The Effect of Environmental Taxes on Car Prices, Purchases and Mileage*

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Abstract

In an effort to reduce overall emissions of carbon and other pollutants, Israel implemented a major tax reform in 2009 intended to encourage consumption of less polluting automobiles. Under the reform, import taxes on vehicles are now based on the particular vehicle’s score on a pollution index, with less polluting cars taxes proportionately less and more polluting cars taxed proportionately higher. Using databases covering all car sales in Israel since 2000, along with their pollution ranking and yearly odometer readings, we find that the green tax did cause a significant shift in car purchases towards less polluting ones. However, some of the environmental gains appear to be offset by the facts that the reform brought about an increase in the overall amount of cars on the road and that newer, albeit more efficient cars were, on average, driven more than older cars.

Keywords: green taxation, automobiles, pollution, tax incidence†

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1 Introduction

Transportation is responsible for roughly 30% of total energy consumption, and nearly a quarter of global greenhouse gas emissions (Atabani, et al. 2011; Yevdokimov, 2010), as well as substantial amounts of local air pollutants with severe consequences for public health (EU, 2003; OECD, 2014). Without changes in either technology and/or transportation policy, vehicle pollution is likely to become even more severe, as the number of active vehicles is projected to increase from 700 million in 2000 to 2 billion by 2040 (Smith, 2016). Although a significant element of much transportation policy has been promoting alternatives to private transportation, such as public transit and motorized-transportation (e.g., bike lanes), serious attempts to curb transportation pollution must focus on private vehicles, given their pervasiveness.

Policymakers have used a range of both command and control and market mechanisms to address transportation-related pollution issues. Pigouvian taxes and subsidies have long been a suggested policy for achieving efficient social outcomes in the case of vehicle emissions (e.g. Patterson et al 2005; Parry et al 2007; Sterner 2006). In addition to sending proper price signals to consumers and achieving environmental benefits, environmental taxes may provide other benefits, such as implementing the “polluter pays” principle, or allowing for a reduction in other taxes (e.g., on income), thereby reducing deadweight loss in those markets (Goulder 1995; Parry and Benton 2000; Jaeger 2011). Ideally, an efficient Pigouvian tax would be directly tied to the damage caused by emissions; however, a policy that requires the measurement of the emissions of each vehicle are challenging to implement, cost ineffective, and would only indirectly measure damages. Ensuring that Pigouvian taxes are tailored to the exact source of the externality is vital, as studies have shown that poorly-planned vehicle taxes can exacerbate environmental damages (Adamou, Clerides, and Zachariadis 2012). Given these challenges, governments are left to choose from several second-best options, including fuel taxes, vehicle taxes, traffic congestion fees, and fees on mileage driven (OECD, 1995). In addition, many governments also implement subsidies for more efficient
vehicles, such as electric and hybrid vehicles, or those using liquefied natural gas (e.g., Beresteanu and Li 2011; Gallagher and Muehlegger. 2011; Sallee 2011).

Several studies have found that fuel or mileage taxes are more efficient than taxes on vehicles, engine size, or installation of pollution control equipment (Fullerton, 2002; Portney et al. 2003). In practice, however, governments tend to use a combination of such market-based policies and non-market-based policies, such as mandatory fuel efficiency standards or information campaigns. Fuel efficiency standards are a popular policy in many countries (see (Atabani, et al. 2011, for a review), but have been criticized because consumers often undervalue the long-term benefits of fuel savings (US EPA, 2010), and because at least some of the reduction in fuel consumption due to increased fuel efficiency may be offset by increased usage, a phenomenon commonly referred to as a rebound effect (Dimitropoulos, et al. 2016). While a large literature exists on the effects of information campaigns on energy consumption, relatively little of that addresses vehicle purchase and usage.

