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The value of express delivery services for cross-border e-commerce in European Union markets

Abstract

Further growth of cross-border e-commerce in the European Union markets requires improved express delivery services. The framework presented in this paper identifies relevant contextual factors that affect express delivery adoption rates in European cross-border e-commerce. This framework leads to a set of hypotheses, both on the effects of express deliveries on financial performance indicators (order incidence, order size, and repurchase rate) and on the factors that drive demand for express deliveries (consumer income, logistic costs, and lead-time benefits). A case study provides empirical tests of the hypotheses, using data on about forty thousand sales transactions from a consumer electronics manufacturer's cross-border online shop. The findings are that express delivery has positive effects on financial performance, as it leads to higher order incidence, larger order size, and higher repurchase rates in cross-border transactions. Demand for express delivery services increases with higher income, larger lead-time benefits, and lower logistic costs. Managers can employ the presented framework to formulate and analyse their own targets for performance and express delivery services.

Keywords

e-commerce, express delivery, cross-border, lead-time, logistic cost, centralized distribution centre, order incidence, order size

1. Introduction

E-commerce continues to gain traction in the European retail industry, whereas off-line retail has stagnated or dropped. Nowadays, customers can purchase goods in borderless online markets of neighbouring countries. Cross-border e-commerce offers attractive opportunities to customers, because of competitive prices and wide product assortments. Online retail sales in Europe will reach approximately 185 billion euro in 2015, an increase of 18% compared to 2014, while offline retail sales are expected to decline by 1% in the same period [9]. The online share of total retail trade is not uniform across the European Union, ranging in 2014 from 2% in Italy to 13% in the UK [20], reflecting varying degrees of e-commerce maturity. There is potential for growth in cross-border sales both in mature e-retail markets and in markets with lower online shares due to regional contagion effects [24]. From this perspective, cross-border e-commerce is the key to accelerating the speed of growth in European online retail [11]. In 2014, 15% of the inhabitants of the EU-28 countries purchased goods online from sellers outside their country of residence, compared to 8% in 2009 [20].

Several barriers to cross-border shipping still constrain further growth in cross-border e-commerce, including unreliable and lengthy transit times, complex and ambiguous return processes, customs bottlenecks, limited transparency on delivery, price opacity, limited ability to alter delivery times, and limited mutual trust [25]. In this paper, mutual trust is measured in terms of order incidence, order size, and repurchase ratios. Except for customs bottlenecks, e-commerce managers can reduce the other barriers to cross-border sales by providing clear delivery and return policies to their customers. Of particular importance are reliable deliveries with short lead-times, so that this paper will focus on the role of express delivery services in improving cross-border e-commerce. A survey of EU national regulatory authorities [10] in 2013 showed that standard and express offers are substitutes for parcel delivery at the cross-border level. Some retail programs like Amazon Prime and Google Express have recently introduced prime express delivery services and have even implemented their own transport networks. Thus, express delivery has gained acceptance as a means for providing substantial value for cross-border e-commerce in terms of logistics performance [22].

As predicted by the gravity model for intra-and international trade and home bias [26], lengthy transit times for longer distances make e-retail customers reluctant to purchase goods outside their home country. This may explain the lower propensity for e-commerce in the EU as compared to the US. Cross-border e-commerce in the EU is still less developed in terms of transit times than interstate e-commerce in the US. Although the land area of the EU is only 45% of the US (United Nations Year Book, 2011), it has similar or even longer transportation times due to border effects [13]. Online retail sales in the US reached 224 billion euro in 2014, which is 43% higher than e-commerce sales in the EU [9], despite the EU's 6% higher GDP. The e-commerce figures for the US suggest that its EU counterpart can expand by using more efficient logistics solutions that shorten the transit times of cross-border trade, for example, through the adoption of express delivery. Current express delivery solutions enable next-day delivery through the airfreight network in Europe. Consumers using cross-border e-shops will no longer perceive geographical distances if express delivery methods are well implemented in terms of costs and lead times.

In the EU retail market, cross-border e-commerce with express delivery is currently still in its early stages, as rational consumers regard express delivery costs as additional transaction costs [7], even if retailers include these costs as part of the product price [12]. Several studies have attempted to suggest cost-effective delivery models [2, 12, 15, 16], but to the best of our knowledge, our paper is the first to investigate cross-border e-commerce equipped with express delivery as alternative to regular ground delivery. We propose a framework that includes three contextual factors, that is, customer, product, and regional characteristics. Customer characteristics include disposable income and preferences for delivery speed, and regional aspects determine logistic costs and lead-times. As concerns product categories, cross-border e-shopping is especially attractive for customers looking for products that are not easily available from domestic e-shops or local off-line shops. This holds true, for example, for products with uncertain demand and low profit, such as accessories, recently launched products, and spare parts. Manufacturers prefer to run a centralized distribution system for such types of products, as cross-border virtual presence is more feasible and less expensive than local supply of these products [21]. They can bypass retailers through an online distribution channel [25] using a central distribution centre (CDC) to efficiently manage stock and uncertain demand.

For the above reasons, cross-border e-commerce is an attractive business model for product categories like consumer electronics that have high stock keeping costs due to short life spans and widely differentiated assortments. Some consumer electronics manufacturers are already selling directly, enabling shoppers in many countries to buy products online and have them shipped from the company’s factory [25] or from a central distribution centre for multi-country transactions. Such centralized online shops offer an interesting case to examine relations between express delivery and online behaviour, in particular if customers have no alternative purchasing channels for the products they need. This paper provides an empirical analysis of express delivery services in cross-border e-commerce by a case study with transaction data of a large consumer electronics manufacturer. The centralized distribution centre is located in the Netherlands and provides cross-border e-commerce services to five EU countries: United Kingdom, Germany, Italy, Spain, and Sweden. The obtained magnitude of effects are specific for the case study, but managers can employ the provided general framework and empirical methodology to decide on their own implementation of express delivery in cross-border e-commerce.

