total car sales, new car sales, and used car sales respectively. Each measure is taken as the natural logarithm of sales per 1,000 workers in county i in time t . α reflects the county-specific fixed effects (such as the presence of the underutilized MetroLink in certain counties) that will be controlled for in the fixed effects estimation. U is the unemployment rate in county i in time t . τ is a dummy variable that takes a value of one if county i has a personal property tax on vehicles, and zero otherwise. In the fixed effects estimation, τ is interacted with a dummy variable for December and January such that the interaction takes a value of one in each specific month (e.g. December) only for counties that

have a personal property tax. Finally to capture any seasonal effects, dummy variables are also included for December and January to account for the general downward trend in car sales each winter.⁶ These factors take a value of one in each specific month regardless of the county.

Examining the theoretical expectations of each of these factors, one should expect to see negative coefficient for β_1 . Higher unemployment rates reduce the number of workers in a county, thereby reducing the need for additional vehicle purchases. And counties with an annual personal property tax in place on vehicles should feature fewer new sales, particularly in December, so β_2 should be negative. Likewise, if a rebound in purchases happens in January due to prospective buyers waiting until January to lower their tax burden, β_3 should be positive. Furthermore, as the time series graphs in the appendix indicate, there is a general trend in the market for sales to slowly increase until the end of the summer and then quickly fall off towards the end of the year, so we should expect to see negative values for the coefficients of the two winter months that are included in the model. Finally, note that while consumers can purchase a vehicle at any dealership even outside of the region, sales taxes and personal property taxes are assessed based upon their home address. Due to this, the study assumes that buyers will behave rationally and will make their vehicle purchase close to home. This is especially true given that few, if any, dealerships offer promotions above and beyond the manufacturer's incentives, except due to local circumstances like the anonymous report from the dealership mentioned earlier in this study.

5. Estimation Results

The results of the estimation for each of the three categories of car sales can be seen in Table 3 below. The coefficients of the interactions can be interpreted as the marginal difference

⁶ See the appendix for time series graphs illustrating the presence of time trends.

in county-level sales brought on by the presence of the personal property tax relative to the county-level sales in tax-free counties.

Table 3: Fixed Effects Regression of the Impact of a Personal Property Tax on County-Level Vehicle Sales

Coefficient:	ln(Total/1000WRs)	ln(New/1000WRs)	ln(Used/1000WRs)
Unemployment Rate			
<i>Coefficient:</i>	-0.0376***	-0.0242***	-0.0691***
<i>RSE:</i>	(0.0052)	(0.0057)	(0.0053)
Tax-Dec Interaction			
<i>Coefficient:</i>	-0.1294***	-0.1185***	-0.2005***
<i>RSE:</i>	(0.0256)	(0.0328)	(0.0560)
Tax-Jan Interaction			
<i>Coefficient:</i>	0.0108	0.0370	-0.0246
<i>RSE:</i>	(0.0211)	(0.0265)	(0.0405)
December Dummy			
<i>Coefficient:</i>	-0.1826***	-0.2238***	-0.0498
<i>RSE:</i>	(0.0208)	(0.0241)	(0.0334)
January Dummy			
<i>Coefficient:</i>	-0.0272*	-0.0133	-0.0763***
<i>RSE:</i>	(0.0145)	(0.0203)	(0.0177)
R²	.4094	.3471	.3913
F	171.53	114.87	55.36
n: groups	604: 12	604: 12	604: 12

Note: *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level

As the results indicate, the tax has a significant impact on sales of both new and used cars. The overall marginal impact of the personal property taxes on vehicles is a 12.94% average decline in sales relative to the average county that is not taxed. In combination with the downward trend felt region-wide, counties with a tax can expect the number of cars sold in December to be, on average, 31.2% lower than in the average month. Furthermore, while one would suspect that sales pick up in January following the December decline, the positive coefficient for β_3 is not statistically significant, so it appears that sales in January are not statistically different across the region. With that said, relative to December, sales in January are much closer to the average month, coming in at just 2.7% lower on average. Thus it appears that even though sales fall dramatically in December, sales are not offset by a similarly large gain in

January. Finally, as expected, the unemployment rate appears to negatively impact the automobile market. Each 1% increase in county-level unemployment will decrease sales by 3.76% on average.

An examination of the market for new cars shows similar results. The marginal impact of the tax in December is 11.85% for an overall decline in those counties of 34.23% on average which is slightly greater than in the overall market. On the other hand, new car sales in January are no different than in any other month for either set of counties, which implies a slightly better trend than in the overall market. Finally, among used cars, sales typically decline just over 20% on average in December. Unlike the new car market, this entire decline is brought on by the presence of the personal property tax. Also of interest for the used car market is that the unemployment rate appears to play a much more significant role in sales. As the unemployment rate increases by 1%, new car sales fall by 2.42% on average. But in the used car market, sales will fall 6.91% on average. Thus demand appears to be much more elastic relative to labor market trends for used cars than for new cars.

6. Conclusion

Greater Saint Louis presents an interesting case study on the impact of specialized taxation on a target market. Half of the region geographically, and two-thirds of the population, are subject to a relatively substantial annual personal property tax on vehicle purchases. According to dealerships in the region, prospective buyers may defer purchases to reduce their tax burden, particularly at the end of the year. Such actions can reduce the true-purchase price of the vehicle by 2.15% without a trade-in vehicle or 1.075% following the trade of a vehicle worth 50% of the purchase price.

Using a fixed effects model, this study shows that sales in December are indeed hindered by the presence of this tax. Typically, winter months bring about a decline in sales relative to the rest of the year, and the tax exacerbates this downturn by directly accounting for a 12%-20% additional drop in sales. In terms of the impact on the automobile market, this drop is equivalent to a 4% increase in the unemployment rate. Furthermore, the estimation does not suggest that the market will rebound any faster in counties that face the tax relative to counties that do not. Thus while sales in January are relatively higher than in December, there is little reason to believe the anecdote among Greater Saint Louis dealerships that buyers will simply wait until the new year to make their purchases.

The policy implications are two-fold. On the public-side, local governments that use this personal property tax to fund schools, roads, police and fire departments, and other projects may find that they would be able to raise tax revenues more effectively through another means. Given that in the average month, in the average county in this sample, nearly 3,500 cars are sold, the decline attributable to the tax reduces sales in December by 13%, or 455 cars. An 8% sales tax on those 455 cars would yield a greater amount of tax revenue to the government than the 1.075% average yield from the personal property tax on the remaining 3,045 cars. On the private-side, automobile dealerships on the Missouri-side of the region would have already faced a major downturn each winter regardless of the tax. But with the tax nearly doubling the average December slowdown, dealerships are hit especially hard by this tax; and even with some dealerships offering tax-oriented promotions to prospective consumers, they can still expect revenues to hit annual lows.

Above all else, given the recent migration into Metro East, Missouri may also want to consider the overall satisfaction and preferences of its taxpayers and the retention of businesses

that may also move out of the impacted counties. Some other unanticipated consequences also include an increased inventory cost for dealerships, the loss of performance-related manufacturer incentives (which are generally attached to monthly sales volume), a potential employment reduction in terms of salespeople, and of course, a decrease in funding for local services as tax revenue drops. Hence, if local governments eliminate the personal property tax on cars, one would suspect that revenues would be up for both dealerships and the county-level government agencies, creating a win-win net effect for the local economy.

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Appendix

