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Effects of a mileage tax for trucks

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ABSTRACT

We evaluate the effect of the introduction of a mileage tax for trucks in Switzerland in 2001 on traffic volume and externalities. Using a regression discontinuity design, we find a reduction in overall truck traffic of around 4–6%, no effects on car traffic and time-shifted placebos, suggestive evidence for traffic substitution toward rail, and negative effects on nitrogen oxides at curbside monitors. Complementary estimates on the effects of the German mileage tax and complementary estimates based on the synthetic control method are broadly consistent with our main results, although the latter are not statistically significant. Depending on prevailing levels of transportation costs, mileage tax-induced transportation cost increases may accelerate or reverse spatial economic concentration processes. Such implications for economic geography featured prominently in Switzerland and are a promising area for future research.

1. Introduction

On American roads, 3675 persons died in 2010 in accidents with large trucks. Heavy-duty vehicles emitted 3.8 million tonnes of nitrogen oxides (18% of all U.S. emissions) and 389.3 million tonnes of carbon dioxide (6% of all U.S. emissions). In Switzerland, with a road network that is one hundred times smaller than the American one, the respective figures are 28 fatalities, 11,886 tonnes of nitrogen oxides (14% of all Swiss emissions), and 2.9 million tonnes of carbon dioxide (7% of all Swiss emissions).[1] Moreover, road freight traffic is a major cause of road wear and tear, noise, and congestion. The external costs of road freight largely depend on the distance traveled with additional factors being emission standards of vehicles (local air pollution), fuel efficiency (local and global air pollution), weight (accidents and road wear and tear) as well as location and time (e.g., Parry et al., 2007).

Politicians and regulators attack these externalities with both command-and-control policies and incentive-based policies (e.g., Santos et al., 2010; Schmutzler, 2011). Incentive-based policies are more cost effective as they take into account heterogeneity in compliance costs and typically exploit more behavioral responses. In contrast, command-and-control policies often limit the range of response options, which increases compliance costs and may lead to perverse effects (e.g., Harrington and Krupnick, 2012). Fuel economy standards increase distance-related externalities by reducing mileage costs (e.g., Small and Van Dender, 2007), strict standards for new vehicles slow down the retirement of old polluting cars (Gruenspecht, 1982), or license plate-based driving bans create incentives for extra vehicles (Davis, 2008). Indirect links between externalities and behavioral responses to policies also plague fuel taxes. Fuel taxes affect both fuel economy and distance traveled and are, therefore, less effective in combating distance-related externalities (Parry and Small, 2005).[2] Against this backdrop, mileage taxes compare favorably and several European countries

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[1] U.S. accident, CO_2, and NO_x emissions figures are from National Highway Traffic Safety Administration (2012), U.S. Environmental Protection Agency (2012) and U.S. Federal Highway Administration (2005), respectively. The Swiss NO_x and CO_2 emissions figures are from Federal Office for the Environment (2010) and Federal Statistical Office (2012), respectively. The source of the Swiss accident figure is the Federal Road Office's accident data used in this paper. All figures are for the year 2010 except U.S. NO_x emissions, which are for 2002.

[2] For trucks, the drawbacks of fuel taxes compared to mileage taxes are smaller because of low fuel economy and, thus, greater importance of fuel-related external costs (Parry, 2008). Further, emission standards are defined in units per engine output which depends on fuel efficiency and fuel use.

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introduced mileage taxes for heavy-duty trucks (henceforth trucks), starting with Switzerland in 2001. In the U.S., several states are considering such schemes for cars (e.g., Vock, 2013). As we will discuss in more detail below, mileage taxes also have important implications for economic geography by increasing the costs of transportation. A rise in transportation costs may accelerate or reverse spatial economic concentration processes, depending on prevailing levels of transportation costs.

In 2001, Switzerland introduced a distance-related fee on vehicles with a maximum permissible total weight of more than 3.5 tonnes. In contrast to the more recent schemes in other European countries, the fee is not restricted to major highways. The rates depend on the maximum permissible total weight and emission category of vehicles. The rates are substantial and range from 5.6% to 20.9% of operating and vehicle costs per mile.[3] The rates are not differentiated by time or location. Nevertheless, the policy is arguably much closer to an ideal pricing scheme than many existing alternatives. It is, therefore, of considerable general interest to know how effective this policy was in curbing road freight traffic and related externalities.

In this paper, we estimate the effects of the Swiss mileage tax for trucks on the volume of road freight traffic. Our main analysis is based on a regression discontinuity design with daily traffic count data for the years 1997–2004. We focus on a short time window and control for time-varying effects of other factors on traffic volume by including a flexible polynomial in time. If the effects of other factors change smoothly around the policy change, observations immediately before the change are good comparisons for observations immediately after the change (see also Davis, 2008; Auffhammer and Kellogg, 2011; Chen and Whalley, 2012).