The remainder of the paper is structured as follows. Section 2 provides a brief literature review. Section 3 presents the research hypotheses, and Section 4 describes the case study environment. The empirical results are shown in Section 5, both the effects of express transport usage on customers' trust indicators (order size, order incidence, and repurchase ratio) and the factors that drive express transport choices. Finally, Section 6 summarizes some operational implications.

2. Literature review

Globalization of e-commerce is a common trend in contemporary e-retail business [17]. Both consumers and manufacturers can profit from cross-border e-commerce, because centralized e-shops with large product assortments can serve multiple countries and are less costly [21]. Still, excessive transit times from distant countries can be a barrier to cross-border e-commerce [11]. Currently, European Courier, Express, and Parcel [CEP] services provide opportunities to increase cross-border e-commerce in Europe [8]. Our study assesses the value of express delivery for cross-border e-commerce business models. Customer loyalty plays an important role in business profitability , as it costs five to eight times more to attract a new customer than to retain an existing one [23]. Our study examines the effect of express delivery on repurchase ratios, order size (purchase amount), and order incidence (frequency at which consumers select express delivery).

The main drivers of e-commerce growth in EU countries are internet penetration ratio, intensity of telecom investment, availability of venture capital, availability of credit cards, education level, and spill-over effects from neighbouring countries' e-commerce [14]. In our study, we take gross domestic product per capita as general indicator of market potential.

Online retailers can compete in markets with full product and price information by means of their physical distribution service performance, in particular the delivery speed [22]. Shortening delivery time by express parcel service provides greater customer satisfaction, resulting in customer retention. Our study investigates the effect of reduced lead-times on customers' choices for express delivery. The value of freight transport time saving, or equivalently, the willingness to pay for reduced in-transit freight transportation time, has been studied from the business-to-business viewpoint [18, 27]. To our knowledge, our paper is the first to examine delivery time-savings from the perspective of consumers, which becomes viable because the e-commerce platform provides information on their choice behaviour. Rational consumers base their decisions on the marginal utility of money [1, 17] and compare the extra cost of express delivery with the lead-time benefit. For given express tariffs, express delivery becomes more attractive for regions with high congestion, for high-valued goods, and for high disposable income [27]. Our study incorporates lead-time benefit, road transport cost, and the cost mark-up of express delivery (per saved day of lead-time) as driving factors for the consumers' choice between normal ground delivery and express delivery by air.

A case study of an online grocery shop showed that shipping fees are more important for customer retention than customer acquisition [16]. Simulation models indicate that free ground shipping policies attract 26% more customers but negatively impacted profit by 82% as compared to the optimized delivery strategy [15]. Retailers try to use shipping fee partitioning tactics to generate more customer demand without destroying their margins by subsidizing light, small, and premium priced products, since consumers hesitate over paying shipping charges for these categories [12]. In our study, the relative cost of express delivery in cross-border e-commerce is expressed by the logistic cost ratio, that is, the extra cost of express delivery relative to the price of the ordered goods.

In the following, we integrate the various discussed relations between contextual factors (like consumer, product, and regional characteristics) with logistic competence and financial performance into a conceptual framework to analyse the role of express delivery for cross-border e-commerce.

3. Conceptual model and research hypotheses

3.1 Conceptual model

In e-commerce markets, it is usually not possible to take advantage by means of product quality or price, due to high quality control standards of manufacturing systems and competitive pricing by price comparison sites. E-shops can compete by providing extra utility to customers by offering wider product assortments and by showing superior logistics competence to meet different customer, product, and regional needs. E-shops with high logistics competence can achieve higher sales than less competitive ones, as customers base their purchase decisions on inclusive costs [7, 22].

Figure 1 summarizes our conceptual model for logistic competence in cross-border e-commerce. The usefulness of e-commerce to customers depends on how e-commerce simplifies and improves the effectiveness of their shopping. Reliability and speed of delivery are dominant factors, and we take express delivery as measure of the logistic competence perceived by customers. Just as e-commerce has been studied as a new technology in the technology acceptance model [5], we view e-commerce equipped with express delivery as the adoption of a new technology. The perceived logistic competence depends on customer characteristics like gross domestic product, on product characteristics such as price, weight, and volume, and on regional characteristics like lead-times and road transport costs. The logistic competence affects financial performance in terms of order size, order incidence, and repurchase rates.

[Insert Figure 1 here]

3.2 Effects of logistic competence on financial performance

E-shop users in the EU considering a vendor outside their own country used to encounter two problems compared to domestic shops, that is, longer lead-times and higher delivery costs. Nowadays, these disadvantages diminish rapidly thanks to express delivery services and increasing economies of scale in cross-border e-commerce traffic [8]. A recent survey [10] reveals that express delivery of cross-border e-commerce can substitute regular delivery options. We represent logistic competency by the express delivery adoption level in e-shops. The express delivery adoption level (EX) is defined as the percentage of all e-shop transactions that is delivered by express services. The e-shop's financial performance is measured in terms of the order size (OS) of the purchasing transaction, the order incidence (OI) as number of orders per week per population, and the repurchase ratio (RP) of total purchasing transactions.

Like any other business, financial performance is a primary goal of cross-border e-commerce, though here this goal is achieved mainly through logistic competency rather than marketing activities. For example, OS can be increased through threshold effects [2], OI by offering discounted or free shipping [12], and RP by improving loyalty by providing a satisfactory level of service quality [22]. Our first research hypothesis (H1 in Figure 1) is as follows:

H1: Logistic competence, in terms of express delivery, positively affects financial performance in cross-border e-commerce. That is, EX has positive effects on OI, OS, and RP.

3.3 Driving factors for logistic competence

Logistic competence varies by customer behaviour, products handled, and region.

Customers living in countries with higher per capita gross domestic product (GDP) attach higher value to fast delivery times [27]. Such customers are more time sensitive and desire shorter lead-times. Figure 2 illustrates the negative relation between time sensitivity and accepted lead-time. Customers with low time sensitivity are satisfied by conventional transport. Higher time sensitivity leads to higher demand for express mode transport. As richer customers tend to be more time sensitive, the popularity of express mode will increase with GDP. Customers with very high time sensitivity are not satisfied by express delivery and instead prefer to transport the product themselves. We formulate the following hypothesis (H2.1 in Figure 1):

H2.1: Countries with higher per capita income have higher demand for express usage. That is, GDP has a positive effect on EX.