In this study, we examine the effects of a tax reform implemented in Israel, designed to encourage purchase of fuel efficient vehicles. First implemented in August 2009, Israeli’s green tax is a progressive import tax based on a vehicle’s overall “green grade” – a pollution emissions rating closely related to fuel efficiency. Unlike most other OECD countries that base their vehicle taxes on reducing carbon emissions, Israel calculated its tax rates based on all relevant and measurable emissions from cars, weighted by their relative social costs. The green grade formula was first updated in August 2013, and is adjusted every two years beginning in January 2015. We use administrative data from the Israeli tax authority on all car purchases in Israel between 2000 and 2015, and on private vehicle utilization from annually required vehicle licensing tests during that same period. This work seeks to estimate the effect of Israel’s green tax on the composition of vehicle purchases and the net environment effects of the tax. Because Green scores were required to be posted on all cars beginning in early 2009, we can use the period between January and July 2009 to differentiate between the increased salience of how polluting a car is and the price effect of the associated tax.
2 Literature

Vehicle fuel efficiency has implications for both the consumer, in terms of long-term expenditures, as well as to society at large, in terms of external pollution costs. Therefore, potential consumers may face multiple incentives, both private and public, to account for fuel efficiency in vehicle purchases and usage. Regarding private incentives, several studies have attempted to identify the effect of fuel prices and fuel efficiency ratings on car purchases (e.g., OECD 2007; Turrentine and Kurani 2007; Clerides and Zachariadis 2008; Litman 2008; Busee et al 2009; Green 2010; Klier and Linn 2010). Helfand and Wolverton (2009) and EPA (2010) provide reviews of this literature. The latter find that roughly half of consumers significantly undervalued future fuel consumption in their purchasing decisions, while half either approximately fully valued or significantly over-value them.

Alberini et al (2016) examine a Swiss fuel efficiency labeling program and found a price premium higher-ranked cars. They also find, however, that the price premium for the highest-ranked grouping relative to the next highest rating, was substantial (6-11%), despite relatively small differences in actual fuel efficiency. As much of the behavioral economics literature supports, this indicates that consumers may take informational cues into consideration more than utility-maximization when making car purchases.

In order to internalize the public goods aspect of fuel efficiency, several countries have implemented some form of Pigouvian taxes on vehicles. Bartocci and Pisani (2013) provide theoretical support for the economic efficiency of such taxes using a general equilibrium model based on European data across four countries. In terms of empirical studies, Ryan et al.(2009) examine carbon emission-related fees on CO2 on car sales and find carbon-differentiated taxes to be preferable to registration taxes in terms of incentivizing fuel efficiency. Both Rogan et al. (2011) and Henessy and Tol (2011) find that a carbon-based vehicle tax in Ireland shifted car purchases and ownership from diesel to petrol cars, resulting in lower levels of CO2, but higher local-levels pollution. The latter, however, proposes that much of the potential carbon emissions reductions were offset by rebound effects, i.e., increased usage of vehicles.
Three primary factors have been put forth to explain rebound effects. The first is a direct price effect, whereby the improvements in technical efficiency reduce usage costs and lead to increased consumption. The second is an indirect income effect. As the cost of usage decreases, disposable income increases and some of this income can be used to consume more of the good in question. Finally, some researchers have identified structural or macro-level rebound effects, emanating from changing demand, production, and distribution patterns (see Greening et al. (2000) and Turner et al. (2013) for a review of rebound effects for energy consumption).

Several studies have attempted to estimate rebound effects in transportation in general and vehicle use, specifically (e.g., Small and Van Dender 2007a and 2007b; Sorell 2009; Sorell et al 2009; Hymel et al 2010; Litman 2010; Litman, 2013; Steren, 2016). A wide range of estimates are identified. While some studies find relatively small rebound effects (e.g., Litman, 2013), a meta-analysis finds that they can be substantial, with direct effects averaging 12% in the short-run and 32% in the long-run (Dimitropoulos, et al., 2016). Such effects have the result of substantially reducing the pollution reduction outcomes of increased efficiency standards.

