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Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

The effect on CO₂ emissions of taxing truck distance in retail transports

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ARTICLE INFO

Article history:

Received 12 June 2015

Received in revised form 6 September 2016

Accepted 11 January 2017

JEL codes:

D22

L13

L81

R12

Keywords:

Spatial distribution of e-tailing and consumers

CO₂ emissions measurement

Online retailing

Environmental taxes

Carbon footprint

Road network

ABSTRACT

To finance transportation infrastructure and to address social and environmental negative externalities of road transports, several countries have recently introduced or consider a distance based tax on trucks. In competitive retail and transportation markets, such tax can be expected to lower the demand and thereby reduce CO₂ emissions of road transports. However, as we show in this paper, such tax might also slow down the transition towards e-tailing. Considering that previous research indicates that a consumer switching from brick-and-mortar shopping to e-tailing reduces her CO₂ emissions substantially, the direction and magnitude of the environmental net effect of the tax is unclear. In this paper, we assess the net effect in a Swedish regional retail market where the tax not yet is in place. We predict the net effect on CO₂ emissions to be positive, but off-set by about 50% because of a slower transition to e-tailing.

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1. Introduction

A negative externality arises from road transports due to fossil fueled vehicles emitting CO₂. To internalize the external costs of CO₂ emissions in general, the cap and trade system termed EU Emissions Trading System has emerged in Europe. However, the transport sector is left out of the system even if the road transports are affected by the fuel taxes that frequently are environmentally motivated. Moreover, in some countries such as Switzerland (in 2001), Austria (in 2004), Germany (in 2005), Czech republic (in 2007), Slovakia (in 2010) and Poland (in 2011) a Vehicle Miles Travelled tax (VMT-tax or kilometer tax) has been imposed on (primarily) trucks. The foremost rationale for a VMT-tax is the financing of transportation infrastructure, but also to address social and environmental negative externalities of road transports (e.g. Calthrop et al., 2007; Sorensen and Taylor, 2006; Lindsey, 2010; Hammar et al., 2011; Brännlund et al., 2013; Stelling, 2014; Jenn et al.,

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2015). Several governments are contemplating the VMT-tax including the newly installed Swedish government. The scheme of the Swedish version of a VMT-tax is to charge a fixed value per kilometer on trucks. Hammar et al. (2011) studied how the Swedish manufacturing industry would be affected in terms of their competitiveness by the introduction of a VMT-tax on trucks, and their results show that the tax would decrease transport demand while increasing the demand for labor.

Transports are essential for retailing, which in turn is a core activity in most economies. Products are usually distributed by trucks to market places to which consumers travel with cars. Retailing is however gradually shifting towards e-tailing, i.e. the consumer orders the product online rather than buy it in a brick-and-mortar (BM) store, and has it transported by a professional carrier to (in Sweden, uncommonly) the home or to a delivery point in the vicinity of the consumer's home.¹ Carling et al. (2015a) found that e-tailing implies a more efficient transportation of the product thereby leading to substantially less CO₂ emissions (the reduction in CO₂ emissions in the standard model was estimated to be 84%).

A VMT-tax in a competitive retail market can be expected to increase the retail price due to increased transportation costs and thereby lowering the demand such that transports and its CO₂ emissions related to retailing decreases. However, the relative price for the consumer of shopping online compared to in a BM-store would increase at the same time. Hence, it is to be expected that a VMT-tax will slow down the transition towards e-tailing, thereby counter-acting the anticipated reduction in CO₂ emissions resulting from more e-tailing in the future (cf Calthrop et al., 2007).

Calthrop et al. (2007) considered the case when an externality is jointly produced by the use of intermediate inputs by firms and the consumption of final goods by households and referred to partial taxing if only one of the agents incurred the tax. They specifically discussed VMT-tax on trucks while private transports are exempted from it. Their theoretical modelling led them to the conclusion that a partial tax to internalize the externality may actually have negative welfare effects.

The aim of this paper is to estimate the net effect of a VMT-tax on CO₂ emissions related to transportations in the retail sector. Hence, the contribution of this paper is to complement the theoretical analysis of Calthrop et al. (2007) by assessing the effect of a partial tax. The effect is studied in a representative regional retail market in Sweden focusing on consumer electronics. Consumer electronics is the category of products most purchased online and believed to lead the way to e-tailing of other categories of retail products.

This paper is organized as follows. In Section 2 we outline a simple microeconomic model for consumers' transition to e-tailing. This model is used for projecting the transition towards e-tailing in the region under study in the cases with and without a VMT-tax. In Section 3 the data of the regional retail market is presented and the method for measuring CO₂ emissions, in various scenarios, related to a consumer's shopping is outlined. Section 4 presents results on how the VMT-tax affects CO₂ emissions induced by shopping related transports. In Section 5 we discuss the sensitivity of the results to the assumptions made and make a concluding discussion.

2. The switch towards e-tailing

The introduction of a VMT-tax for trucks will affect the demand for retail products in two distinct ways. First, assuming that both the retail and the transport markets are competitive,² the tax will increase the price, including the cost of transports to the BM-store or the online delivery point and thereafter to the consumer residence, of the product.³ This part of the tax is anticipated to reduce CO₂ emissions as the demand for products and their transportation decreases, and where the magnitude of the reduction will be dependent on the price elasticity of the products.

The second effect, largely overlooked in the Swedish debate, of the tax is that it will change the relative price of e-tailing versus traditional BM-store shopping, and this change in relative price will also have an effect on CO₂ emissions. To focus on how the tax will affect the on-going transition towards e-tailing, and this in turn affects emissions, we assume that the total market demand for the products under study is perfectly inelastic with respect to prices, and focus only on how the share of e-tailing is determined by the relative prices.

To make this idea operational in a simple way, suppose that the consumer faces a utility gain if the choice of e-tailing decreases the price of the product including transportation. A similar model was used by Aronsson et al. (2001) when analyzing how relative price differences between brand name and generic pharmaceuticals affected brand name market shares. Let Δu_t be the total discounted change in expected utility of the consumer if changing from a BM-store to an online retailer in period t . We simplify further by assuming that Δu_t depends only on the observed price of the product at the BM-store relative to the e-tailing price, including transportation cost in both cases. That is:

$$\Delta u_t = \frac{n}{(1 - \delta)} \left(\frac{p_t^{bm}}{p_t^e} - 1 \right) \quad (1)$$

¹ In Sweden, the consumer is offered a choice of delivery points for picking up online purchases. Swedish Post, handling most e-tail packages, offers consumers a list of delivery points, the nearest the consumer's residence being the suggested primary alternative. The vast majority (85–90%) of surveyed consumers chose to pick up products at the proposed nearest outlet. (HUI Research, 2014).

² Carling et al. (2015a, 2015b) discussed the consumer electronics market in Sweden and pointed at fierce competition as the main cause of the substantial number of vendors filing for bankruptcy in recent years. The Swedish transport sector is also subject to competition as a consequence of the recent surge in cabotage within the EU, forcing Swedish firms to compete with transportation firms from low wage countries mainly located in Eastern Europe. The share of cabotage transports in the EU12 has increased from 12% in 2004 to 40% in 2011 (European Union, 2013).

³ A consumer may purchase one product or a package of products at the time. The transportation is primarily related to the occasion of purchase, not to the number of products. We will therefore use product and parcel of products interchangeably.

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