[Insert Figure 2 here]

Online shops can employ partitioned delivery pricing strategies that differ from actual shipping charges, which depend mainly on product weight and volume. For expensive products, for example, online retailers sometimes offer free shipping. Customers compare transport cost with the price of the ordered product when choosing between regular and express delivery. The logistic cost ratio (LCR) is defined as the cost mark-up of express delivery as compared to conventional delivery, measured as percentage of the price of the delivered product. For products of high value, that is, with low LCR, customers are more likely to pay for express delivery services on top of the normal delivery price. Our research hypothesis (H2.2 in Figure 1) states:

H2.2: The willingness to pay a mark-up cost for express delivery increases for higher priced products. That is, LCR has a negative effect on EX.

Lead-time benefits through express delivery services are an important consideration for cross-border customers. The lead-time benefit (LTB) is defined as the percentage lead-time reduction of express delivery services as compared to the lead-time of normal ground delivery. The charges for express delivery from transport agents increase with transportation distance, so that cross-border online shops also charge larger express delivery costs to customers located farther away from the CDC [18]. Customers' willingness to pay for express delivery increases for larger lead-time benefits. Figure 3 illustrates the situation where customers demand express delivery only if the cost falls below their willingness to pay. In the sketched situation, with a ceiling for the willingness to pay for express services, the relation between LTB and EX becomes non-linear. As customer location is the main determinant of LTB, this result means that express delivery is of interest only for regions at intermediate distances from the CDC, that is, with lead-time benefits within the range from LTB1 to LTB2 in Figure 3. Regions close to the CDC are satisfied with normal delivery, whereas customers in far-away regions face prohibitive express charges.

[Insert Figure 3 here]

Customers compare costs and benefits in their economic decisions concerning express delivery. Their willingness to pay depends on the magnitude of lead-time reduction [17], and we define the costs of time saving (CTS) as the ratio of the cost mark-up of express delivery over the lead-time reduction in days. Express delivery is attractive for low values of CTS, as the cost is then low as compared to the achieved lead-time reduction.

Express delivery networks in Europe are concentrated in urban areas with suitable freight volumes and relatively low road transport costs (RTC) due to high competition between transport companies. Such regional characteristics affect the demand for express services. Tight links between airfreight networks and well-built road infrastructure allow for fast and reliable express delivery from multinational companies. Non-urbanized regions lead to higher transport costs and less demand for express services.

We summarize the above analysis of regional effects on express delivery services in cross-border e-commerce, by means of three research hypotheses (H2.3 in Figure 1).

H2.3: *The effect of lead-time benefit (LTB) on EX is non-linear, with a maximum for intermediate distances between CDC and customer. Further, EX is negatively affected by costs of time saving (CTS) and by road transport costs (RTC).*

Test outcomes for the foregoing set of hypotheses will be presented in Section 5 and can be used by e-commerce managers to optimize their strategies in logistics (costs and lead-times), pricing (cost mark-up for express services), and marketing (targeting of promising consumer groups).

4. Case study environment and data

The case study concerns 39,749 transactions conducted over a 17-month period (August 2013 through December 2014) by an ICT goods manufacturer that sells products directly to end customers of multiple countries through a cross-border e-shop. Table 1 summarizes logistic data of the cross-border e-shop, which provides the same assortment of ICT goods from the CDC located in the Netherlands to five Western European countries: United Kingdom, Germany, Italy, Spain, and Sweden. The cross-border e-chops of our case study support own languages of all destinations and apply trustworthy global online payment systems [11] to simplify the ordering process for customers. The destinations are grouped by 509 postal code areas, using the country code and the first two postal digits; the UK has relatively many areas as it uses alphabetical instead of numerical postal codes. The areas vary in population, transport activity, lead-time, express delivery surcharge, order incidence, and order size. E-shops in different countries have different operating periods and population sizes per postal code, so that average incidence per week per postal code per million people is used to compare e-sales per area. Total quantity of goods transported by air is lowest in Sweden and largest in Germany. The average order incidence is highest in the UK (5.2) and lowest in Spain (1.4), and average order size per purchase is highest in Germany (153 euro) and lowest in Italy (50 euro). Customers can choose between air express delivery and conventional ground delivery. The average surcharge for express delivery is highest for Sweden (10.8 euro) and lowest for the UK and Germany (7.6 euro).

Ground delivery lead-time depends on the distance from the Netherlands, but the lead-time for express delivery by air is one day for almost all destinations, irrespective of distance. For twenty postal code areas (ten in Italy, five in Germany, and five in Sweden), express deliveries are often delayed. Some of these areas correspond to isolated destinations, such as islands without connection to the airfreight network. The other areas have only a single or a few express deliveries, most of which were delayed because of bank holidays. In such cases, the lead-time benefit of express delivery, as anticipated by the customer when placing the order, could not be realized. The combined transaction share of these twenty areas is 1% (394 out of 39,749 transactions), with in total 74 express deliveries. The average lead-time of these express deliveries is 2.95 days, which is only slightly below the average normal ground delivery lead-time of 3.15 for these areas. The average lead-time benefit for these twenty areas is therefore very small (6%, as compared to 55% overall), and the associated average cost of time saving by express delivery is excessively large (44 euro per day actually saved, as compared to 6 euro overall).

[Insert Table 1 here]

The potential size of cross-border e-shop markets can be estimated from current retail throughput data. For this purpose, we use a recently released e-commerce report that includes the retail and cross-border shares in the e-commerce index for the European Union [20]. Projected monthly e-commerce and cross-border e-commerce market sizes can be obtained by combining the e-commerce index data with actual monthly sales figures of the manufacturer. Such projections provide useful knowledge in launching new cross-border e-commerce shops [3]. Table 2 shows that the current cross-border e-commerce market covers only 53% of the projected market size. Sweden comes out as the most promising country, with only 15% current coverage. The UK is also promising, as it has the widest gap between actual and projected sales volume and is renowned as multi-channel leader in Europe. The results for Italy are somewhat exceptional, as the actual coverage is nearly five times as large as anticipated. This result is due mainly to a very low projected e-commerce share of retail (1.1%). It seems that the manufacturer of the case study is relatively successful in its e-commerce activities in Italy.