3 Israel’s Green Tax

Vehicle import taxes in Israel have historically been among the highest in developed economies. As of 2005, the effective purchase tax was 95% of car value, only surpassed by Denmark among OECD countries. These high tax rates corresponded with low motorization levels and a high proportion of older cars. In 2006, the vehicle ownership rate was 0.38 per capita (CBS 2016), below that of most OECD countries, but because Israel is a small and densely populated country, its rate of vehicle density (measured as vehicles per kilometer of road) was among the highest (OECD, 2016). The associated pollution represents a substantial

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1 There are some minor adjustments made for engine size and other attributes. It should be noted that the car tax is in addition to significant fuel taxes, which are among the highest among OECD countries (OECD 2011).
national public health threat, environmental hazard, and economic burden. Air pollution, especially from transportation, was estimated to cause 2,500 deaths (Israeli Ministry of Environmental Protection, 2017), and as of 2009, transportation contributed 26% of national carbon emissions (McKinsey, 2009). External costs of private vehicle usage were estimated to be 6% of GDP in 2004 (OECD, 2016).

The tax treatment of vehicles has changed significantly since 2005. In an effort to become more aligned with OECD countries and to encourage the replacement of older vehicles in service, a tax reform was implemented in December 2005 to gradually reduce taxes to 72% by 2010. It was recognized that the effect of a tax reduction, however, would aggravate pollution by encouraging more car purchases. In 2006, a commission was established to study policy options to address the external costs of road transportation, and in January 2008, the recommendations of a Green Tax Committee were approved to establish an import tax based on the vehicle’s pollution potential, and these taxes were implemented in August of that year.

Israel’s Green Tax went further than most other countries that implemented carbon taxes on vehicles. Rather than focusing on only carbon emissions, the tax rate was instead based on a car’s overall pollution potential. Under the reform, each car is assigned a “green grade” based on all measurable pollutants, including several local air pollutants: carbon monoxide, nitrogen oxides, hydrocarbons, particulate matter, and carbon dioxide. The green grades range from 1 to 15, with a higher score indicating higher pollution potential. In August 2009, the basis for the vehicle import tax was 83% of the pre-tax value of the car, and rebates to adjust effective tax rates downward depending on the green grade: the resulting rates ranged from 10% to 83%. Because import taxes represent a significant portion of most vehicle sticker prices, the policy reform may have a substantial impact in the type of vehicles purchased.

To prepare for the implementation of the new Green Tax, car manufacturers were required to report the emission levels on all vehicles. Green scores of each car was posted at all points
of sale beginning in early 2009, so information on the polluting potential of cars was available to consumers, in principle. After the green tax was implemented, green scores continue to be posted, but only after-tax prices are reported. As a result, it is unclear whether the relationship between green scores and import tax rates are salient to consumers.

Initial indications are that the tax reform has indeed changed purchasing behavior: there has been a proportionately higher increase in low-polluting vehicles, and the average pollution score for cars purchased declined by over 12% between 2009 and the end of 2011 (Bankrate, 2013). Figure 2 shows that average green score has been declining since 2008, though began to tick up in 2013. This is not due, however, to an increase in the sales of more polluting cars, but, rather, due to the shift in the adjusted green score schedule. For the same pollution outputs (level of CO2, for example), each update in the green score schedule raised the green score that the automobile received. For example, a BMW 640I sold in 2012 had a green score equal to 9, applying he 2013 schedule retroactively, this same car would have received a 13 and using the 2015 schedule, it would have received a 14. Holding constant anyone of the green score schedules shows a declining green score for the average car being sold.