We find that the introduction of the Swiss heavy vehicle fee reduced the number of trucks on the roads by around 4–6% under plausible assumptions on the effect of a simultaneous increase of the maximum permissible total weight for trucks. The estimates are not sensitive to changes in the length of the sample period or order of the time polynomial. Yet, there is considerable heterogeneity in estimated effects across monitors. We find no significant effects on car traffic, on time-shifted placebo policy changes or for traffic diversion to neighboring countries, but suggestive evidence for an increase in rail freight traffic.

The regression discontinuity design allows us to capture the short-term response but is not well-suited to estimate longer-term effects. Further, estimates may be biased by anticipation effects (Lee and Lemieux, 2010). To address these concerns, we complement the regression discontinuity analyses with estimates based on the synthetic control method. We find a negative effect of the mileage tax on truck traffic density that is similar to the regression discontinuity estimates in the first year after the implementation. In subsequent years, the effect on traffic density becomes substantially larger. However, placebo tests suggest that the effect is not statistically significant. Thus, the two approaches yield a very consistent picture of a small but weakly significant or insignificant reduction in traffic of around 5%.

In addition to the estimates on road traffic, we also estimate the effects of the heavy vehicle fee on accidents and nitrogen oxides. We find no effects on the number of accidents with trucks and on overall nitrogen oxides (NO_x) pollution. Yet, we find a significantly negative effect for NO_x next to roads of -5.6%.

This paper contributes to a growing body of literature assessing the effectiveness of policies against road traffic externalities (see Section 2 for references). It is the first paper evaluating a comprehensive scheme of a mileage tax from an ex post perspective. Thus, it helps to inform decisions on mileage taxes in other contexts. There is one study on the Swiss heavy vehicle fee commissioned by the Swiss government after the implementation of the policy (Federal Office for Spatial Development, 2007). The study combines estimates of mileage costs increases with published price elasticity estimates. Thus, although commissioned ex post, the study has the character of an ex ante evaluation. Nevertheless, it is interesting to note that the results are comparable to our ex post evaluation.

By increasing transport costs, a mileage tax affects the geography of economic activity. The extent to which the mileage tax actually increases transportation costs depends on the substitutability of truck transportation and alternative transportation modes, notably rail transport. Among other factors such as the importance of fast delivery, this substitutability largely depends on firms' access to the rail network. Though some Swiss firms are directly connected to the rail network and produce almost exclusively for export, most firms rely at least for shipment to transshipment terminals and for final distribution on truck transportation. Thus, it seems worthwhile to briefly reflect on the implications of the mileage tax for the spatial distribution of economic activity.

Economies of scale in production induce some firms to geographically concentrate production next to the main markets in urban centers. With costly transportation, this concentration process is self-perpetuating as it opens a gap in living costs, thereby, luring still more individuals to urban centers. However, with sufficiently high transportation costs, dispersed production can emerge as firms locate close to immobile farmers in rural areas (Krugman, 1991).[4] Starting from low production costs, a small increase in transportation costs arguably accelerates the concentration process by increasing the difference in living costs.[5] Indeed, this argument featured very prominently in parliamentary debates on the Swiss heavy vehicle fee, especially because peripheral regions often lack access to the rail network. For this reason, it has been decided that mountainous and peripheral regions should receive an extra share of the heavy vehicle revenues (e.g., Lautenschütz, 1997; Schlumpf, 1997). However, a large enough increase in transportation costs may reverse the concentration process and lead to more dispersion of economic activity. Some representatives from peripheral regions welcomed the introduction of the mileage tax as it would protect local producers from competition (Bezzola, 1998). In the end, fears of negative consequences prevailed in rural areas, resulting in an exceptionally large rural–urban divide in voting behavior in the 1998 referendum on the mileage tax (Discours Suisse, 2004). Assessing whether these fears were warranted is beyond the scope of the present paper.

The remainder of the paper is organized as follows. In Section 2, we review the related literature and present details about the Swiss heavy vehicle fee. In Section 3, we discuss our empirical strategy. Section 4 presents the data and Section 5 the results. In Section 6, we offer concluding remarks.

2. Background

In this section, we discuss studies estimating the effects of policies aimed at reducing the external costs of road and, in particular,

[3] The cost increases are calculated using cost data for four permissible total weight brackets (Federal Office for Spatial Development, 2007). We use the mid-bracket value to calculate the average fee paid per mile and emission category.

[4] The results of Rosenthal and Strange (2001) are consistent with the notion that concentration patterns can be explained by firms' endeavor to save transportation costs. They find that industries with perishable outputs are less concentrated than other industries since firms in these industries move close to final consumer demand.

[5] Naturally, the incidence of the mileage tax depends on the usual factors such as industry structure, structure of the transport sector, and demand elasticity.