[Insert Table 2 here]

Table 3 summarizes descriptive statistics of the case study data for each of the variables mentioned in our set of hypotheses in Section 3. The total number of transactions per postal code area ranges from 1 to 737, with an average value of 78. Express delivery is the preferred choice in 27% of the transactions, with a lead-time benefit of 55% on average and 78% as maximum. The logistic cost ratio is 17% on average, but rises as high as 110% for some cheap transactions. The mean value of 6 for cost time savings means that the average extra surcharge of express delivery is 6 euro per gained day. CTS is the only variable with missing values (5 out of 509) and contains 15 outlier values in the range 20-100 caused by very small realized lead-time reductions. These twenty postal code areas are the same as discussed before and correspond with island destinations and areas with few express deliveries most of which experienced excessive delays due to bank holidays. Sometimes we will omit these twenty areas when analysing the effects of CTS on express delivery usage, to prevent that these exceptional areas dominate the analysis.

[Insert Table 3 here]

5. Empirical results for cross-border e-commerce

5.1 Correlation analysis

As a first step, we consider the bivariate correlations between the variables of interest. Table 4 shows sample correlations for the dataset of 509 postal code areas. The results in the top-right part of the table are unweighted, so that all observations have equal weight irrespective of the number of transactions per area. As a rule of thumb, correlations larger than 0.07 in absolute value are significant against a one-sided alternative at the five percent level. More precisely, a sample correlation r > 0 is significant against the one-sided alternative hypothesis of positive correlation if $r \geq 1.65/\sqrt{509} = 0.07$, and r < 0 is significantly negative if r ≤ –0.07. The two largest correlations in absolute value are -0.63 for CTS and LTB, and -0.62 for LCR and OS. These two negative correlations stem directly from the definitions of these variables, as CTS is inversely proportional to LTB and LCR is inversely proportional to OS.

The first row of Table 4 shows the unweighted correlations of express delivery with each of the variables of our research hypotheses presented in Section 3. The positive correlations of EX with OI, OS, and RP confirm our hypothesis (H1) that express usage improves financial performance, and the largest effect is found for customer trust in terms of repurchase rates. As EX is correlated positively with GDP and negatively with costs (LCR), these results confirm two of our hypotheses on driving factors (H2.1 and H2.2). The other three hypotheses on these driving factors (H2.3) are also confirmed, as EX is correlated positively with benefits (LTB) and negatively with costs (CTS and RTC).

The bottom-left half of Table 4 shows weighted correlations, where each postal code area gets weighted proportional to the number of transactions in the area. More precisely, for observed values x_i and y_i in postal code area i with N_i transactions, the weighted correlation of x and y is defined as $\sum_i N_i(x_i - \bar{x})(y_i - \bar{y}) \;/\; \sqrt{\sum_i N_i(x_i - \bar{x})^2 \sum_i N_i(y_i - \bar{y})^2}$, where $\bar{x} = \sum_i x_i/509$ and $\bar{y} = \sum_i y_i/509$ are unweighted means. The weighted correlations are in line with the unweighted ones and tend to be larger in absolute value for express delivery. Our research hypothesis on financial performance finds stronger confirmation for OS and RP, and weaker for OI. The hypotheses for GDP, LCR, LTB, and CTS find considerably stronger confirmation, but the weighted correlation between EX and RTC is not significant.

[Insert Table 4 here]

5.2 Effects of express delivery on financial performance

To assess the effect of cross-border express delivery usage on the financial performance of the online shop, we perform weighted least squares (WLS). For each postal code area, the numerical value of each of the variables in Table 3 is the sample average over all N_i transactions in that area. The standard deviation of a sample average is proportional to $1/\sqrt{N_i}$, so that all postal code areas get equal measurement uncertainty if the sample data are multiplied by $\sqrt{N_i}$ for each area, and these are the weights that we use in WLS. An intuitive interpretation is that postal code areas with larger transaction activity are more important for the online shop.

The regression results for the effect of EX on order incidence, order size, and repurchase rate are shown in Table 5. The outcomes show positive effects of EX on all three financial performance indicators, which confirms our hypothesis (H1). The coefficient 0.119 for OI means that each extra percent of express delivery usage leads, on average, to an increase of order incidence of about 0.12 per week per million persons. Similar linear relations for OS and RP (not shown in the table) give coefficients of 0.89 (standard error 0.19) for OS and 0.21 (standard error 0.02) for RP. On average, for each extra percent of express delivery usage, the order size increases by about 90 eurocent and the repurchase rate increases by about 0.2 percent. We allow for possible threshold effects by specifying a quadratic relation, which is significant for OS and RP (see Table 5) but not for OI (not shown in the table, p-value of quadratic term is 0.10). The marginal effect of extra express delivery usage on OS and RP becomes positive above a threshold value, namely for EX > 5.415/(2×0.096)

= 28.2 for OS and for EX > 0.225/(2×0.007) = 16.1 for RP. As EX has mean value 27, we conclude that the effect on the repurchase rate is positive for the great majority of transactions, whereas the effect on order size is positive mainly for areas where express usage is already reasonably accepted.

[Insert Table 5 here]

5.3 Driving factors for express delivery

Section 3 presented a set of five hypotheses for the driving factors of express delivery usage in cross-border e-commerce: GDP positive effect (H2.1), LCR negative effect (H2.2), LTB positive effect, and CTS and RTC negative effects (H2.3).

Before analysing the combined effects of all factors, we first consider the effect of lead-time benefit (LTB). Our hypothesis is that the relation between LTB and express usage is non-linear and maximal for locations at intermediate distance from the CDC. For this purpose, we specify a cubic relation between LTB and EX. The reason for studying this non-linear relation apart from the other factors is the high collinearity of CTS with LTB and its squared and cubic terms (WLS of CTS on a constant, LTB, LTB^2, and LTB^3 gives an R-squared of 0.93 after omitting the twenty postal code areas with excessive CTS values). The WLS results in Table 6 in terms of the lead-time benefit ratio X = (LTB/100) mean that a positive effect on express delivery usage is estimated for the range where $-142.5 + 864.4\,X - 903.1\,X^2 > 0$, which corresponds to the condition that LTB lies between 21 and 75. The marginal effect of LTB on EX increases in the interval from 21 to 48 and decreases from 48 to 75. As LTB has mean 55 and maximum 78 (see Table 3), we find that the effect of lead-time benefit is positive for the far majority of transactions with saturation near the maximally achievable benefit observed in the data. These findings confirm our hypothesis that LTB has a non-linear effect on EX with maximum at intermediate distances (LTB = 48), that is, for destinations where express delivery provides about 50% savings in delivery time. From the management perspective for cross-border e-shops, discounted or free express delivery promotions should target customers in such regions.

[Insert Table 6 here]

Next, we consider the joint effect of all factors on express usage, incorporating only a linear term for LTB to prevent the aforementioned multi-collinearity problem of CTS with non-linear specifications of LTB. Table 7 presents WLS regression results for two datasets. One dataset has 504 postal code areas, where 5 out of 509 areas are lost due to missing CTS values. The other dataset with 489 areas is obtained after removing 15 destinations with very small realized express delivery lead-time benefits, caused by unavailable airline connections or bank holidays (see Section 4). As our research hypotheses specify the direction – positive or negative – of each factor-effect on express delivery usage, we test the significance of each effect by the corresponding one-sided alternative hypothesis. In the model for 504 areas, most of our hypotheses (H2.1, H2.2, and two out of three for H2.3) are confirmed, except for a non-significant effect of CTS. After removing isolated destinations and delayed express deliveries, the model for the remaining 489 areas confirms all our five hypotheses. The coefficients in Table 7 represent the partial effects, that is, the effects of one factor after controlling for all the other factors. A simple interpretation is in terms of what is needed to generate one extra percent point express delivery usage. This occurs if GDP per capita grows by 1600 euro; or if the lead-time benefit increases by 2.7%; or if the cost mark-up of express delivery decreases by 1.5% as compared to the price of the delivered product or by 60 eurocents per achieved day of lead-time reduction; or if the road transport cost to carry one truck to destination decreases by 463 euro.

[Insert Table 7 here]

5.4 Structural equation model

The foregoing analysis concerned relations for parts of the conceptual model in Figure 1. An integrated approach, incorporating logistic competence and financial performance as latent factors, is obtained by structural equation modelling (SEM). We use partial least squares (PLS) [6, 17] as confirmatory tool of analysis to evaluate the links from exogenous causes (GDP, LCR, LTB, CTS, RTC), via endogenous factors (with EX as observed measure of logistic competence and financial performance as unobserved latent factor), to observed effects (OI, OS, and RP). The strength and significance of the various links is estimated by the SPSS-tool Smart-PLS, with the number of transactions per postal code area as weights and using bootstrapping with re-sample size 5000 to get simulated standard errors and p-values. The estimation dataset consists of the 489 postal code areas that remain after deleting the twenty areas with large express delivery delays, as discussed before.

The results are shown in Figure 4, for standardized variables and with one-sided p-values corresponding to our research hypotheses (H1, H2.1, H2.2, and H2.3). Our analysis is of a confirmatory nature, because the directions of arrows in Figure 4 have been imposed to reflect the conceptual model of previous studies in e-commerce [5, 22]. All links are significant at the 5% level, and all coefficients have the right sign: negative for the links from LCR, CTS, and RTC to EX, and positive for all other links. This provides confirmation of each of our research hypotheses

H1, H2.1, H2.2, and H2.3. Of central importance is the positive effect of logistic competence on financial performance, with coefficient 0.41 and with adjusted R-squared 0.16, meaning that 16% of the variance of financial performance can be attributed to differences in express delivery usage. Further, 47% of the variance in EX is explained by the five exogenous factors GDP, LCR, LTB, CTS, and RTC. The largest effect on EX is that of lead-time benefit (LTB), and the largest effect of financial performance is that on the repurchase rate (RP). The largest indirect effect implied by the SEM is that of LTB on RP, with coefficient 0.16. As the variables are standardized and the standard deviations of LTB and RP are respectively 20 and 9 (see Table 3), this means that a rise of 20% in LTB causes a rise of about $0.16 \times 9 = 1.4\%$ in RP. As this link is the strongest one in the SEM, this result confirms the importance of lead-time for express delivery and for the perceived usefulness of technology [5, 19] in cross-border e-commerce.

[Insert Figure 4 here]

6. Conclusion

The claimed "death of distance" [4] seems to become reality in the cross-border e-commerce market, which is expected to turn the EU soon into a single market [10, 11]. Our study verifies that an important contributor to cross-border e-commerce is a well-developed international express parcel service integrated with an airfreight network to guarantee fast delivery. Manufacturers who plan free express delivery promotions for market expansion across borders need to gain insight into the relationship between express usage and factors like lead-time benefits, logistics costs, and purchasing power in their target markets.

Our case study shows that logistic performance in terms of express delivery usage has positive effects on financial performance and customer trust, as measured by order incidence, order size, and repurchase rates. Lead-time benefit is a primary driver for the use of express services in e-shops, as it is here that customers experience the benefits of using express services over standard delivery. The effect is maximal for lead-time savings of about 50% of standard delivery, and e-commerce managers can use this information to target express deliveries to customers located about two days away in terms of conventional transit times. The results are also useful to support pricing strategies for express services, as one extra percent point express delivery usage can be generated by decreasing the cost mark-up of express delivery by 1.5% as compared to the price of the delivered product or by 60 eurocents per achieved day of lead-time reduction. Offering express services in cross-border e-commerce is particularly attractive for customers with high income who order relatively expensive products as such customers perceive relatively lower cost mark-ups for express delivery when they place their order.

Our study provides an integrated framework for the study of cross-border e-commerce by identifying driving factors of logistic competence and their financial consequences. The presented methodology can be applied for each cross-border e-commerce market, but specific details like effect magnitudes may be specific to each application. Cross-border e-commerce operators can apply the suggested framework to their own operational data to expand their activities. What they need for this type of analysis is an integrated database containing information on logistic performance (logistic costs, lead times, express delivery surcharges), commercial performance (order incidence, order size, repurchase ratio), and consumer characteristics (income, distance, ordered products, express delivery usage).

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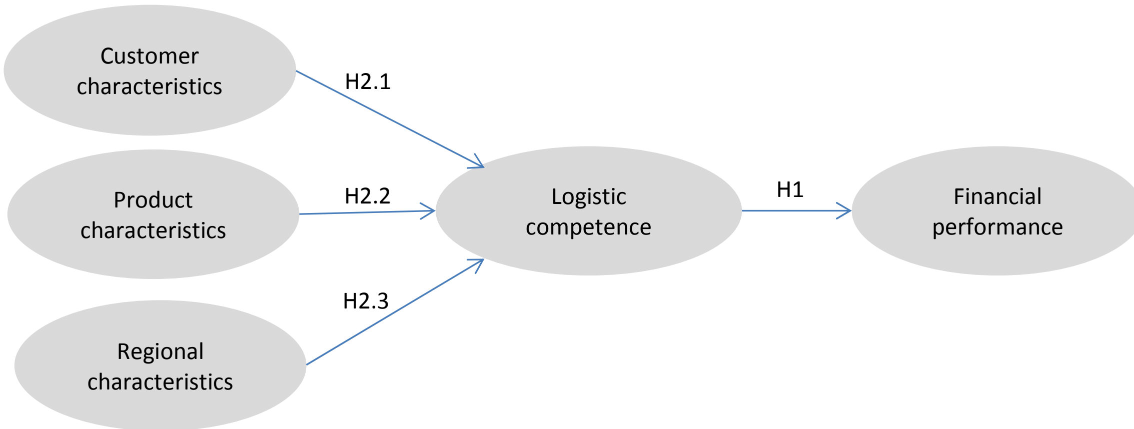

Figure 1: Conceptual model and set of hypotheses.

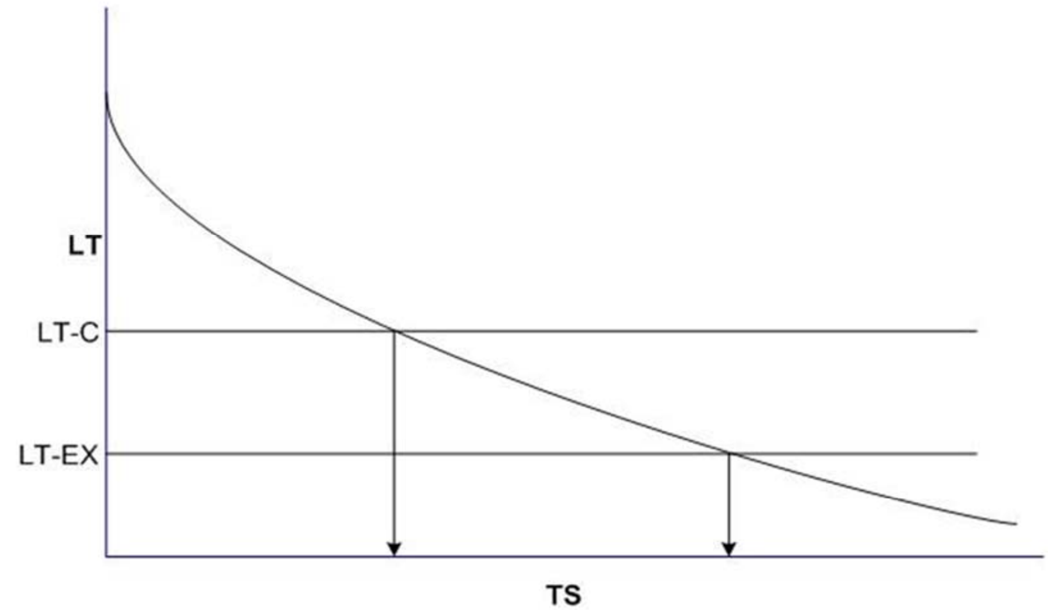

Figure 2: Acceptable lead-time (LT) as function of time sensitivity (TS); LT-C is the lead-time of conventional delivery, and LT-EX that of express delivery.

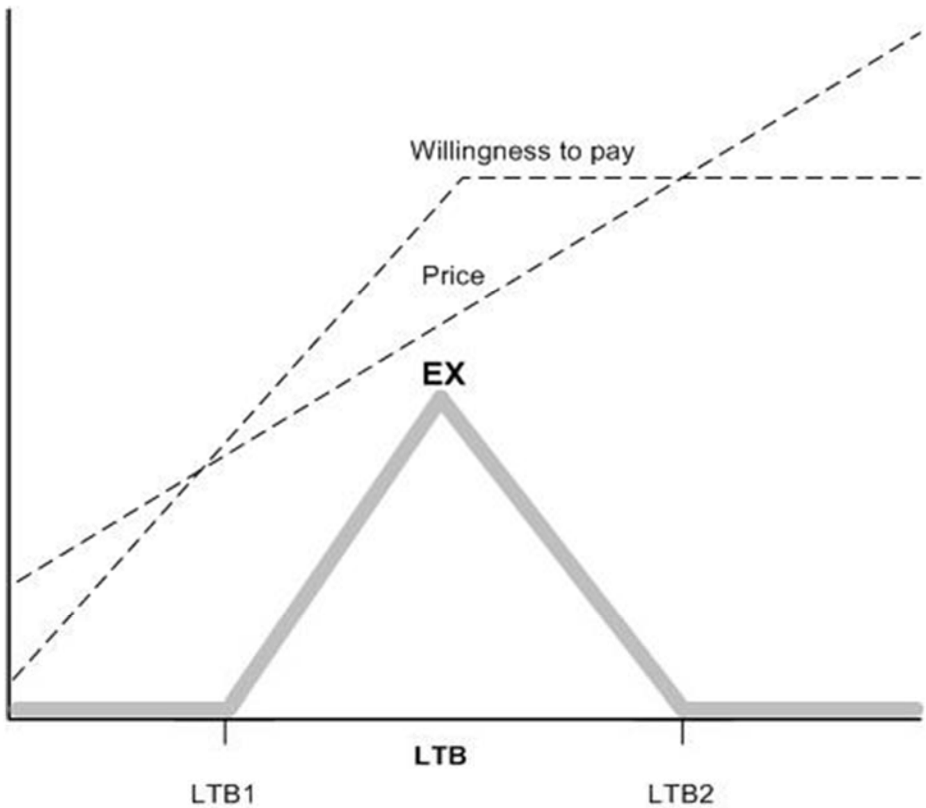

Figure 3: Express usage ratio (EX) as function of lead-time benefit (LTB).

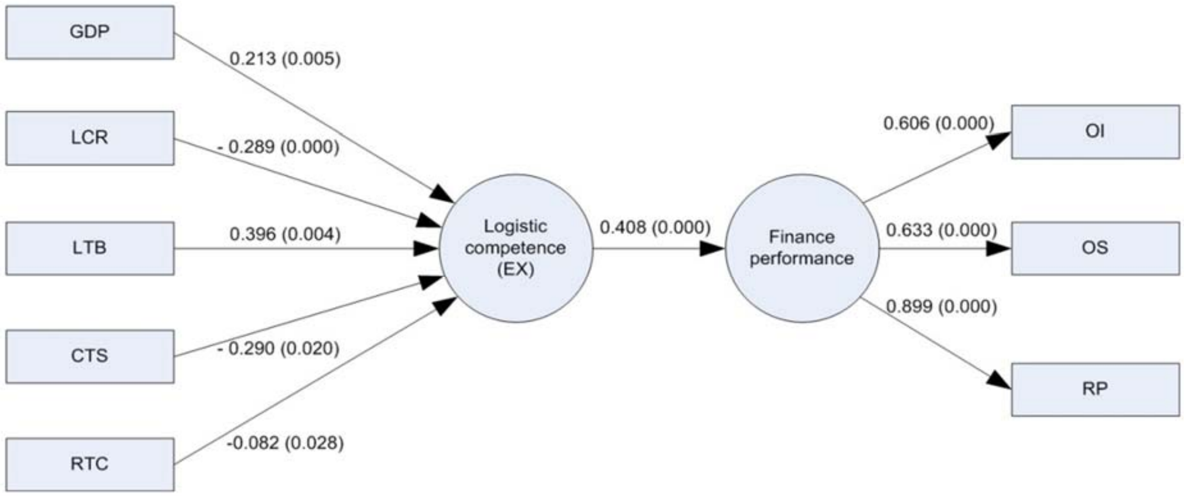

Figure 4: Structural equation model (with standardized regression weights and one-sided p-values).

Table 1: Logistic e-commerce characteristics for five countries

	Country	UK	GER	ITA	SPA	SWE	Total
(1)	Postal code areas (PCA)	185	98	94	48	84	509
(2)	Operating weeks	80	31	33	31	50	45
(3)	Total incidence	24,489	7,040	4,286	2,003	1,931	39,749
(4)	Avg. population per PCA (1000 persons)	318	820	634	985	113	502
(5)	Avg. incidence per PCA	132.4	71.8	45.6	41.7	23.0	78.1
(6)	Avg. incidence per week per PCA	1.7	2.3	1.4	1.3	0.5	1.7
(7)	Avg. incidence per week per PCA per milion persons	5.2	2.8	2.2	1.4	4.1	3.5
(8)	Avg. order size per incidence (euro)	78.2	152.8	50.0	59.4	85.0	85.1
(9)	Avg. express delivery surcharge (euro)	7.6	7.6	9.3	9.3	10.8	8.9
(10)	Avg. normal ground delivery lead-time (days)	2.3	2.9	2.9	3.9	2.9	3.0
(11)	Goods transport by air (1000 tonnes)	2,406	4,336	864	594	142	8,342

Table notes

* Country codes are United Kingdom (UK), Germany (GER), Italy (ITA), Spain (SPA), and Sweden (SWE).

* Case study data (1, 2, 3, 8, 9, 10) are obtained from manufacturer; population size (4) and total volume of goods transported by air (11) are obtained from Eurostat (2014); variables (5, 6, 7) are derived variables.

* The case study observation period runs from August 2013 through December 2014 (80 weeks).

* Incidence means one order by one customer (unconsolidated).

* Express delivery surcharge is the difference between this service and normal ground delivery.

* For "Total", (1, 3, 11) are sum totals, (2, 8, 9, 10) are unweighted averages, (4) is weighted average, (5) = (3)/(1), (6) = (5)/(2), and (7) = 1000*(6)/(4).

Table 2: Actual and projected cross-border e-commerce market size (monthly averages) for five countries

Country	UK	GER	ITA	SPA	SWE	Total
E-commerce market size						
(1) Total retail sales (pcs)	224,204	224,100	181,776	133,611	93,292	856,983
(2) Projected e-commerce share of retail (%)	15.5	9.0	1.1	3.0	6.4	x
(3) Projected e-commerce market size (pcs)	34,752	20,169	2,000	4,008	5,971	66,899
Cross-border e-commerce market size						
(4) Projected cross-border e-commerce share (%)	14	11	7	11	23	x
(5) Projected cross-border e-commerce market size (pcs)	4,865	2,219	140	441	1,373	9,038
(6) Actual cross-border e-commerce sales (pcs)	1,861	1,645	684	375	204	4,769
(7) Actual coverage vs projected market size (%)	38	74	489	85	15	53

Table notes

***** The sales data in rows (1) and (6) apply for the case study, and the market shares in rows (2) and (4) are taken from [20].

* The data in the other rows are obtained as follows: (3) = (1)x(2)/100; (5) = (3)x(4)/100; and (7) = 100x(6)/(5).

* Projected e-commerce share of retail is the ratio of total e-commerce over total retail, and projected cross-border e-commerce share is the ratio of cross-border e-commerce over total e-commerce.

Table 3: Overview of cross-border logistic and e-commerce variables

Variable	Acronym	Mean	Median	Min	Max	Std. Dev.
Express delivery ratio (%)	EX	27	22	0	100	18
Order incidence (#)	OI	4	3	0	47	4
Order size (€)	OS	87	63	8	582	70
Repurchase ratio (%)	RP	9	8	0	69	9
Gross domestic product per capita (1000 €)	GDP	44	44	30	58	8
Logistic cost ratio (%)	LCR	17	15	1	110	10
Lead time benefit (%)	LTB	55	67	0	78	20
Costs time saving by express delivery (€/day)	CTS	6	5	2	100	8
Road transport cost (1000 €)	RTC	1.50	1.46	0.35	4.38	0.74
Sample size per postal code area	N	78	44	1	737	95

Table notes

* Data summaries are for 509 postal code areas in five countries (UK, Germany, Italy, Spain, and Sweden).
* Data are obtained from case study manufacturer, except for GDP that is obtained from the World Economic Database (IMF, 2014).
* The variables are defined as follows:

EX: percentage of total transactions in e-shops that are delivered by express delivery services.

OI: average number of weekly purchase orders per milion persons of postal code area.

OS: average purchase amount per order.

RP: Percentage of total transactions that are from existing customers.

GDP: gross domestic product per capita.

LCR: average cost markup of express as compared to conventional delivery, as percentage of the average price of delivered products.

LTB: percentage lead-time reduction of express delivery services compared to lead-time of conventional delivery.

CTS: average cost markup of express as compared to conventional delivery, divided by the average lead-time reduction in days.

RTC: cost to carry one truck from central distribution center to postal code area.

N: total number of transactions per postal code area.

Table 4: Correlations between cross-border logistic and e-commerce variables

	EX	OI	OS	RP	GDP	LCR	LTB	CTS	RTC
EX	x	0.19	0.24	0.32	0.07	-0.23	0.26	-0.22	-0.15
OI	0.11	x	0.01	0.26	0.07	-0.16	0.12	-0.09	-0.09
OS	0.41	0.20	x	0.35	0.23	-0.62	-0.30	0.07	-0.37
RP	0.45	0.37	0.58	x	0.06	-0.23	0.13	-0.10	-0.07
GDP	0.42	-0.23	0.21	0.21	x	-0.31	-0.19	0.15	-0.36
LCR	-0.42	-0.12	-0.86	-0.41	-0.30	x	0.27	-0.04	0.40
LTB	0.53	-0.06	-0.11	0.19	-0.03	0.07	x	-0.63	0.32
CTS	-0.48	0.12	0.04	-0.16	-0.06	0.01	-0.85	x	0.02
RTC	-0.04	-0.06	-0.26	-0.17	-0.30	0.33	0.27	-0.14	x

Table notes

* Correlations apply for data of 509 postal code areas in the UK, Germany, Italy, Spain, and Sweden.
* The top-right part of the table shows unweighted correlations, and the bottom-left part shows weighted correlations where each postal code area is weighted by the number of transactions.
* Unweighted correlations of 0.07 and above in absolute value are significant (at the 5% level) against a one-sided alternative.
* See Table 3 for the meaning of acronyms of variables.

Table 5: Effects of express delivery usage on three financial performance indicators

Dependent variable	OI		OS		RP	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Constant	4.511	0.000	140.569	0.000	10.134	0.000
EX	0.119	0.000	-5.415	0.000	-0.225	0.006
EX^2	x		0.096	0.000	0.007	0.000
Observations	509		509		509	
R-squared	0.061		0.193		0.211	
S.E. of regression	7.172		60.368		7.281	

Table notes

* Dependent variable is order incidence (OI), order size (OS, or repurchase rate (RP).
* Relations are estimated by weighted least squares, using that the measurement variance of OI, OS, and RP is inversely proportional to N, the total number of transactions per postal code area.
* The square of EX is not significant for OI (p-value 0.098) and is omitted in the model for OI.
* The p-value is for the null hypothesis of zero coefficient against two-sided (non-zero) alternative.

Table 6: Relation between lead-time benefit and express delivery usage

Variable	Coeff.	Std. Error	t-Statistic	p-value
Constant	30.720	7.706	3.986	0.000
LTB/100	-142.500	62.050	-2.297	0.022
(LTB/100)^2	432.180	158.104	2.734	0.007
(LTB/100)^3	-301.024	123.847	-2.431	0.015
Observations	509			
R-squared	0.280			
S.E. of regression	13.162			

Table notes

* Dependent variable is express usage (EX).
* Relation is estimated by weighted least squares, using that the variance of EX is inversely proportional to N, the total number of transactions per postal code area.
* The p-value is for the null hypothesis of zero coefficient against two-sided (non-zero) alternative.

Table 7: Effects of consumer, product, and regional characteristics on express delivery usage

Sample	All			CTS < 20		
	Coeff.	p-value(2)	p-value(1)	Coeff.	p-value(2)	p-value(1)
Constant	-16.643	0.006	x	5.989	0.537	x
GDP	0.572	0.000	0.000	0.622	0.000	0.000
LCR	-0.722	0.000	0.000	-0.674	0.000	0.000
LTB	0.646	0.000	0.000	0.368	0.000	0.000
CTS	0.234	0.120	0.940	-1.754	0.006	0.003
RTC	-2.413	0.026	0.013	-2.161	0.052	0.026
Observations	504			489		
R-squared	0.460			0.470		
S.E. of regression	11.402			11.258		

Table notes

* Dependent variable is express usage (EX).
* For sample "All", 5 out of 509 postal code areas drop out because of missing data for CTS, and for sample "CTS < 20", 15 additional areas (with CTS >= 20) drop out.
* Relations are estimated by weighted least squares, using that the measurement variance of EX is inversely proportional to N, the total number of transactions per postal code area.
* The p-value(2) is for the null hypothesis of zero coefficient against two-sided (non-zero) alternative.
* The p-value(1) is for the null hypothesis of zero coefficient against the one-sided research hypothesis (positive for GDP and LTB, and negative for LCR, CTS, and RTC).