The actual impacts of the tax reform are, however, not straightforward for a number of reasons. There are several factors other than the reform itself that occurred concomitantly that also can affect vehicle purchases, such as changes in disposable income, the global financial crisis, and fluctuations in the price of fuel. In addition, the Israeli automobile market is only semi-competitive because there is a single importer per vehicle manufacturer. While there is competition across manufacturers, the limited competition may allow importers to capture economic rents on vehicles sold or cross-subsidize between models, especially to the extent that brand loyalty plays a role in vehicle purchases, a phenomenon well-documented in the literature (e.g., Kressman et al 2011). There is some anecdotal evidence that this may be occurring (Horowitz 2012). The vehicle pollution score is another dimension on which dealers potentially compete, so automobiles with high scores may compensate consumers along the
price dimension. This is consistent with existing literature that has documented retailers' willingness to change prices in response to consumer concerns over fuel costs (e.g., Langer and Miller 2013). The Israel car market is small, and has no domestic car manufacturing capacity, so there is no expected response of manufacturers to the Green Tax.

Although the Green Tax reform was meant to be revenue-neutral, tax collections initially saw a sharp increase due to increased sales, followed by a steep reduction as consumers shifted to cheaper vehicles. Between 2008 and 2012, total revenues fell by 13% while imports increased by 7.6% (OECD 2016). In part due to this decline, the formula for calculating green tax rates was revised in August 2013, generally shifting all grades upwards and affecting diesel cars by relatively more than petrol cars. It was determined that the green tax formula would be re-evaluated and updated every two years, beginning in January 2015. The 2013 update was not publicly known in advance, and there is little information provided about the planned updates.

Even if the tax reform resulted in a shift toward more fuel efficient cars, the overall environmental impacts remain unclear. The tax reform may result in an overall increase in vehicles in service. The reform essentially lowered the effective price of fuel-efficient vehicles, making them more affordable. Rather than simply displacing purchases of more polluting vehicles, the reform may have lowered the low-end range of car prices, thereby making the option of car ownership more accessible to those who would otherwise not have purchased a vehicle. Indeed, initial evidence indicates that increases in new car purchases has at least partially offsetting the lower average pollution scores (Ben Gedalyahu 2013). In addition, the tax reform may have affected decisions regarding the timing of vehicle replacement (Cozad and LaRiviere 2013). As such, the tax may not only have resulted in low polluting vehicles displacing more polluting vehicles, but may have also resulted in their displacement of more environmentally friendly options, such as public transportation, as well. Another reason is the aforementioned rebound effect which may have resulted in increased mileage driven and increased congestion.
In sum, Israel’s tax reform is an innovative, broad based means for potentially reducing the environmental impact of automobiles. The potential for a change in consumer behavior is substantial given the scale of relative changes in retail sticker prices for all new automobiles sold in the country. While, preliminary data demonstrate a shift in vehicle purchases towards more fuel efficient models following implementation of the tax reform. Based on such figures, governmental agencies such as the tax authority have claimed that the green tax has been successful in reducing pollution, without controlling for numerous confounding variables, as well as accounting for impacts in terms of overall national fleet size and vehicle use, it is not possible to ascertain the extent to which the reform is actually achieving the environmental policy goals of reduced emissions.

4 Data and Methodology

Figure ?? illustrates the impact on sticker prices for a subset of greenscore. As the figure shows, immediately after the implementation of the Green Law, the typical sticker price fell across the board for the average car for each of the selected green scores shown reflecting the fact that consumers bore a significant fraction of the reduction in taxes and this was increasing the lower the green score.

Mileage data

We estimate a generalized difference-in-differences specification, using variation in the differential change in tax rates applied to different cars.

An empirical challenge is that information to create green scores prior to 2009 are not available in the data. We supplement our information with data scraped from XXX website, which the Israeli tax authorities indicate was the source for their information when designing the Green Tax policy. We are constructing a matching algorithm to identify the pollutants measures for cars in the pre-reform period.
Each line holds constant the green score formula for the year that it was implemented. Thus, for example, the dotted line for Green Score -2009 illustrates what was the actual green score until mid-2013 (after which the formula was updated) and what would have been the average green score for all sales post mid-2013 had the formula not changed.
Figure 2. Sales Weighted Average Price / Pre-tax price by Green Score

Each line presents the ratio of average final price divided by average pre-tax price by green score.