Understanding the heterogeneous effects of gasoline taxes across income and location

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ABSTRACT

Using confidential household-level data, we estimate spatial and demographic heterogeneity in household-level gasoline price elasticities and gasoline tax burdens from a 60-cent federal gasoline tax increase. In order to address unobserved consumer heterogeneity, we employ a parametric adaptation of the maximum score methodology to model the household’s choice of vehicles and driving decisions, allowing for disaggregated vehicle choices, vehicle-specific fixed effects, and interactions among the multiple vehicles in each household. We estimate average price elasticities of demand for gasoline at −0.74, with significant heterogeneity across space and demographics. We also find that rural and poor households bear the greater share of the burden from increasing taxes. Finally, we suggest a revenue recycling policy that helps mitigate the gasoline tax’s resulting economic inequalities across household location and income. In addition, a gasoline tax is an effective policy for reducing the externalities associated with driving, our policy also allows the government to retain some revenue from the tax even after the revenue recycling.

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1. Introduction

Gasoline consumption by households accounts for at least 17 percent of total greenhouse gas emissions in the United States (U.S. EPA, 2011). Additionally, about 49 percent of all petroleum consumed in the United States comes from foreign sources (U.S. EIA, 2011a,b). Given the threats of air pollution, climate change, and political instability in countries that provide foreign oil, policy makers have struggled with how to reduce gasoline consumption. Economists tend to focus on gasoline taxes as an optimal solution to the externalities associated with driving, with the added benefit of providing revenue for the government. 1 However, there is evidence that policymakers are concerned with the economic burden that increased taxes may place on their constituent households (Knight, 2004). Previous studies also suggest that increases in gasoline taxes are fully passed along to consumers (Marion and Muehlegger, 2011). Thus, in order to get policymakers to implement a gasoline tax and reduce gasoline pollution by decreasing its demand, it is important to understand the heterogeneity in economic impact on households from higher gasoline prices. For example, certain segments of the population (such as low income or rural households) may be especially burdened by the higher taxes. Partridge et al. (2010) found that the ability of rural

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1 Gasoline taxes provide the major source of transportation funding in the United States.

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households to integrate into urban areas through commuting depends upon their distance to urban centers, demonstrating the importance of accounting for within-region heterogeneity of gasoline tax impacts. This article seeks to identify the diverse impacts of gasoline taxes by estimating the household-level price elasticities of gasoline demand and the economic burden imposed by higher taxes. It also proposes a potential policy solution to minimize the distributional effects.

In general, gasoline taxes reduce the amount of vehicle miles traveled (VMT) and gasoline consumed mainly through the price effect. More importantly, they impose less of a burden on consumers than alternative policies aimed at reducing gasoline consumption, such as increasing Corporate Average Fuel Economy (CAFE) standards (Jacobsen, 2013),2 a policy which can also produce a rebound effect (see Moshiri and Kamil, 2017). However, unlike some other taxes, a household can mitigate the negative impacts of gasoline taxes by adapting its driving behavior. The ability to adapt, and overall sensitivity to gasoline prices, may depend on household structure (Bento et al., 2009; Schmalensee and Stoker, 1999; Davis, 2008; Nicol, 2003), income (Gillingham, 2011b; Moshiri and Kamil, 2017; Santos and Catchesides, 2005), vehicle ownership (Berkowitz et al., 1990; Feng et al., 2013; Spiller, 2011; Wadud et al., 2010; Gillingham, 2011b), or other factors that affect the ability of the household to substitute away from driving such as access to public transit or where the household lives (Goldberg, 1998; Schmalensee and Stoker, 1999; Gillingham, 2011a,b; Tiezzi and Verde, 2016; Santos and Catchesides, 2005). There has been extensive research demonstrating the need to account for regional and distributional heterogeneity in economic outcomes when conducting policy analysis (e.g. Paehlke, 1989; Carneiro et al., 2002; Ferguson et al., 2007; Partridge et al., 2008a; Porter, 2003). However, in estimating price elasticities, much of the previous literature has relied on regional-level data or aggregated individual or household data into regional or demographic groups.

The heterogeneity in household characteristics, location, and vehicle ownership that result in diverse elasticity estimates and driving patterns across households can also lead to differences in the economic burdens of new gasoline taxes. For example, previous research found that environmental taxes (such as gasoline taxes) may especially burden the poor (Cremera et al., 2003). Using state-level data, Krupnick et al. (1993) considered the impact of a 43-cent federal gasoline tax increase and estimated that rural households would be more affected by the tax increase than urban and suburban households, especially because these households tend to drive more. Filippini and Heimsch (2016) considered the impact of a CO2 tax on gasoline demand in Switzerland, using data on municipalities in Switzerland, and found that the burden of the tax is greater for rural households than for their urban counterparts. Additionally, Nikodinoska and Schröder (2016) found that gasoline taxes not only affect demand but also household budgets; thus, the impact will be higher for households for whom gasoline comprises a large portion of their budget, and these may be the households that can least afford that burden.

Our article contributes to the literature by using household-level data — including demographic information and observed vehicle purchasing and use behavior — and incorporating significant heterogeneity, both within and across different regions, into the estimation of individual-level gasoline price elasticities. Using these results, we are then able to analyze the regional and distributional impacts of higher gasoline taxes at a disaggregated level.

The model we employ allows us to calculate the elasticity of demand for gasoline for each household in our dataset, accounting for both how much the household drives (the intensive margin) and what types of vehicles it owns (the extensive margin). We use confidential household-level data from the 2009 National Household Travel Survey (NHTS)3 and other detailed, geographically defined data to account for how far a household lives from a metropolitan area; we also account for the local cost of living. We exploit the heterogeneity in gasoline prices across time and space during the period of the survey in 2008 and 2009. After estimating household-level gasoline price elasticities, we investigate how the burden of higher gasoline taxes varies with different household characteristics, including location and income.

We utilize a novel method of estimating elasticities of demand for gasoline that allows the researcher to avoid many assumptions on household behavior that are usually employed in the literature such as: aggregation of the choice set; ignoring that households substitute between the vehicles they own; and not including vehicle-specific fixed effects. These modeling assumptions restrict the ability of the researcher to capture more subtle changes in consumer behavior, which can cause an underestimation of the elasticity of demand for gasoline and impact estimates of the burdens from higher gasoline taxes. We use a maximum likelihood technique developed in Spiller (2011) which is extended here to allow for greater heterogeneity across various household characteristics.

We find significant heterogeneity across households in terms of sensitivity to gasoline prices. The elasticity estimates vary widely depending on household characteristics. For example, richer households and households with more than one vehicle are much more sensitive to gasoline prices than are poorer households with only one vehicle. We also find substantial heterogeneity in terms of location — where elasticities vary widely by the distance to urban centers and region. When we consider a possible gasoline tax, we find that, though taxes can be very effective in reducing driving, GHG emissions and air pollution, they can impact certain regions and disadvantaged populations more than others. In fact, in some cases, those with more elastic demand still pay more of the tax increase. We thus propose a revenue-recycling mechanism that the government can use to mitigate the negative distributional effects associated with a gasoline tax.

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2 However, there is some evidence that some of the costs imposed by CAFE standards are lower when analyzed over a longer time frame (Klier and Linn, 2012).

3 The NHTS 2009 dataset is, to date, the most recent dataset available from this survey.
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