E-commerce last-mile in Belgium: Developing an external cost delivery index

Iván Cárdenas⁎, Joris Beckers, Thierry Vanelslander

Department of Transport and Regional Economics, University of Antwerp, Prinsstraat 13, 2000 Antwerp, Belgium

ARTICLE INFO

Keywords:
E-commerce
Last mile
External costs
Urban logistics

ABSTRACT

The rise in online B2C sales resulted in a fragmentation of freight shipments. Logistics service providers are challenged to cope with high competition, a consumer-driven economy, failed delivery issues, reverse logistics and environmental measures taken by policymakers, which are all putting pressure on the costs. The last-mile of these deliveries, widely accepted as the most expensive part of the trip, is a trade-off between internal costs, externalities and the density of deliveries. Little is known so far about the actual impacts of e-commerce on transport and logistics on society. In this paper, we first analyse the spatial distribution of e-commerce deliveries during a 4-month period in Belgium. Next, we propose a methodology based on the total vehicle-kilometres travelled to calculate the external costs per parcel at the national level. The results show that despite the high urbanization in the country, the e-commerce consumption per capita is higher in rural areas while the total number of kilometres travelled remains similar to that in urban areas. While urban areas undergo most of the disadvantages related to the e-commerce last-mile, the average external cost per parcel was found to be higher in rural areas.

1. Introduction

During the last years, e-commerce has been growing at a two-digit rate, and an increasing number of customers use the business-to-customer (B2C) e-commerce channel to order products online and have them delivered at home. However, this raises new challenges for logistics since the supply chain has to cope with the increased fragmentation to satisfy the needs of customers. High competition, a consumer-driven economy, failed delivery issues, reverse logistics and environmental measures taken by policymakers are factors that increase the costs of delivering online orders. The consequence is that the last mile is regarded as the most expensive section of goods distribution (Fernie, Sparks, & McKinnon, 2010; Gevaers, Van de Voorde, & Vanelslander, 2014). Because of the complexities present in the delivery of e-commerce goods, improving the availability, quality and affordability of delivery solutions has been identified as one of the objectives to stimulate e-commerce growth (European Commission, 2013).

B2C e-commerce implies individual shipments, resulting in an increasing number of trips and kilometres (Taniguchi & Kakimoto, 2004). The B2C channel represents around 30% of the e-commerce turnover (FTI Consulting, 2011), and it generates 56% of all the e-commerce shipments (Copenhagen Economics, 2013). While there is no general acknowledgement, estimates indicate that the volume of shipping worldwide is close to 31 billion parcels per year (PitneyBowes, 2016).

The negative impact of B2C e-commerce last-mile have raised interest from urban logistics researchers, transport and retail geographers as well as practitioners and public decision makers (Weltevreden & Rotem-Mindali, 2009). The relevance of this discussion is that delivering the last mile is a trade-off between internal costs, externalities and the density of the deliveries. On the one hand, customer density is essential for achieving efficiency in the last-mile. Therefore, rural deliveries can be three times more expensive than urban ones (Boyer, Prud’homme, & Chung, 2009; Gevaers et al., 2014). In the urban areas, the density is higher and logistics carriers benefit from lower costs. However, the residents undergo more negative impacts such as congestion, noise, and emissions than rural areas (Holguín-Veras, Thorson, & Zorrilla, 2008; Zito et al., 2013). At the end, the various stakeholders have to manage different externalities in different regions, which underlines the difficulties associated to the last mile.

Still, little is known about the effects e-commerce has on transport and logistics. An unresolved issue remains whether urban areas generate higher transport demand for transport than their rural counterparts. Recently, Boschma and Weltevreden (2008), who were analysing the evolution of the retail sector, mention the incubation hypothesis in e-commerce adoption, highlighting cities as early centres of innovation.
However, Clarke, Thompson, & Birkin (2015) found that B2C e-commerce is expanding rapidly and conclude that at least for the UK, B2C e-commerce is not exclusively restricted to urban areas anymore. Linked with this discussion is the observation that while urban areas are more sensitive to the negative impacts of transport, spreading the externalities can result in an even worse situation. For example, Dablanc and Rakotonarivo (2010) argue that the CO₂ emissions are increasing dramatically because of the geographical dispersion of e-commerce usage in Paris. The very complex nature of e-commerce deliveries and the fact that it is a relatively new phenomenon imply that neither the spatial distribution of B2C e-commerce nor its impacts on the society are fully understood.

The aim of this paper is threefold. Firstly, we shed light onto the spatial distribution of the demand of B2C deliveries by exploring where in Belgium the deliveries occur. Secondly, we propose a methodology to estimate the share of each region in the total amount of travelled kilometres to deliver B2C e-commerce goods. Finally, we quantify the negative impacts of the transport used to deliver in the last mile.

The analysis is performed based on data from a parcel delivery company in Belgium who will remain anonymous for privacy issues. Based on the data, we derive the number of vehicle-kilometres needed to deliver e-commerce goods. Moreover, values for external costs are assigned based on the total travelling distance and depending on the morphological characteristics of the regions. Because of the high urbanization present in the country, it is important to distinguish between rural, semi-urban, and urban areas and weight the impacts on these different types of areas.

This paper is organised as follows. Section 2 introduces the methodology, available data and the different parameters. Next, the approach used to derive the total vehicle kilometres travelled (VKT) from the original dataset as well as the external costs included in the approach used to derive the total vehicle kilometres travelled (VKT) since more kilometres almost always imply more externalities. VKT can bring more or less externalities, depending on the population density of the area where they occur. For this reason, we try to consider this effect by not only calculating the VKT but by weighting them based on the affected area. In this section, we therefore firstly present the framework depicted in Fig. 1 to calculate a cost index per parcel for different areas in Belgium.

### 2. Methodology

#### 2.1. Data source

To estimate the impacts of B2C e-commerce transport for Belgium, we face the challenge of estimating the routes used for delivering (Gonzalez-Feliu, Ambrosini, & Routhier, 2012). Since this information is not easily available, those trips were estimated based on the location of parcel deliveries. The data used in this paper corresponds to the B2C deliveries at address level performed by a logistics carrier in a four-month time window in 2015 in Belgium. For each delivery address, the number of deliveries is known. In total, 1143 parcels were delivered during this period. The data is assumed to cover a share of about 10% of the total delivery market. A spatial bias could nevertheless exist because of regional differences in e-commerce behaviour and, therefore, logistics carriers. Due to the unavailability of information from other logistics carriers, we consider the available data as a proxy for the total Belgian population.

Predicting where the deliveries occur imposes some difficulties. The demand for B2C e-commerce is not spatially contiguous and depends on socio-economic characteristics such as age, income etc. (Clarke et al., 2015), two alternatives can be chosen to determine the destination of deliveries. One alternative is identifying the role played by socio-economic characteristics and indirectly predicting where the destination of the parcels is. The problem with this method is that in addition to the normal uncertainty in the predictions, many e-commerce deliveries do not occur at the home address (Gardrat et al., 2016). In Belgium, around 30% of deliveries occur in a different location than where the customer lives (Comeos, 2014). This percentage is even higher in other countries (Morganti, Dablanc, & Fortin, 2014; Morganti, Seidel, et al., 2014). A second alternative is therefore to directly use data from the deliveries executed by the carriers. This data provides a unique insight into the spatial pattern of deliveries.

The data is aggregated to the level of zip code. Therefore, the country is divided into 1153 spatial units with an average area of 26.8 km². The costs of external impacts will be calculated at this scale. For refinement of the external cost parameters, we attach the geographical morphology to each zip code based on the definition by Luyten and Van Hecke (2007). The authors identify Belgium’s main urban agglomerations based on population density. These agglomerations, together with the functionally related suburban areas, form a city region. To ease international comparisons, these city regions are identified as urban regions. The communities surrounding these city regions, but tightly linked due to commuting flows, are classified as semi-urban. The remaining areas fall under the rural category.

#### 2.2. Methodology

In this paper, we assess the external costs of e-commerce deliveries. The main objective of the external costs calculation is to reveal the hidden costs in the cost structure of the market. By monetizing the different impacts of transport, we can assess the external costs as a transversal indicator of the negative impacts of transport. Through the calculation of the impacts, we are able to weigh properly the number of total vehicle-kilometres travelled in rural, semi-urban or urban areas. Moreover, this allows developing a sustainability index for the entire country.

Because of the wide range of transportation impacts, various external cost calculations can be identified in the literature (Collins, 2015; Durand & Gonzalez-Feliu, 2012; Edwards, McKinnon, & Cullinane, 2010). The common denominator among them is calculating the total VKT since more kilometres almost always imply more externalities. However, VKT can bring more or less externalities, depending on the population density of the area where they occur. For this reason, we try to consider this effect by not only calculating the VKT but by weighting them based on the affected area. In this section, we therefore firstly present the framework depicted in Fig. 1 to calculate a cost index per parcel for different areas in Belgium.

#### 2.2.1. Parameter inputs

In the first stage, parameters form the characteristics of the vehicles are obtained via the logistics companies, mainly the capacity and the average duration of the tours. The capacity is fixed at 100 parcels per van per day, which is an appropriate estimation from daily operations of the company. Next, the distribution centres were located. While the location of distribution centres from the carrier is known, in order to not disclose the data provider indirectly and to broaden the generalisation of the analysis, distribution centres are assumed to be located in

---

**Fig. 1. External costs index calculation framework.**

Source: Own Elaboration
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شبکه
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات