Cross-Border Electronic Commerce: Distance Effects and Express Delivery in European Union Markets

Thai Young Kim, Rommert Dekker & Christiaan Heij

Cross-Border Electronic Commerce: Distance Effects and Express Delivery in European Union Markets

Thai Young Kim, Rommert Dekker, and Christiaan Heij

ABSTRACT: This empirical study examines distance effects on cross-border electronic commerce and in particular the importance of express delivery in reducing the time dimension of distance. E-commerce provides suppliers with a range of opportunities to reduce distance as perceived by online buyers. They can reduce psychological barriers to cross-border demand by designing websites that simplify the search for and comparison of products and suppliers across countries. They can reduce cost barriers by applying pricing strategies that redistribute transportation costs, and they can overcome time barriers offering express delivery services. This study of 721 regions in five countries of the European Union shows that distance is not "dead" in e-commerce, that express delivery reduces distance for cross-border demand, and that e-demand delivered by express services is more time sensitive and less price sensitive than e-demand satisfied by standard delivery. The willingness of e-customers to pay for express services is shown to be affected by income and by the relative lead-time benefits and express charges. Furthermore, the adoption of express delivery is positively associated with e-loyalty in terms of repurchase rates. The results confirm the importance for e-suppliers of cleverly designed delivery services to reduce distance in order to attract online customers across borders.

KEY WORDS AND PHRASES: Centralized distribution centers, cross-border demand, distance, distance effects, express delivery, global e-commerce, gravity model, willingness to pay.

International trade has traditionally been studied for offline trade flows from supplying countries to satisfy demand in other countries. A popular model to study such international trade flows is the gravity model [26, 56] that explains the volume of trade between two countries in terms of their gross domestic product and the distance between them. The general finding is that the volume of trade flows between two countries grows with increasing income and declining distance. Initially distance was defined simply in terms of geographical distance, but later extensions of the gravity model also incorporated subjective and institutional distance dimensions such as whether or not the two countries share a common language, history, legal system, or trade agreement. Firms active in international trade invest in long-term relations with their partners abroad to reduce distance by creating mutual trust and reducing psychological barriers.

Nowadays, customers can purchase goods in borderless online markets. Cross-border electronic commerce offers attractive opportunities to customers because of competitive prices and wide product assortments. The rapidly expanding international e-commerce market [65] for online business-to-customer (B2C) supply shares the importance of income and distance factors with traditional offline business-to-business (B2B) international trade flows. The main distinction with traditional international trade lies in the distance dimensions that separate online buyers from e-business suppliers across borders. The Internet has made the world flatter [19] and some have claimed the "death of distance" [8], whereas others [36] still find cross-border distance effects for online trade but to a lesser extent than for offline trade.

E-business suppliers have various options to reduce the distance to their online clients abroad. For example, they can reduce psychological barriers for cross-border clients by offering websites in their own language, by personalizing websites based on client-specific purchase history and personal information [25, 41], and by simplifying the search for and comparison of products and suppliers through websites for international product comparisons and supplier ratings [46, 64]. Suppliers can also improve the objective cost and time dimensions of distance to their clients. They can overcome cost barriers by flattening their transport tariffs and basing them on the willingness of clients to pay for the delivered service [20], and they can reduce time barriers by offering fast transport modes, such as express delivery, which result in shorter lead times between product order and delivery to the client.

The aim of this paper is to improve understanding of the time and cost dimensions of distance in cross-border electronic commerce. We study these dimensions within the general setting of gravity models for international trade. Such models are attractive to study cross-border e-commerce trade flows as they incorporate important demand factors, including income and objective and subjective distance dimensions as perceived by e-customers. This empirical study concerns B2C supply from a centralized distribution center of an electronics company via cross-border online shops to clients in 721 regions of five countries in the European Union. The main research questions are: To what extent does distance affect cross-border online demand, and how far does express delivery help in reducing this effect? What are the factors that influence the willingness of clients abroad to pay for such express services? And to what extent is the adoption of express usage by clients related to loyalty in terms of repurchase rates? The answers to these questions provide insight in the behavior of online clients abroad, which can help e-commerce managers in developing strategies to reduce their distance to potential cross-border clients and to improve the satisfaction experienced from buying via their online shops.

Literature Review

Gravity Model and Distance Dimensions in International Trade

The gravity model for bilateral trade flows was originally proposed by Tinbergen [56] and Pöyhönen [47]. The term "gravity" refers to the assumption that the

attraction between two countries depends in a multiplicative way on their distance and on their economic "masses" measured by their gross domestic product (GDP), similar to Newton's law of gravity in classical mechanics. Today, the gravity model is well-grounded in the economic theory of international trade [26]. The distance factor not only refers to the geographical distance between the two countries but also to institutional and psychological factors such as home bias and (not) sharing a trade union, legal system, currency, language, or history [36]. The persistence of distance effects is not only due to transport costs but also to unfamiliarity [32] and even exists on the intranational level [61]. Distance can be used as a proxy for transport cost and border taxes as a proxy for economic distance [2]. Contrary to popular beliefs that the world has become "flat" [19] and that distance is "dead" [8], empirical economic research on traditional, offline international trade demonstrates the opposite [26]. National borders remain an important barrier to trade [3, 43], and distance is not dead [35]. A meta-analysis of a large number of international trade studies spanning more than a century shows persistent distance effects that do not decrease over time [12].

The above literature is concerned with distance effects for traditional, offline product flows between countries or in international B2B trade. We next review some findings related to the distance dimensions for cross-border B2C trade. An important difference between B2B and B2C trade is the establishment of trust, as it is much easier for firms to build mutual trust with their major business partners than with their numerous individual customers abroad. As trust is an important driver of cross-country online shopping [25, 39], e-commerce managers should exploit the specific opportunities that online technology offers to reduce the distance perceived by their customers. This distance can be reduced along three main dimensions: information, cost, and time. First, e-commerce managers can reduce information frictions by simplifying the search for and comparison of products via manufacturer websites and price and reputation comparison websites. Consumers with higher price-search intentions are more likely to switch to online channels [25], but poor seller reputation discourages consumers from transactions with distant agents [29]. The service quality of e-suppliers can be compared via customer ratings [46]. An example is eBay's seller-rating technology that reduces distance effects on eBay [36]. Second, e-commerce managers can influence the perceived cost dimension of distance by adapting their transport pricing strategies. E-commerce demand can be influenced by partitioned shipping prices and free shipping [20, 37], and [24] provide an empirical comparison of these two pricing strategies. The effects of distribution services and shipping fees on the profit of internet retailers are investigated empirically in [49] and by means of numerical studies in [34], and some cross-border e-commerce studies find no significant distance impacts on parcel delivery cost [21, 36]. Third, e-commerce managers can reduce the time dimension of distance by offering reliable express delivery options to their customers. Opportunities for express delivery services do not yet seem to have received much attention in the literature so far.

The empirical findings on the three distance dimensions in cross-border e-commerce are currently still somewhat mixed. Because of cultural differences, negative distance effects persist for digital products even in the absence of

transport costs, search costs, and other trade barriers [6]. Compared to offline purchasing in "brick-and-mortar" stores, customers in online e-commerce profit from better information and lower search costs [29, 36], but they are worse off when crossing linguistic borders [21]. Geographic distance affects online trade to a lesser degree than offline trade [36], but home bias persists due to the perceived risks of contract breach [29]. The cost dimension of distance is sometimes found to be relevant [20] and sometimes not, for example, for eBay [36].

Trends and Barriers in European Cross-Border E-commerce

Globalization of e-commerce is a common trend in contemporary e-retail business [5, 39]. 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 [48]. E-commerce also continues to gain traction in the European retail industry, where offline retail has recently stagnated or dropped. Online retail sales in Europe reached approximately €185 billion in 2015, an increase of 18 percent compared to 2014, while offline retail sales were expected to decline by 1 percent in the same period [14]. In the European Union (EU), 15 percent of the inhabitants purchased goods online from sellers outside their country of residence in 2014, compared to 8 percent in 2009 [45]. The online share of total retail trade varies across the EU, ranging in 2014 from 2 percent in Italy to 13 percent in the UK [45], reflecting varying degrees of e-commerce maturity. 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 spillover effects from neighboring countries' e-commerce [28]. There is much 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 [55]. From this perspective, cross-border e-commerce is the key to accelerating the growth of online retail in Europe [21] and globally [5].

Several barriers 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 [57]. Except for customs bottlenecks, e-commerce managers can reduce most of these barriers by providing clear delivery and return policies to their customers. Transit times for cross-border e-commerce in the EU are currently still considerably longer than those for interstate e-commerce in the United States (US). Although the land area of the EU is only 45 percent that of the US (*United Nations Year Book*, 2011), it has similar or even longer transportation times due to border effects [27]. As predicted by the gravity model [26], lengthier transit times make e-retail customers more reluctant to purchase goods outside their home country. This may explain the lower propensity for e-commerce in the EU compared to the US. Online retail sales in the US reached €224 billion in 2014, which is 43 percent higher than in the EU [14], despite the fact that GDP in the EU is 6 percent higher (World Bank statistics, 2014).

US e-commerce data suggest that the EU can expand its e-commerce market by shortening transit times of cross-border trade, for example, by adopting express delivery. Consumers using cross-border e-shops will perceive less geographical distance if express delivery is well-implemented in terms of low prices and short lead times. Current express solutions can offer reliable next-day delivery through the airfreight network in Europe. A survey of EU national regulatory authorities [16] shows 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 [49], and European Courier, Express, and Parcel services provide opportunities to increase cross-border e-commerce in Europe [13]. Still, rational consumers regard express delivery charges as additional transaction costs [10], even if retailers include these costs as part of the product price [24]. Several studies have suggested cost-effective delivery strategies by means of simulation studies [4, 34] and empirical studies [24, 37], but these studies do not examine e-commerce offering express delivery services.

Customer Satisfaction in Cross-Border E-commerce

In neoclassical microeconomics, consumers base their individual choices on marginal utility in terms of costs and benefits [15, 33, 40]. In line with this general idea, the theory of buyer behavior [30] suggests that consumer satisfaction results from an evaluation of the rewards and sacrifices associated with the purchase. The experienced utility or satisfaction of consumption depends on the price, quality, and value of products [63] or services [11, 51], also for online customers [38]. Consistency of price with performance is an important moderator of customer satisfaction in the process of prepurchase expectation, actual performance, and postpurchase assessment [58]. E-service quality in terms of efficiency, reliability, fulfilment, and privacy are key factors to encourage repeat purchase and to build customer loyalty [64]. Online shoppers experience costs in terms of product price, charged prices for transportation and delivery, and waiting time between order and delivery, and they experience benefits in terms of quality of delivered products and value of offered services. Because online customers miss face-to-face contact with retailers, e-commerce managers need to pay attention to all the aspects of the buying experience and the satisfaction of their customers [41, 52]. Better experiences lead to higher customer e-loyalty, defined as the "customer's favourable attitude toward the e-retailer that results in repeat buying behaviour" [54, page 42]. Loyalty is very important for business profitability, as it costs five to eight times more to attract a new customer than to retain an existing one [50]. E-commerce is characterized by a relatively high level of customer loyalty, depending on market share, positioning strategy, concentration of customer spending, and number of operating categories [31].

The service quality experienced by online customers can be enhanced by offering personalized web pages in the customer's language [21] and the perceived costs can be reduced by adjusting transport pricing policies and by offering fast delivery options [34]. A case study of an online grocery shop shows that shipping fees are more important for customer retention than for customer acquisition [37]. Simulation models indicate that free ground shipping policies attract 26 percent more customers, but this factor has a negative effect of 82 percent on profit compared to the optimized delivery strategy [34]. Online retailers can try shipping-fee partitioning tactics to generate more customer demand without destroying their margins by subsidizing light, small, and premium-priced products, since consumers hesitate about paying shipping charges for these categories [24]. They can compete in online markets with full product and price information by improving their physical distribution service performance, in particular delivery speed [49]. 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 B2B viewpoint, showing that express delivery becomes more attractive for regions with higher congestion, for higher-valued goods, and for consumers with higher disposable incomes [42, 62] . The choice for express delivery in e-commerce can be seen as the adoption of a new technology, just as e-commerce itself has been studied within the framework of the technology acceptance model [9, 44].

E-shoppers in the EU considering a vendor outside their own country formerly encountered two problems compared to domestic e-shops: longer lead times and higher delivery charges. These problems have largely been solved due to express delivery services and increasing economies of scale in cross-border e-commerce traffic [13]. A recent survey [16] reveals that express delivery of cross-border e-commerce can substitute standard delivery options. Shorter delivery times provide greater customer satisfaction. From this B2C perspective, rational consumers may base their decisions on the marginal utility of money [1, 39] by comparing the extra charges for express delivery with the associated benefits. The express delivery cost depends on the distance of the delivery address from the distribution center and on the weight and volume of the delivered products. The main benefit for the customer is a shorter lead time. The e-business supplier may also benefit from offering express services, as demonstration of high logistic competence increases customer satisfaction with associated benefits of higher repurchase intention. As stated before, B2C e-commerce equipped with express delivery options for online customers has not yet received much attention in the literature.

Research Hypotheses

Distance in Cross-Border E-commerce

The gravity model of international trade postulates that cross-border trade is affected positively by income and negatively by distance. A recent issue

of much interest and debate is whether distance effects are declining in modern globalized economies. Whereas some have claimed the death of distance [8] in a flat world [19], others find that distance effects are increasing for offline international trade [26], and some argue that the world will never be culturally or economically flat [35]. Results for cross-border online B2C trade are mixed. Distance effects are found to be 65 percent smaller for eBay compared to traditional transactions [36], whereas costs related to payment systems and language barriers eliminate these differences so that the home bias of European online trade is similar in magnitude to that of offline trade [21]. Such barriers between countries, as well as other institutional and psychological dimensions like legal frameworks, trade agreements, and culture and history, can be accounted for by allowing for country-specific effects in gravity models [18, 26]. These findings lead to the first hypothesis:

> **Hypothesis 1 (Distance in cross-border e-commerce):** *E-commerce does not kill distance, because demand for cross-border B2C e-commerce is negatively affected by distance measured in terms of delivery cost and time (after correcting for income and country-specific effects).*

E-commerce offers various options to influence the distance perceived by online customers [36]. Online shops can employ partitioned delivery pricing strategies that differ from actual shipping charges, which depend mainly on product weight and volume [24]. For example, online retailers sometimes offer free shipping for expensive products. Express delivery is of particular interest, as it provides e-commerce managers the option to offer their online customers a trade-off between the two distance dimensions of delivery time and delivery cost. By including average shipping costs in the product price, e-suppliers can present a flat price when products are delivered by standard ground services. As express services by air are costly and depend on the weight and volume of products, such flat rates are less feasible for express deliveries. The charges for express delivery from transport agents increase with transportation distance, so that cross-border online shops may choose to charge higher express delivery costs to customers located farther away from their distribution centers [42]. Online buyers can choose between cheap and slow standard delivery or fast and more expensive express delivery on the basis of perceived values [63]. Within the EU, express delivery via air freight networks is reliable and guarantees next-day delivery for almost all destinations. The lead-time benefit, that is, the reduction in time between order and delivery, and the extra cost of express charges both depend on the geographical distance between the customer and the (nearest) supplier's distribution center. Express delivery reduces the time dimension and increases the cost dimension of distance experienced by online customers. E-customers who opt for the service [63, 64] of express delivery trade their money for

time savings and hence show stronger time preference and less price resistance than e-customers who opt for standard delivery. This leads to the following hypothesis:

> **Hypothesis 2 (Express delivery in cross-border e-commerce):** *Demand for express delivery in cross-border B2C e-commerce is positively related to reduction of delivery time and negatively related to express delivery charges, and e-demand delivered by express services is more time sensitive and less price sensitive than e-demand delivered by standard ground delivery.*

Demand for Express Delivery in Cross-Border E-commerce

According to the theory of buyer behaviour [30, 51], consumer satisfaction from purchase decisions depends on the evaluation of the sacrifices made and the rewards obtained. The above discussion shows that express delivery options present online customers with a trade-off between the sacrifice of higher charges and the reward of shorter lead times. It is usually assumed that the effect of extra stimuli is proportional to the base level [59] and hence diminishes at higher levels [22]. The utility derived from one extra unit of money, for example, is higher for smaller income, just as the eye is more sensitive to light when coming from the dark. Customers will tend to compare the utility derived from express delivery with that of standard ground delivery in terms of the associated relative—as opposed to absolute—gains and losses. The lead-time benefit is therefore defined as the difference between the delivery times of standard and express transport, relative to the standard delivery time. The express cost markup ratio is defined in a similar way in terms of the total price the customer has to pay for the product and its delivery, that is, as the difference between the total price charged for express and standard delivery relative to the total price charged for standard delivery. Furthermore, as negative stimuli of express charges are felt less intensely for higher income levels, the willingness to pay for express services is expected to increase with income [62]. These considerations lead to the following hypothesis:

> **Hypothesis 3 (Adoption of express delivery in cross-border e-commerce):** *The willingness to adopt express delivery services in cross-border B2C e-commerce is positively related to income and lead-time benefits and negatively related to the express cost markup ratio.*

Customer Loyalty and Express Delivery Adoption

As in any other business, cross-border e-commerce has to be a financially viable enterprise. Indicators of financial performance of e-shops are the repurchase rate, that is, the fraction of all purchasing transactions made by returning customers; the average order size per transaction; and the order incidence, which is the average number of orders per unit of time and population. E-commerce managers have various ways to influence the
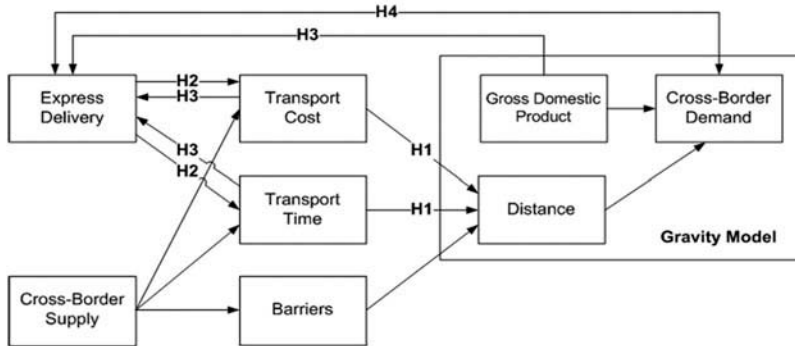
Figure 1. Gravity factors in cross-border e-commerce with four hypotheses

financial performance of their business. They can increase the repurchase rate by providing satisfactory levels of service quality to improve loyalty [11, 49, 51], and the order size by exploiting threshold effects [4] and by offering discounted or free shipping [24]. The quality of provided services is important to attract and retain e-customers [41, 52]. The usefulness of e-commerce to customers depends on how far it simplifies and improves the effectiveness of their shopping. Reliability and speed of delivery are dominant factors, and express delivery provides an important service to cross-border online buyers to reduce distance effects. This leads to:

> **Hypothesis 4 (Customer loyalty and adoption of express delivery in cross-border e-commerce):** *The adoption rate of express delivery in cross-border B2C e-commerce is positively associated with customer loyalty in terms of repurchase rates.*

Figure 1 summarizes the main variables, relations, and hypotheses related to cross-border e-commerce within the framework of gravity models for cross-border B2C e-commerce.

Data and Methodology

Case Study Setting

Cross-border e-shopping is especially attractive to customers looking for products that are not easily available from domestic e-shops or local offline shops. This holds true, for example, for products with low and uncertain demand and low profit, such as accessories, recently launched products, and spare parts. Cross-border e-commerce is therefore an attractive business model for product categories such as consumer electronics that have high stock-keeping costs due to short life spans and widely differentiated assortments. Manufacturers of such products often prefer to run a centralized distribution system because cross-

border virtual presence is more feasible and less expensive than local supply of these products [48]. They can bypass retailers through online distribution channels [57] using a central distribution center (CDC) to efficiently manage stock and uncertain demand. 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 or CDC. Such centralized online shops offer an interesting case to examine the relationship between express delivery and online behavior, 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 means of a case study with transaction data of a large and worldwide operating consumer electronics manufacturer. The CDC is located in the Netherlands and provides cross-border e-commerce services to 721 regions in five EU countries: Germany, Italy, Spain, Sweden, and the United Kingdom. These countries are EU members that share a largely common legal system and free trade agreements. The online product assortment consists of consumer electronics products such as brown goods and white goods, and the e-shop is divided into five main departments: mobile telephony, television and audio, home appliances, information technology (IT) products, and accessories. The total number of offered products, including options, varies over time between 1,500 and 2,000. The e-commerce platform is presented to online shoppers in their own language (based on IP address). It provides the same information and services, so that all customers can choose from the same range of products with identical conditions, online payment systems, and service options. The manufacturer is currently developing systems for personalized websites for its cross-border online customers, but such personalization had not yet been implemented during the case study period that ran from September 2013 through October 2015. Out of a total of 67,899 cross-border online purchase transactions during this period, 56,170 of these were delivered by standard ground transport and 11,729 were delivered by express (17 percent).

The e-manufacturer employs a partitioned pricing policy for transport costs. For standard transport, the actual costs that the e-manufacturer has to pay for logistic delivery services are not revealed to the customer and are included in the product price. As these costs differ per destination country, product prices show some variation across countries, but customers within the same country pay the same price for the same product irrespective of where they live. The actual costs that the e-manufacturer has to pay for express delivery depend on the distance between the CDC and the customer as well as on the weight and volume of the product. Express delivery networks in the EU are concentrated in urban areas with suitable freight volumes and low road transportation costs due to high competition between transport companies. Tight links between airfreight networks and well-built road infrastructure allow for fast and reliable express delivery in such areas, whereas in nonurbanized regions the costs of transportation and express services are higher. On the e-shop's website, customers can choose between standard and express delivery. Standard delivery is the default option, and customers have to pay a cost markup for express delivery with a flat

tariff per country independent of the product, except that for some countries no express costs are charged for orders above a threshold value.

Gravity-based Models: Trade Flows, Income, and Distance

The classical gravity model [3, 36] postulates a multiplicative relation of the form:

$$Q_{ij} = \frac{Y_i Y_j}{Y_W} \left(\frac{T_{ij}}{R_i R_j} \right)^\delta, \tag{1}$$

where Q_{ij} is the trade flow from exporting country j to importing country i; Y_i and Y_j denote the total income of these two countries, and Y_W is total world income; T_{ij} are the trade costs from country j to country i; R_i and R_j denote resistance effects against import to country i and export from country j, respectively; and δ is the trade cost elasticity. In the gravity literature, the trade costs T_{ij} are usually expressed in terms of the distance D_{ij} between countries i and j, so that $= T_{ij} = D_{ij}{}^\rho$. By taking the natural logarithm (ln) of both sides of the trade Equation (1), this equation becomes:

$$\ln(Q_{ij}) = \ln(Y_i) + \ln(Y_j) - \ln(Y_W) + \delta\rho \ln(D_{ij}) - \delta \ln(R_i) - \delta \ln(R_j), \tag{2}$$

This macroeconomic model for bilateral trade flows between countries can be adapted to the type of data considered in this paper. These data are at the micro level of a single manufacturer, and the products flow unilaterally from this manufacturer to customers in various countries. As the manufacturer delivers the products from a single CDC, the exporting country (j) is fixed, so that the term $\alpha_0 = \ln(Y_j) - \ln(Y_W) - \delta \ln(R_j)$ in Equation (2) is also fixed. Furthermore, the import delivered by this manufacturer will only be a (small) part of the total imports to each country, so that the income effect $\ln(Y_i)$ is replaced by $\beta \ln(Y_i)$. Finally, the term $\alpha_i = \alpha_0 - \delta \ln(R_i)$ in Equation (2) acts as a country-specific effect for each importing country [18, 26]. By substituting these results into Equation (2) and defining $\gamma = \delta\rho$, we get:

$$\ln(Q_i) = \alpha_i + \beta \ln(Y_i) + \gamma \ln(D_i), \tag{3}$$

where Q_i is the cross-border e-commerce trade flow from the CDC to online customers in country i with income Y_i and at distance D_i from the CDC. As the income and distance effects are constant across countries, the five country-specific models of Equation (3) can be combined in the joint model:

$$\ln(Q_i) = \sum_{h=1}^{5} a_h \Delta_{hi} + \beta \ln(Y_i) + \gamma \ln(D_i), \tag{4}$$

where Δ_{hi} denote country dummies with value $\Delta_{hi} = 1$ for $h = i$ and $\Delta_{hi} = 0$ for $h \neq i$. Finally, as each destination country (i) is divided into various

delivery regions (r) with region-specific cross-border online demand Q_{ir}, regional income Y_{ir}, and distance D_{ir} from this region to the CDC, the gravity-based model for the case study data becomes:

$$\ln(Q_{ir}) = \sum_{h=1}^{5} a_h \Delta_{hi} + \beta \ln(Y_{ir}) + \gamma \ln(D_{ir}) + \varepsilon_{ir}, \tag{5}$$

where ε_{ir} represents all effects on cross-border e-commerce flows that are not captured by the gravity factors. This model allows us to estimate distance effects in cross-border e-commerce after controlling for income and country-specific effects including institutional and psychological barriers for trade across borders. Although the distance D_{ir} is taken as the geographical distance in classical gravity models for offline trade, alternative specifications in terms of delivery time and delivery cost are of interest for e-commerce applications.

The slope parameters (β and γ) in Equation (5) have the economic interpretation of elasticities, that is, e-commerce demand from a region is expected to be β percent higher for each percent higher income and γ percent higher for each percent extra distance from the CDC. Note that these parameters in Equation (5) measure partial effects, that is, after controlling for the country in which the region lies. Stated otherwise, the gross differences in e-commerce demand between countries with regard to income and distance from the CDC will be captured in the country-specific effects (α_h). Evidently, differences in income and especially in distance will be more pronounced between countries than between regions within the same country. For this reason, the country-specific effects may obscure the actual distance effects on e-commerce demand. It is therefore of interest to estimate the above model after omitting the country-specific effects, so that:

$$\ln(Q_{ir}) = \alpha + \beta \ln(Y_{ir}) + \gamma \ln(D_{ir}) + \varepsilon_{ir}. \tag{6}$$

As noted before, the country-specific effects have been introduced in gravity models to account for trade barriers between countries. If these barriers are small, the country-specific effects can be omitted, as no resistance means $R_i = 1$ in Equation (1) so that $\alpha_i = \alpha_0 - \delta \ln(R_i) = \alpha_0$ is fixed for all countries. It seems not unrealistic to assume that these barriers are relatively small for our case data, because the destination regions lie in five EU countries with close economic and social ties, the e-shop is user friendly in terms of provided website languages and paying system options, and the manufacturer is world-renowned and based outside the EU so that consumer sentiments with respect to this manufacturer will not differ much among the five countries.

The studied regions differ considerably in terms of population size and income, which affects the value of trade flows and also the amount of uncertainty in the error terms ε_{ir} in the gravity Equations (5) and (6). Stated in statistical terms, the variance of these error terms may differ across regions, in which case the ordinary least squares standard errors are

incorrect. It is therefore imperative to test for the presence of heteroskedasticity, for which we use the well-known Breusch–Pagan test [7]. As we find substantial heteroskedasticity in all our gravity models, we employ White standard errors [60] that are robust to any form of heteroskedasticity.

Gravity Statistics per Country

We obtained data on population size, geographical distance, and GDP from the Eurostat database [17]. These data were collected at the NUTS-3 level (Nomenclature of Units for Territorial Statistics) in total 741 regions for the five countries of the case study. The principles for this regional division are that population sizes should be roughly comparable and that administrative divisions and geographic units are favored. The case study is restricted to 721 of these regions, as no demand data are available for twenty regions. The excluded regions, seven of which are for the Canary Islands, are

Table 1. Gravity statistics per country.

	GER	ITA	SPA	SWE	UK	Total
(1) Regions	409	109	48	21	134	721
(2) Population (total, thousands)	81,656	60,550	43,635	9,447	60,739	256,027
(3) Population per region (average, thousands)	200	556	909	450	453	355
(4) Gross domestic product (total, billion euro)	2,606	1,574	997	385	1,694	7,255
(5) Gross domestic product per capita (euro)	31,914	25,988	22,846	40,790	27,884	28,339
(6) Distance from CDC (average, kilometer)	522	1,534	1,796	1,627	806	845
(7) Operating weeks	71	68	71	56	60	65
(8) E-commerce demand (average total per year, euro)	3,103,700	662,826	818,268	977,395	1,588,286	7,150,474
(9) E-commerce demand per thousand capita (average total per year, euro)	38	11	19	103	26	28
(10) Transactions (total)	26,717	11,870	6,599	5,600	17,113	67,899
(11) Transactions (average total per year per million capita)	240	150	111	550	244	209

*Regional data for (1-6) are obtained from Eurostat, from the February 2016 releases of 'nama_10r_3-popgdp' for population, of 'nama_10r_3popgdp' for gross domestic product, and of the so-called 'tercet flatfiles' for distance.

*Country codes are Germany (GER), Italy (ITA), Spain (SPA), Sweden (SWE), and United Kingdom (UK); 20 of the 741 Eurostat NUTS-3 regions are excluded, with total population size 4,793 thousand (1.8 percent of total), and all statistics (2-11) apply for the 721 included regions.

*The statistics in (3) and (6) are averages per region per country, those in (8), (9), and (11) are yearly averages per country, and those in (10) are totals over the full operating period per country.

*Total is sum total over the five countries in (1), (2), (4), (8), and (10), total average in (5) and (9), average per region in (3) and (6), simple average in (7), and weighted average in (11) with population weights (2) for the five countries.

* Euro values for Sweden and the UK are obtained from the average exchange rate over the operating period per country (1 SEK = 0.108 €, 1 GBP = 1.250 €).

relatively small (1.8 percent of the total population) and lie relatively far away with an average transportation distance of more than four times that of the other 721 regions.

Table 1 provides an overview of some key statistics per country. Population size per region varies considerably, with the largest average size in Spain and smallest in Germany. Sweden has the highest income per capita and Spain has the lowest, with a difference of about 80 percent. The other statistics in Table 1 are provided by the e-manufacturer. The observation period runs from September 2013 (week 36) to October 2015 (week 44) with operating periods that differ per country because web shops opened at different moments. The cross-border e-transactions included in the analysis run from July 2014 to October 2015 (71 weeks) for Germany and Spain; from July 2014 to September 2015 (68 weeks) for Italy; from October 2014 to October 2015 (56 weeks) for Sweden; and from September 2013 to October 2014 (60 weeks) for the UK. Among these five countries, the UK is a forerunner in e-commerce and has relatively the most competitive e-market. This manufacturer started its first e-commerce business in the UK, has offered only the express option to the UK since November 2014, and established a new CDC solely for deliveries in the UK in December 2015. For these reasons, we included observations for the UK only until October 2014. Measured per year and per capita, Sweden has the highest number of e-commerce transactions, followed by Germany and the UK. These numbers are relatively the smallest for Italy and Spain. The considerable differences across countries can partly be explained by geographical conditions. Sweden, for example, is sparsely populated and many of its inhabitants live far from offline shops, making e-commerce an attractive alternative.

E-commerce Statistics per Region

Table 2 shows summary statistics per region of several variables related to the e-commerce transactions of the case study. The total number of transactions per region ranges from 1 to 1,792, with an average of 94. As operating periods differ per country and population sizes differ per region, the available weekly e-sales data per region are evaluated in terms of the yearly average order value per thousand inhabitants, with an average of €16 for standard delivery and €11 for express delivery. The express usage ratio is defined as the percentage of all e-shop transactions delivered by express services. Although this ratio is only 13.4 percent on average, the average regional value of products delivered by express services is 48.6 percent of all deliveries (4,823 out of 9,917), so that express orders are on average much more valuable than standard orders. In other words, customers who order expensive products tend to choose express delivery more often. The average repurchase rate of all transactions is 10.8 percent, with 10.1 percent for standard deliveries and 13.3 percent for express deliveries.

The lead times and delivery costs for the e-shop are based on service-level agreements from carriers that provide delivery services for cross-border e-commerce shops. Average standard lead times range from 2.0 days in

Table 2. E-commerce statistics per region.

Variable	Acronym	Mean	Median	Max	Min	St. Dev.
E-commerce demand (total average value per year, euro)	–	9,917.4	4,535.6	369,815.3	55.3	24,703.3
Standard		5,094.7	2,878.6	127,104.7	55.3	9,690.3
Express		4,822.7	1,613.1	279,892.1	0.0	17,825.2
E-commerce demand per thousand capita (total average per year, euro)	Q	27.5	22.2	199.8	0.1	21.6
Standard		16.3	13.5	67.1	0.1	12.1
Express		11.1	7.6	134.6	0.0	13.8
Gross domestic product per capita (thousand euro)	GDPC	27.8	25.4	164.1	11.4	11.9
Distance (average distance from CDC, kilometer)	DIST-KM	844.7	680.3	2,607.1	96.1	531.4
Lead-time (average transport time from CDC, days)	DIST-DAY	2.3	1.9	6.0	1.5	0.8
Standard		2.5	2.0	6.0	2.0	1.0
Express		1.1	1.0	5.0	1.0	0.4
Lead-time benefit (of express, as % of standard lead-time)	LTB	54.5	50.0	83.3	16.7	9.8
Actual delivery cost (average per order, standard and express, euro)	–	6.7	6.3	11.6	6.2	0.8
Relative delivery cost (actual cost as % of value of delivered products)	COST	17.0	16.1	33.7	6.3	3.9
Express cost mark-up charged to customer (euro)	–	8.7	8.4	14.5	5.6	1.1
Express cost mark-up ratio (% of value of delivered products)	ECR	24.4	21.6	57.8	9.4	7.4
Germany and Italy		20.4	20.3	30.6	9.4	2.8
Spain, Sweden, and UK		34.6	34.3	57.8	18.8	5.2
Order size (average per order, standard and express, euro)	–	125.2	126.8	343.2	19.0	59.0
Repurchase rate (% of transactions from existing customers)	RP	10.8	10.8	50.0	0.0	7.3
Express usage ratio (% of transactions delivered by express)	EX	13.4	12.5	45.2	0.0	7.4
Transactions (total, regular and express, full operating period)	N	94.2	55.0	1,792.0	1.0	159.1

* The statistics are for 721 regions in five countries: Germany, Italy, Spain, Sweden, and the UK.
* All euro values for Sweden and the UK are obtained by using the average exchange rate over the operating period per country.

Germany to 4.4 days in Sweden. Express lead times are much shorter and flatter across regions and on average range from 1.0 day in Germany and the UK to 1.5 days in Italy. Express deliveries therefore contribute substantially to making the world flatter when measured along the time dimension of distance. The lead-time benefit is defined as the difference in lead times between standard and express delivery, as a percentage of the standard lead time. The lead time of standard deliveries is on average more than

twice as long compared to that of express deliveries, and the lead-time benefit of express deliveries is on average 55 percent.

As mentioned before, the e-manufacturer follows a partitioned pricing policy that incorporates the actual overall transport costs in product prices (for standard deliveries) and cost markups (for express deliveries). Details of the pricing policy are confidential and not available for analysis, but transport costs are carried in one way or another by the customers and as such affect total e-commerce demand. The actual delivery costs, relative to the order size per region, are therefore postulated as one of the factors driving the value of cross-border e-commerce demand. These relative delivery costs range from 6.3 percent to 33.7 percent per region, with an average of 17.0 percent. Furthermore, the express cost markup shown to customers will be one of the factors driving their choice between standard and express delivery, by comparing this cost markup to the price they have to pay for their order. The express cost markup ratio, defined per region as the express cost markup relative to the average order value, is therefore one of the factors that attract customers to express delivery. This ratio ranges from 9.4 percent to 57.8 percent per region, with an average of 24.4 percent. The e-commerce manager follows country-specific pricing policies, resulting in average express cost ratios that are considerably higher for Spain, Sweden, and the UK (34.6 percent) than for Germany and Italy (20.4 percent). The model for the choice between standard and express deliveries will therefore contain a country-group indicator to account for this difference in cost gap between the two modes of delivery that customers experience in the two country groups.

Results on Express Delivery, Distance, and Customer Loyalty

We first consider simple bivariate relations before presenting empirical results obtained from multivariate models for the empirical investigation of each of the four research hypotheses.

Preliminary Results Based on Bivariate Correlations

The classical gravity variables of interest are the value of transport flows, income, and geographical distance. For the value of transport flows (Q), we take the regional order size, that is, the average value of e-commerce demand per year per thousand inhabitants of the region. Income is measured by annual gross domestic product per capita (GDPC), and distance by the average distance (KM) from the CDC. In e-commerce, customers experience distance along the dimensions of transport time and transport cost. We define transport time as the average number of days between ordering and receiving products (DAY), and transport cost (COST) as the average actual delivery costs relative to the value of delivered products per region. Figure 2 shows scatter diagrams of the transport flows for the 721 regions against
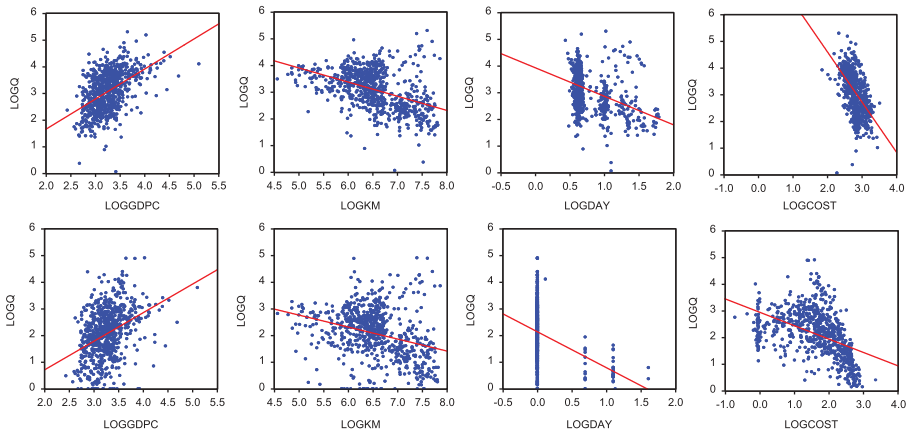
Figure 2. Gravity factors in cross-border e-commerce for transactions with standard delivery (top) and with express delivery (bottom).

income and against the three distance variables, for standard deliveries (top row) and for express deliveries (bottom row). Each scatter diagram also shows the simple regression line obtained by regressing the transport flow data on the variable shown on the horizontal axis, where all variables are taken in natural logarithms as is usual in gravity models. Cross-border B2C e-commerce demand is positively related to income and negatively related to distance for each of the three distance dimensions: geographical, time, and cost. These results support H1.

As it is not easy to assess the magnitude of the effects from the diagrams in Figure 2, parts (a) and (b) of Table 3 show bivariate correlations between the gravity variables (in logarithms). Table 3(a) shows the correlations for the combined standard and express delivery flows, and these two flows are split up in Table 3(b). Compared to e-demand with standard delivery, e-demand with express delivery shows smaller correlations with income (0.39 vs. 0.47), with geographical distance (–0.34 vs. –0.43), and with delivery cost (–0.46 vs. –0.63), although the correlations with delivery time are similar (–0.34 vs. –0.32). We therefore find support for H2 that all three distance dimensions have negative effects on cross-border B2C e-commerce with express delivery and that the cost and geographical dimensions of distance matter less for express delivery than for standard delivery. However, the time dimension of distance seems to be of similar importance for the two delivery modes.

The scatter diagrams in Figure 3 and the correlations in Table 3(c) are related to H3 and H4 on the express usage ratio (EX), the percentage of all transactions delivered by express services. As mentioned before, the e-manager uses different pricing policies for delivery costs for Germany and Italy compared to Spain, Sweden, and the UK. We therefore study the bivariate relations of interest separately for these two country groups. The variables involved are the express cost markup ratio (ECR) defined by the express cost markup as a percentage of the value of delivered products, the lead-time benefit (LTB) of express delivery as a percentage of standard lead time, and

Table 3. Correlations between (logarithmic) gravity variables and between e-commerce variables.

(a) Total	Q	GDPC	DIST-KM	DIST-DAY	COST
Q	1				
GDPC	0.50	1			
DIST-KM	−0.45	−0.27	1		
DIST-DAY	−0.41	−0.24	0.64	1	
COST	−0.56	−0.34	0.35	0.22	1

(b) Standard /Express					
Q	X	0.39	−0.34	−0.34	−0.46
GDPC	0.47	X	−0.27	−0.27	−0.14
DIST-KM	−0.43	−0.27	X	0.37	0.37
DIST-DAY	−0.32	−0.21	0.67	X	0.26
COST	−0.63	−0.29	0.34	0.21	X

(c) Total	EX	GDPC	LTB	ECR-GI	ECR-SSU	RP
EX	1					
GDPC	0.07	1				
LTB	0.24	−0.03	1			
ECR-GI	−0.40	−0.14	−0.10	1		
ECR-SSU	−0.57	−0.28	0.14	X	1	
RP	0.11	0.11	−0.01	−0.18	−0.39	1

* Variable acronyms are explained in Table 2; ECR-GI and ECR-SSU are the average express cost mark-up ratio (ECR) respectively for Germany and Italy and for Spain, Sweden and the UK.
* All variables in Tables (a) and (b) are in logarithms, and in Table (c) income (GDPC) is in logarithms whereas the other (ratio) variables EX, LTB, ECR, and RP are all in levels.
* Tables (a) and (c) are for the regional observations of joint regular and express flows, whereas Table (b) shows correlations for the regular flows at the south-west corner and those for express flows at the north-east corner (the express flows are 0 for 21 regions and COST is undefined for those 21 cases).
* In Table (c), the correlations for ECR-GI are based on 518 regions and those for ECR-SSU on 203 regions.

the repurchase rate (RP) defined as the percentage of transactions made by previous customers. The first three columns of Figure 3 show scatter diagrams of EX against GDPC (in logarithms), LTB, and ECR, for Germany and Italy in the top row and for Spain, Sweden, and the UK in the bottom row. These diagrams indicate that express usage is negatively related to express costs and weakly positively related to lead-time benefit. Furthermore, it is positively related to income in Spain, Sweden, and the UK, but nearly unrelated to income in Germany and Italy. These findings are supported by the correlations in Table 3(c), showing the largest cost effects for Spain, Sweden and the UK. As a rule of thumb, correlations are significant at the 5 percent (or 10 or 1 percent) level if they are larger in absolute value than $2/\sqrt{n}$ (or $1.65/\sqrt{n}$ or $2.58/\sqrt{n}$), where n is the sample size. In our case $n = 721$, so that correlations are significant at the 5 percent (or 10 or 1 percent) level if they are larger than 0.075 (or 0.061 or 0.096) in absolute value. The correlation of EX with GDPC is 0.07 and is therefore significant
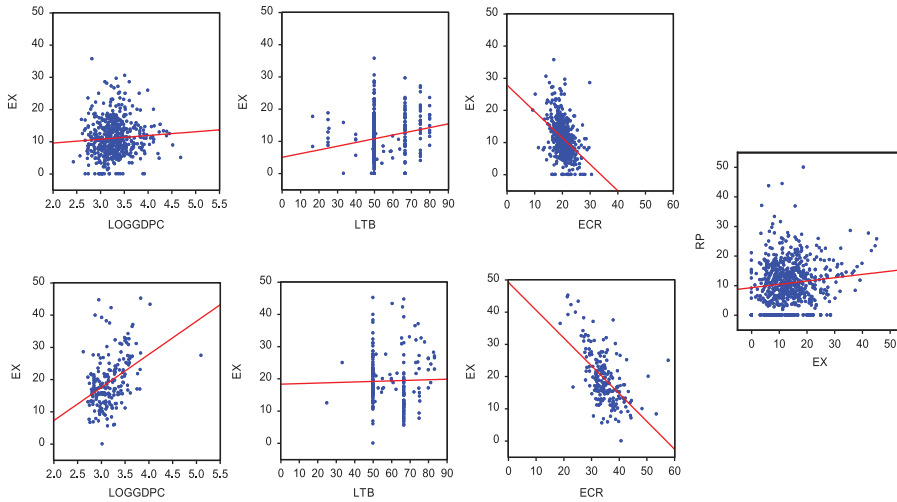
Figure 3. Three factors for express delivery adoption (EX) in cross-border e-commerce in Germany and Italy (top) and in Spain, Sweden and the UK (bottom); the scatter diagram of repurchase rate against EX on the right is for all five countries combined.

only at the 10 percent level, whereas the positive correlation with LTB (0.24) and the negative correlations with ECR (–0.40 and –0.57) are significant at the 1 percent level. We therefore find support for H3 that willingness to adopt express delivery services in cross-border B2C e-commerce is positively related to lead-time benefits, and negatively related to express charges. However, we find only weak support for the classical gravity variable of income. Finally, the rightmost scatter diagram in Figure 3 and the correlation of 0.11 between EX and RP (significant at the 1 percent level) in Table 3(c) are in line with H4 that adoption of express delivery and customer loyalty in terms of repurchase rates are positively associated.

Empirical Results for Distance in Cross-Border E-commerce (Hypothesis 1)

The case study data provide cross-border e-commerce flows from the manufacturer's CDC to e-customers in 721 regions in five EU countries. We start by relating these flows to the classical gravity variables income and distance by means of the simple gravity model in Equation (6). Because the regions vary in operating period and population size, the value of demand flow per region is standardized to the average e-commerce demand (with standard and express deliveries combined) per year per thousand inhabitants of the region (Q as defined in Table 2). In line with this standardization, the income variable (Y) is defined as the regional gross domestic product per capita (GDPC in Table 2). Distance (D) is the average transport distance per region between the CDC and the delivery addresses in that region (DIST-KM in Table 2). The least-squares

residuals of Equation (6) show a considerable amount of heteroskedasticity (the Breusch–Pagan test [7] has a p-value < 0.0005), so that White standard errors [60] are employed. Similar results hold true for all other gravity regressions in Tables 4 and 5, so that we will always present White standard errors for the coefficients of all these models. The outcomes of the gravity model in Equation (6) are shown in Model (a) in Table 4. The income effect is positive and the estimated income elasticity of e-demand of 0.923 does not differ significantly from 1 (p-value 0.335 for the null hypothesis of unit elasticity). This means that two regions that are equally far from the CDC and differ by 1 percent in income show on average also about 1 percent difference in e-commerce demand. The distance effect is negative, and 1 percent extra distance from the CDC leads, under the assumption of fixed income, to about 0.4 percent less demand on average, with 95 percent confidence interval from 0.3 percent to 0.5 percent. This negative distance effect is in line with classical gravity theory and indicates that (geographical) distance is not "dead" in e-commerce. The obtained e-demand elasticity of –0.4 confirms elasticities estimated for eBay transactions in [36] that range from –0.3 to –0.5. These outcomes support H1.

Model (a) in Table 4 neglects possible differences in trade barriers across countries. Model (b) in Table 4 corrects for such country-specific effects by including e-demand level effects per country, where Germany is taken as reference country as it has the majority of destination regions (409 out of 721). This model is the classical gravity model with trade resistance factors shown in Equation (5). The results show that, compared to Germany and for given income and distance, e-commerce demand is smaller in Italy, the UK, and Spain, and larger in Sweden. The income elasticity is now estimated at about 0.67 (with 95 percent confidence interval 0.54 to 0.79), which is somewhat smaller than in Model (a). The reason is that the income effect in Model (b) is the effect within each country, thereby eliminating effects that are due to income differences between countries. For the same reason, the distance effect in Model (b) is also smaller than before, with an elasticity of about –0.14 (with 95 percent confidence interval –0.23 to –0.06). Evidently, distances from the CDC differ much less within a country than between countries. Still, distance has a significantly negative effect on e-demand for fixed income and within each of the destination countries. The outcomes of Model (b) therefore also support H1.

Whereas distance is measured in terms of geographical distance in Models (a) and (b), the distance dimensions of time and cost that are relevant for e-commerce are added as additional demand drivers in Models (c) and (d) in Table 4. The outcomes of the simple model of Equation (6) are qualitatively similar to those of the model of Equation (5) that includes country-specific effects, so we discuss only the results of the latter Model (d) in Table 4 (in terms of 95 percent confidence intervals for the estimated e-demand elasticities). The income elasticity is positive (0.35 to 0.59) and the distance elasticity is negative along all three considered dimensions—geographical (–0.26 to –0.10), delivery time (–0.49 to –0.17), and delivery cost (–2.02 to –1.16). Note that these distance effects are partial effects so that, for example, if delivery time decreases by 10 percent, demand increases by about 1.7–4.9 percent for fixed geographical distance and fixed delivery cost. Table 3(a) shows the evident fact that the three

Table 4. Gravity models for cross-border e-commerce.

Model	(a)	(b)	(c)	(d)	(e)
Dependent variable	ln(Q)	ln(Q)	ln(Q)	ln(Q)	ln(Q)
Constant	2.688*** (0.447)	2.102*** (0.348)	5.762*** (0.452)	7.413*** (0.745)	6.089*** (0.627)
Italy	x	-0.936*** (0.071)	x	-0.534*** (0.092)	-0.692*** (0.074)
Spain	x	-0.364*** (0.093)	x	0.467** (0.131)	0.244** (0.109)
Sweden	x	0.940*** (0.110)	x	1.357*** (0.108)	1.183*** (0.093)
United Kingdom	x	-0.582*** (0.063)	x	0.067 (0.111)	-0.033 (0.103)
Gross domestic product per capita (GDPC, log)	0.923*** (0.080)	0.665*** (0.061)	0.668*** (0.073)	0.470*** (0.058)	0.502*** (0.059)
Distance in kilometer (DIST-KM, log)	-0.399*** (0.040)	-0.143*** (0.043)	-0.140*** (0.043)	-0.175*** (0.040)	x
Distance in delivery time (DIST-DAY, log)	x	x	-0.467*** (0.101)	-0.325*** (0.079)	-0.407*** (0.076)
Distance in delivery cost (COST, log)	x	x	-1.269*** (0.118)	-1.589*** (0.215)	-1.517*** (0.212)
Sample	Total	Total	Total	Total	Total
Observations	721	721	721	721	721
R-squared	0.354	0.584	0.487	0.674	0.667

*Dependent variable ln(Q) is the yearly average value of e-commerce demand per thousand inhabitants (Q, in logarithms) per region.
*Sample "Total" means that the values per region of Q, DIST-KM, DIST-DAY, and COST are based on the combined e-commerce demand flows of standard and express deliveries.
*Germany acts as baseline, and indicators for the other countries allow for country-specific effects; for example, ITALY is an indicator variable that takes value 1 for all regions in Italy and value 0 for all regions outside Italy.
*The table shows ordinary least squares coefficients with White standard errors that are robust against heteroskedasticity; ** and *** denote statistical significance at respectively the 10%, 5%, and 1% level.

distance variables are positively correlated (with correlations 0.22, 0.35, and 0.64), so that the partial effects in Model (d) in Table 4 can be seen as being split along three dimensions of the total distance effect. Model (e) in Table 4 shows the estimated e-demand elasticities if geographical distance is removed from the model to get uncorrected time and cost effects as experienced by e-customers. The estimated e-demand elasticity is –0.41 for delivery time and –1.52 for delivery cost. As all estimated distance effects in the gravity Models (c)–(e) are significant (even at the 1 percent level), these outcomes support H1. Distance remains a negative factor in e-commerce, as demand for cross-border B2C supply is significantly negatively affected by distance measured in terms of delivery cost and delivery time, after correcting for income and country-specific effects.

Empirical Results on Express Delivery in Cross-Border E-commerce (Hypothesis 2)

In the previous analysis of cross-border e-commerce demand, the trade flows delivered by standard transport and those delivered by express services were combined. We now separate these two flows for each region and estimate gravity models for each e-demand flow separately. The results are shown in Table 5, which is comparable in structure to Table 4: Models (a), (c), (d), and (e) in Table 4 for the joint flows are split respectively in the model pairs (a, b), (c, d), (e, f), and (g, h) in Table 5 for standard and express flows separately. The sample size for express flows is 700 in Models (d, f, h), as 21 of the 721 regions have no demand for express deliveries so that the average delivery cost (COST) is undefined in those cases.

Models (a–d) in Table 5 provide e-demand elasticities corresponding to gravity Equation (6) under the assumption that trade barriers do not differ between the five EU destination countries. The income elasticity of e-demand is slightly larger for express deliveries (0.91 and 0.76) than for standard deliveries (0.86 and 0.62). The geographic distance effect is weaker for express deliveries (–0.32 and –0.10) than for standard deliveries (–0.39 and –0.18), and the effect for express deliveries in Model (d) is significant only at the 10 percent level (p-value 0.071). The time effect of distance is significantly negative for express deliveries (e-demand elasticity –0.55), but not significant for standard deliveries (p-value 0.159). The cost effect is significant for both types of delivery, with much larger e-demand elasticity for standard deliveries (–1.54) than for express deliveries (–0.39). Summarizing the main findings, e-demand delivered by standard service is negatively affected by the geographic and cost dimensions but not by the time dimension of distance, whereas e-demand delivered by express service is negatively affected by the time and cost dimensions but hardly affected by the geographic dimension of distance. This provides support for H2. First, Model (d) shows that the speed and price of delivery affect cross-border e-commerce demand for products delivered by express service. Second, a comparison of Models (c) and (d) shows that e-commerce demand delivered by express service is more time sensitive and less price sensitive than e-demand delivered by standard ground services.

Table 5. Gravity models for cross-border e-commerce with regular and express delivery.

Model	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Dependent variable	ln (Q)	ln (Q)	ln (Q)	ln (Q)	ln (Q)	ln (Q)	ln (Q)	ln (Q)
Constant	2.326*** (0.406)	1.206* (0.636)	6.363*** (0.434)	0.987* (0.577)	6.383*** (0.838)	1.185*** (0.545)	5.235*** (0.720)	0.564** (0.285)
Italy	×	×	×	×	-0.585*** (0.095)	-0.403*** (0.121)	-0.717*** (0.077)	-0.604*** (0.092)
Spain	×	×	×	×	0.356* (0.154)	-0.012 (0.122)	0.163 (0.132)	-0.255*** (0.087)
Sweden	×	×	×	×	0.823*** (0.145)	1.843*** (0.134)	0.673*** (0.129)	1.607*** (0.097)
United kingdom	×	×	×	×	-0.436*** (0.127)	0.407*** (0.100)	-0.524*** (0.119)	0.316*** (0.093)
Gross domestic product per capita (GDPC, log)	0.857*** (0.080)	0.908*** (0.111)	0.620*** (0.067)	0.756*** (0.098)	0.460*** (0.056)	0.641*** (0.085)	0.490*** (0.055)	0.668*** (0.085)
Distance in kilometer (DIST-KM, log)	-0.386*** (0.033)	-0.320*** (0.056)	-0.184*** (0.040)	-0.101* (0.056)	-0.148*** (0.041)	-0.186*** (0.064)	×	×
Distance in kilometer (DIST-DAY, log)	×	×	-0.125 (0.088)	-0.548*** (0.083)	-0.109 (0.079)	-0.134* (0.078)	-0.171** (0.071)	-0.210*** (0.077)
Distance in delivery cost (COST, log)	×	×	-1.544*** (0.111)	-0.390*** (0.036)	-1.416*** (0.242)	-0.382*** (0.048)	-1.349*** (0.237)	-0.369*** (0.048)
Sample	Standard	Express	Standard	Express	Standard	Express	Standard	Express
Observations	721	721	721	700	721	700	721	700
R-squared	0.321	0.187	0.523	0.351	0.693	0.537	0.687	0.531

* This table has the same structure as Table 4.
* Sample "standard" ("Express") means that the values per region of Q, DIST-KM, DIST-DAY, and COST are based on the e-commerce demand flows with standard (express) deliveries.
* The sample size in Models (d,f,h) is 700, as 21 regions have no express deliveries at all so that the delivery cost (COST) is undefined for express deliveries in these regions.

Models (e) and (f) in Table 5 correct for country-specific trade-barrier effects and correspond to the classical gravity model with trade resistance factors in Equation (5). Compared to Germany, base levels of e-demand are roughly similar in Spain, lower in Italy, and higher in Sweden. The UK has a lower base level for standard deliveries and a higher level for express deliveries. The income elasticity of e-demand is again somewhat larger for express (0.64) than for standard deliveries (0.46). The time effect is a bit stronger for express (–0.13, significant at 10 percent) than for standard delivery (–0.11, not significant at 10 percent). The price effect is again stronger for standard (–1.42) than for express services (–0.38), and the effect of geographic distance is roughly comparable for both delivery modes (–0.15 and –0.19). Note that these are all partial effects so that, for example, the time elasticity of e-demand of –0.13 for express deliveries means that a 10 percent reduction in express delivery time leads on average to about 1.3 percent extra e-commerce demand delivered by express under the assumption of fixed income, fixed geographical distance, and fixed actual delivery cost. In Models (e) and (f) of Table 5, the e-commerce distance dimensions of time and cost are correlated with geographical distance, and Models (g) and (h) in Table 5 show the estimated elasticities after omitting geographical distance. The e-demand elasticities of income, delivery time, and delivery cost are roughly comparable to those in Models (e) and (f), except for stronger and more significant effects of time. For fixed income and fixed delivery costs, the e-demand elasticity with respect to delivery time is –0.21 for express and –0.17 for standard services. The outcomes of Models (a–h) in Table 5 provide support for H2. Reduced lead time of express delivery has positive effects on cross-border B2C e-commerce demand according to all three Models (d, f, h). This time effect is indeed considerably larger than for standard delivery in Model (c), but the difference becomes much smaller in Models (e) and (g) after correcting for country-specific effects. The major cause of these reduced differences is that delivery times of standard ground services are strongly related to the destination country, so that a large portion of the delivery time effects is absorbed by the country-specific effects in Models (e–h). The cost dimension of distance has significant negative effects on cross-border B2C e-commerce demand with much stronger effects for standard than for express delivery in all six models (c–h). All these results support H2.

Empirical Results on Express Delivery Adoption (Hypothesis 3)

The above gravity models analyze cross-border e-commerce demand flows from a macroeconomic perspective in terms of income and distance effects. We now turn to the microeconomic perspective of individual e-shoppers and analyze their decisions whether or not to choose express delivery and whether or not to repeat purchasing at the same e-shop. We first consider the express usage ratio, defined as the percentage of e-commerce transactions delivered by express services. H3 states that the willingness to adopt express delivery in cross-border B2C e-commerce is positively related to income and lead-time benefits, and negatively related to express charges. To investigate

this hypothesis, we relate the express usage ratio (EX) per region to per capita income (GDPC), lead-time benefit (LTB), and the express cost markup ratio (ECR) as defined in Table 2. Here the variables EX, LTB, and ECR are defined as ratios, so that the coefficients measure the effect of relative changes. For this reason, income is included in the model in logarithmic form so that its coefficient also measures the effect of relative changes in income. As the e-manufacturer applies different delivery pricing policies per country, we incorporate country-specific effects in the model to account for these differences. A disadvantage of including these country-specific effects in the model is that the lead-time benefit of express compared to standard deliveries is strongly related to the destination country, as standard delivery times are longer for distant countries (the multiple correlation between LTB and the five country indicators is 0.58). To reduce this kind of absorption of lead-time benefits, we take into account that the e-managers charge relatively low express prices to Germany and Italy and relatively high ones to Spain, Sweden, and the UK (see Table 2). We therefore employ a country group indicator with value 1 for high-cost countries (Spain, Sweden, and the UK) and value 0 for low-cost countries (Germany and Italy; the correlation between LTB and this country-group indicator is 0.28).

Table 6 shows the outcomes of two weighted least squares (WLS) estimates for the effects of explanatory factors on the express adoption ratio per region, Model (a) with country-specific effects and Model (b) with country-

Table 6. Models for adoption of express delivery.

Model	(a)	(b)
Dependent variable	EX	EX
Constant	32.803*** (2.313)	28.254*** (2.414)
Italy	3.529*** (0.540)	X
Spain	25.277*** (0.986)	X
Sweden	35.807** (0.887)	X
United Kingdom	27.367*** (0.668)	X
Indicator for Spain, Sweden and the UK	X	29.370*** (0.727)
Gross domestic product per capita (GDPC, log)	0.756* (0.451)	1.557*** (0.489)
Lead-time benefit (LTB)	0.027 (0.021)	0.150*** (0.018)
Express cost mark-up ratio (ECR)	-1.286*** (0.049)	-1.477*** (0.051)
Sample	Total	Total
Observations	721	721
R-squared (weighted /unweighted)	0.806 /0.407	0.750 /0.323

*Dependent variable is the express usage ratio (EX) per region, that is, the percentage of e-commerce transactions of the region delivered by express services.
*Country indicators and baseline in Model (a) are the same as explained in Table 4.
*The indicator for Spain, Sweden and the UK in Model (b) takes value 1 for these three countries and value 0 for Germany and Italy.
*The table shows weighted least squares coefficients with their associated (WLS) standard errors; the applied weight of each region is equal to the square root of the total number of transactions (N) of that region, that is, $\sqrt{N}$.
*The weighted R-squared applies for the regression with weighted regions, and the unweighted R-squared measures the model fit for unweighted data.

group indicator. We apply WLS because the number of e-commerce transactions varies per region. Let the number of these transactions for a given region be N, then the express usage ratio (EX) for that region is based on N individual choices of e-shoppers, and the sample standard deviation of EX for that region is proportional to $1/\sqrt{N}$. To obtain homoskedastic error terms, that is, with equal standard deviation, the e-commerce data for this region are multiplied by $\sqrt{N}$, and we apply WLS with these regression weights. More precisely, in order to allow estimation by ordinary least squares, we model the express usage ratio by the following equation where N_{ir} is the number of transactions in region r of country i:

$$\sqrt{N_{ir}} \times EX_{ir} = \alpha_i \sqrt{N_{ir}} + \beta \sqrt{N_{ir}} \times \ln(GDPC_{ir}) + \gamma \sqrt{N_{ir}} \times LTB_{ir}$$
$$+ \delta \sqrt{N_{ir}} \times ECR_{ir} + \varepsilon_{ir}. \tag{7}$$

Here the intercept α_i differs for all five countries in Model (a) and takes only two different values in Model (b), with one value for Germany and Italy and the other for Spain, Sweden, and the UK. Stated in intuitive terms, data of regions with more e-commerce transactions get a larger weight in estimation with weight proportional to the square root of the number of transactions. The outcomes of Model (a) show significant cost effects, but no significant effect is found for lead-time benefit whereas the income effect is weak and significant only at the 10 percent level. Model (b) provides significant coefficients for all variables, with positive effects of income and lead-time benefit and a negative effect of express cost markup ratio. A simple interpretation of Model (b) is in terms of changes generating one extra percent point usage of express delivery. This can be achieved by increasing the lead-time benefit by 7 percent (1/0.150) compared to the standard delivery lead time, or by decreasing the cost markup of express delivery by 0.7 percent (1/1.477) compared to the price of the delivered product, or if income rises by 0.6 percent (1/1.557).

These outcomes support H3 that the share of express deliveries in cross-border e-commerce demand is significantly positively related to lead-time benefits and income, and significantly negatively related to the express cost markup ratio.

Empirical Results on the Adoption of Express Delivery and Customer Loyalty (Hypothesis 4)

Finally, we consider the association between the adoption of express delivery and customer loyalty measured by the repurchase rate. A first indication of positive association is the positive correlation of 0.11 in Table 3, which is significant at the 1 percent significance level (as $0.11 > 2.58/\sqrt{721} = 0.10$). We can also perform the paired t-test to compare the repurchase percentage for express delivery transactions (13.28) with that for standard delivery transactions (10.07). The observations for both delivery modes are paired by means of the regions. The paired t-test (with White standard error) for the

repurchase rate difference of 3.21 percent has a t-value of 4.92 (p-value < 0.0005). This result shows that the repurchase rate is significantly larger for express deliveries than for standard deliveries, which confirms H4 that these two variables are positively associated.

The positive association between the adoption of express delivery and the repurchase rate can be due to various reasons, for example, because the speed of express deliveries increases e-shopper satisfaction and hence repurchase intentions, or reversely, because repurchasing e-shoppers want to increase their satisfaction by adopting express delivery. One way to disentangle these two mutual effects is by analyzing the time lag structure of the relations between the two variables, express usage ratio (EX) and repurchase rate (RP), by means of the Granger causality test [23, 53]. As a crude check, we estimate models as in [53] with single time lags for weekly data on express usage and repurchase rate aggregated over all 721 regions, resulting in time series for EX and RP with 114 weekly observations. The estimated models are $EX = \alpha_1 + \beta_1 EX(-1) + \gamma_1 RP(-1) + \varepsilon_1$ and $RP = \alpha_2 + \beta_2 RP(-1) + \gamma_2 EX(-1) + \varepsilon_2$, where (–1) denotes the value in the previous week. Then RP is said to be Granger-causal for EX if γ_1 is nonzero, and EX is said to be Granger-causal for RP if γ_2 is nonzero. Both coefficients are found to be significantly different from zero (p-value 0.008 for γ_1 and 0.006 for γ_2). When evaluated this way, we find that both variables affect each other mutually.

Discussion and Conclusion

Main Findings

The objective of our study was to gain insight into the main drivers of cross-border e-commerce demand, and in particular to investigate the effect of various distance dimensions for online shopping across borders. These distance dimensions can be reduced in international e-commerce by innovations both at the demand side, where the Internet allows for instantaneous and global search for products, and at the supply side by offering fast delivery options. We formulated four hypotheses on cross-border e-commerce and express delivery and tested these by means of data from a case study for consumer electronics products with deliveries from a centralized distribution center to 721 regions in five EU countries. The results can be summarized as follows.

Distance effects in e-commerce and express deliveries were studied in terms of the well-known gravity model for international trade. Distance is still found to be of importance in e-commerce, as e-demand declines with growing distance between supplier and e-customer. The overall e-demand elasticity with respect to geographical distance is –0.4 (Table 4[a]), which is in line with the elasticities found for eBay transactions in [36] that range from –0.3 to –0.5. The distance effect on e-commerce demand can be split along four dimensions: geographical distance, delivery time, delivery cost, and trade barriers. The overall partial e-demand elasticity with respect to delivery time is about –0.5 for express delivery (Table 5[d]) and insignificant for standard delivery (Table 5[c]), showing that e-shoppers choosing express

delivery are more time sensitive than those choosing standard delivery. Geographical distance has a negative impact on e-commerce demand even after correcting for the effects of delivery time, delivery cost, and country-specific barriers, with partial e-demand elasticities ranging from –0.1 to –0.2 (Tables 4 and 5). Actual delivery costs are incorporated in product prices and affect e-commerce demand negatively with a partial elasticity of about –1.4 for standard delivery (Table 5[c, e, g]) and –0.4 for express delivery (Table 5 [d, f, h]). The above results support H1 that demand for cross-border B2C e-commerce is negatively affected by the delivery cost and delivery time dimensions of distance. The results also support H2 that demand for express delivery in cross-border B2C e-commerce is positively related to shorter delivery times and negatively related to express delivery charges, and that e-demand delivered by express service is more time sensitive and less price sensitive than e-demand delivered by standard service. In the case study, the e-shop uses a partitioned and country-specific pricing policy where the actual costs of standard delivery are included in the product price. As actual delivery costs and hence product prices increase with distance, these costs imply negative distance effects on e-demand indirectly via product prices.

H1 and H2 are related to the macro level of regional e-commerce flows with standard and express deliveries, whereas H3 and H44 are related to the micro level of individual e-shopper decisions about whether to choose standard or express delivery, and whether to make repurchases. The willingness to pay for express delivery in cross-border B2C e-commerce is positively related to income and lead-time benefits, and negatively related to express charges. One extra percentage point express delivery usage can be generated by increasing the lead-time benefit of express delivery by 7 percent compared to standard delivery, by decreasing the cost markup of express delivery by 0.7 percent compared to the price of the delivered products, or if income rises by 0.6 percent. The repurchase rate lies three percentage points higher for express than for standard deliveries, which is a statistically significant difference. A tentative analysis indicates that express usage and repurchase rates affect each other mutually: past express usage increases current repurchase intentions and repurchasing e-shoppers are more inclined to choose express delivery. These results support H3 and H4 on the willingness to pay for express services and on the positive association between repurchase loyalty and adoption of express delivery in cross-border e-commerce demand.

Practical Implications

The results provide insight in the behavior of online clients abroad, which can help e-commerce managers in developing strategies to reduce their distance to cross-border clients and to improve their satisfaction when buying via their online shops. Customers of e-shops still experience various consequences of the distance from their e-commerce suppliers. The price of ordered products and their delivery, and the lead time between placing the order and receiving the products have negative impacts on demand

volumes. Apart from these objective economic considerations, demand for cross-border B2C e-commerce is also affected by institutional and subjective trade barriers. The case study indicated substantial country-specific effects for e-commerce demand even after correction for differences in income, distance, delivery charges, and delivery times. For fixed income, distance, costs, and delivery times, the value of trade flows per capita is the smallest in Italy, comparable in Germany and in the UK, larger in Spain, and the largest in Sweden (Table 4[d, e]). From a more global perspective, reducing institutional barriers to international trade such as customs costs and border delays will, of course, be beneficial for cross-border e-commerce, but e-commerce managers can also take several measures to reduce distance as perceived by their customers. Examples include offering lower prices and improving delivery speed through improved contracts with transportation companies that provide international e-commerce logistics services. E-managers can rebalance the costs and benefits of their portfolio by applying the type of gravity analysis presented here to their own e-commerce data. Our study indicates that a well-developed international express parcel service integrated with an airfreight network to guarantee fast delivery is important for the development of an EU single digital market. Express delivery can alleviate distance effects along the time dimension at the expense of added distance along the cost dimension. Manufacturers who wish to offer free express delivery to promote market expansion across borders need to gain insight into the relationship between the adoption of express services and factors such as lead-time benefits and delivery costs in their target markets. Another opportunity to increase e-commerce demand is to reduce subjective barriers by means of effective communication and service policies. E-shop websites can be offered in the language of the e-customer and can be personalized based on the preferences and purchase histories of each customer. Simple payment systems and conditions as well as clear delivery and return policies are also essential. Even though our case study is restricted to five EU countries that largely share a common legal system and free trade agreements, the country-specific effects for e-commerce demand are still considerable. To illustrate the magnitude of these effects we consider the results of Table 4(e), where the country-specific effects on cross-border e-commerce demand are estimated after correction for differences in income, delivery time, and delivery cost. As the dependent variable in this model is the logarithm of the value of e-commerce demand, the country coefficients show multiplicative effects compared to the baseline country, Germany. For given income, delivery time, and delivery cost, the annual per capita value of e-commerce demand in the UK is about the same as in Germany, whereas in Italy it is about 50 percent lower—$\exp(-0.692) = 0.50$—in Spain it is about 30 percent higher—$\exp(0.244) = 1.28$—and in Sweden it is even more than 300 percent higher—$\exp(1.183) = 3.26$. These country-specific effects are a catchall for all kinds of differences between countries, including institutional and subjective barriers to international trade, geographic and demographic factors, differences in Internet penetration ratio, and the availability of offline shops in the near vicinity of customers.

The projections in [45] indicate great potential for further growth of e-commerce markets in the EU, which some expect to soon turn into a single market [16, 21]. Such projections provide useful knowledge in launching new cross-border e-commerce shops [5]. For the five countries of the case study, the projected e-commerce share as a percentage of all retail sales in 2015 is the largest in the UK (15.5), followed by Germany (9.0), Sweden (6.4), Spain (3.0), and Italy (1.1). The projected cross-border e-commerce share as a percentage of all e-commerce transactions is the highest in Sweden (23), followed by the UK (14), Germany (11), Spain (11), and Italy (7). These projections suggest ample space for increasing e-commerce activities in the EU and especially for enlarging the share of cross-border e-commerce, for instance, by means of fast and cheap systems for express delivery.

Limitations and Future Research

The methodology presented here provides an integrated framework for the study of cross-border e-commerce by identifying the driving factors of e-commerce demand and express delivery usage. It can be applied to any cross-border e-commerce market, although specific effect magnitudes may differ per application. Cross-border e-commerce operators can apply the methodology to their own operational data to expand their activities. This type of analysis requires an integrated database containing the following management information per destination region: consumer-related characteristics such as (average) income, geographic distance, type of ordered products, and express delivery usage; commercial performance information such as number of transactions, value of ordered products, and repurchase rate; and logistics performance information such as transportation cost, lead time, and express delivery surcharge. The magnitude of the effects reported here might be specific for the case study, but managers can apply the presented methodology to their own management data to evaluate their own performance and to prepare their own policies in cross-border e-commerce.

The analysis presented here has various limitations. The available data are limited to five EU countries that are relatively similar when judged from a global perspective. A valuable extension would be to include more countries that lie farther apart and that differ more in terms of income, transportation costs, and delivery times. Another limitation lies on the supply side, as only a single supplier is included in the analysis. The applied gravity framework could therefore analyze only demand factors from importing countries, and not supply factors from exporting countries. Although online shoppers on personalized websites offered in their own language may be unaware of the physical location of the supplier and its distribution centers, more variation on the supply side would be helpful for a more detailed study of the effects of product prices and delivery lead times and costs on cross-border e-commerce demand. Still another limitation relates to specific characteristics of the case study company. The involved product categories cover only a limited part of all cross-border

e-commerce transactions. Furthermore, the e-managers of this company apply partitioned and country-specific pricing policies to cover actual transportation costs. One of the consequences of these policies is that e-shoppers make their purchase and delivery decisions based on distorted cost information. Inclusion of more manufacturers with differing pricing policies can help in improving the empirical analysis of the effects of delivery charges on cross-border e-commerce demand.

Conclusion

International e-commerce managers can expand their reach to clients across borders by offering services that reduce perceived distance. This study from an international online shop in consumer electronics shows positive effects of express delivery services, where international clients balance the benefits of faster delivery against express surcharges. The choice of express delivery is more probable for repurchasing clients with higher incomes and when express delivery provides greater lead-time benefits with low surcharges compared to standard delivery. The study is restricted to relatively wealthy EU countries, where the e-commerce market is still in its early stages as compared to the US. Cross-border e-commerce is even less developed, and e-managers across the globe have great opportunities to extend their business across borders if they succeed in developing a closer relationship with their clients in terms of trust and services, including delivery time and price.

REFERENCES

1. Ajzen, I., and Madden, T.J. Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of Experimental Social Psychology*, 22, 5 (1986), 453–474.

2. Anderson, J.E. A theoretical foundation for the gravity equation. *American Economic Review*, 69, 1 (1979), 106–116.

3. Anderson, J.E., and Wincoop, E. van. Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93, 1 (2003), 170–192.

4. Becerril-Arreola R.; Leng, M.; and Parlar, M. Online retailers' promotional pricing, free-shipping threshold, and inventory decisions: A simulation-based analysis. *European Journal of Operational Research*, 230, 2 (2013), 272–283.

5. Ben-Shabat, H.; Moriarty, M.; and Nilforoushan, P. Online retail is front and center in the quest for growth. A.T. Kearney Global Consumer Institute. Report on the 2013 Global Retail E-Commerce Index, 2013.

6. Blum, B.S., and Goldfarb, A. Does the Internet defy the law of gravity? *Journal of International Economics*, 70, 2 (2006), 384–405.

7. Breusch, T.S., and Pagan, A.R. A simple test for heteroskedasticity and random coefficient variation. *Econometrica*, 47, 5 (1979), 1287–1294.

8. Cairncross, F. *The Death of Distance: How the Communications Revolution will Change Our Lives and Our Work*. London: Orion Business Books, 1997.

9. Celik, H.E., and Yilmaz, V. Extending the technology acceptance model for adoption of e-shopping by consumers in Turkey. *Journal of Electronic Commerce Research*, *12*, 2 (2011), 152–164.

10. Coase, R.H. The nature of the firm. *Economica, 4*, 16 (1937), 386–405. Reprinted in G.H. Stigler and K.E. Boulding (eds.), *Readings in Price Theory*. Homewood, IL: Irwin, 1952, pp. 331–351.

11. Cronin, J.J.; Brady, M.K.; and Hult, G.T.M. Assessing the effects of quality, value, and customer satisfaction on consumer behavioral intentions in service environments. *Journal of Retailing*, *76*, 2 (2000), 193–218.

12. Disdier, A.C., and Head, K. The puzzling persistence of the distance effect on bilateral trade. *Review of Economics and Statistics*, *90*, 1 (2008), 37–48.

13. Ducret, R. Parcel deliveries and urban logistics: Changes and challenges in the courier express and parcel sector in Europe: The French case. *Research in Transportation Business and Management*, *11* (July 2014), 15–22.

14. Ecommerce sales in Europe will increase by 18.4% in 2015. http://ecom mercenews.eu/ecommerce-sales-europe-will-increase-18-4-2015/(accessed on March 3, 2015).

15. Edgeworth, F.Y. *Mathematical Psychics: An Essay on the Application of Mathematics to the Moral Sciences*. London: Kegan Paul, 1881. (Reprinted New York: A.M. Kelley, 1967).

16. European cross-border e-commerce parcels delivery. 2014 ERGP opinion to the European Commission: On a better understanding of European cross-border e-commerce parcels delivery markets and the functioning of competition on these markets. http://ec.europa.eu/internal_market/ergp/docs/documentation/2014/ergp-14-26-opinion-parcels-delivery-fin_en.pdf (accessed on March 3, 2015).

17. Eurostat Database. http://ec.europa.eu/eurostat/web/products-data sets/(accessed on April 18, 2016).

18. Feenstra, R.C. *Advanced International Trade: Theory and Evidence*. Princeton, NJ: Princeton University Press, 2004.

19. Friedman, T. *The World Is Flat 3.0: A Brief History of the Twenty-first Century*. New York: Picador, 2007.

20. Frischmann, T.; Hinz, O.; and Skiera, B. Retailers' use of shipping cost strategies: Free shipping or partitioned prices? *International Journal of Electronic Commerce*, *16*, 3 (2012), 65–87.

21. Gomez-Herrera, E.; Martens, B.; and Turlea, G. The drivers and impediments for cross-border e-commerce in the EU. *Information Economics and Policy*, *28* (September 2014), 83–96.

22. Gossen, H.H. *Entwickelung der Gesetze des menschlichen Verkehrs und der daraus fliessenden Regeln fur menschliches Handeln*. 1854. Translated by Blitz, R. C. *The Laws of Human Relations and the Rules of Human Action Derived Therefrom*. Cambridge, MA: MIT Press, 1983.

23. Granger, C.W.J. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, *37*, 3 (1969), 424–438.

24. Gumus, M.; Li, S.; Oh, W.; and Ray, S. Shipping fees or shipping free? A tale of two price partitioning strategies in online retailing. *Production and Operations Management*, *22*, 4 (2013), 758–776.

25. Gupta, A.; Su, B.; and Walter, Z. An empirical study of consumer switching from traditional to electronic channels: A purchase-decision process perspective. *International Journal of Electronic Commerce*, *8*, 3 (2004), 131–161.

26. Head, K., and Mayer, T. Gravity equations: Workhorse, toolkit, and cookbook. In K.R. Elhanan Helpman and G. Gopinath (eds.), *Handbook of International Economics*, vol. 4. Amsterdam: Elsevier, 2014, pp. 131–195.

27. Helble, M. Border effect estimates for France and Germany combining international trade and intranational transport flows. *Review of World Economics*, *143*, 3 (2007), 433–463.

28. Ho, S.C.; Kauffman, R.J.; and Liang, T.P. A growth theory perspective on B2C e-commerce growth in Europe: An exploratory study. *Electronic Commerce Research and Applications*, *6*, 3 (2007), 237–259.

29. Hortaçsu, A.; Martinez-Jerez, F.A.; and Douglas, J. The geography of trade in online transactions: Evidence from eBay and Mercadoibre. *American Economic Journal: Microeconomics*, *1*, 1 (2009), 53–74.

30. Howard, J.A., and Sheth, J.N. *The Theory of Buyer Behavior*. New York: Wiley, 1969.

31. Huang, C.Y. Excess loyalty in online retailing. *International Journal of Electronic Commerce*, *16*, 2 (2012), 115–133.

32. Huang, R.R. Distance and trade: Disentangling unfamiliarity effects and transport cost effects. *European Economic Review*, *51*, 1 (2007), 161–181.

33. Jevons, W.S. *The Theory of Political Economy*, 3rd ed. London: Macmillan, 1888.

34. Jiang, Y.; Shang, J.; and Liu, Y. Optimizing shipping-fee schedules to maximize e-tailer profits. *International Journal of Production Economics*, *146*, 2 (2013), 634–645.

35. Leamer, E.E. A flat world, a level playing field, a small world after all, or none of the above? A review of Thomas Friedman's *The World Is Flat*. *Journal of Economic Literature*, *45*, 1 (2007), 83–126.

36. Lendle, A.; Olarreaga M.; Schropp, S.; and Vézina, P.L. There goes gravity: eBay and the death of distance. *The Economic Journal*, *126* (March 2016), 406–441.

37. Lewis, M. The effect of shipping fees on customer acquisition, customer retention, and purchase quantities. *Journal of Retailing*, *82*, 1 (2006), 13–23.

38. Lopes, A.B, and Galletta, D.F. Consumer perceptions and willingness to pay for intrinsically motivated online content. *Journal of Management Information Systems*, *23*, 2 (2006), 203–231.

39. Mahmood, M.A.; Bagchi, K.; and Ford, T.C. On-line shopping behaviour: Cross-country empirical research. *International Journal of Electronic Commerce*, *9*, 1 (2004), 9–30.

40. Marshall, A. *Principles of Economics*. London: Macmillan, 1890.

41. Massad, N.; Heckman, R.; and Crowston, K. Customer satisfaction with electronic service encounters. *International Journal of Electronic Commerce*, *10*, 4 (2006), 73–104.

42. Massiani, J. A. Micro founded approach to the valuation of benefits of freight travel time savings. *Research in Transportation Economics*, *47* (November 2014), 61–69.

43. McCallum, J. National borders matter: Canada–US regional trade patterns. *American Economic Review*, *85*, 3 (1995), 615–623.

44. Molla, A., and Licker, P.S. eCommerce adoption in developing countries: A model and instrument. *Information and Management*, *42*, 6 (2005), 877–899.

45. Nagelvoort, B.; Van Welie, R.; Van den Brink, P.; Weening, A.; and Abraham, J. Europe B2C E-commerce reports. http://www.ecommerce-eur ope.eu, 2014/2015 (accessed on November 10, 2015).

46. Park, I.; Bhatnagar, A.; and Rao, H.R. Assurance seals, on-line customer satisfaction, and repurchase intention. *International Journal of Electronic Commerce*, *14*, 3 (2010), 11–34.

47. Pöyhönen, P. A tentative model for the volume of trade between countries. *Weltwirtschaftliches Archiv*, *90*, 1 (1963), 93–99.

48. Quelch, J.A., and Klein, L. The Internet and international marketing. *Sloan Management Review*, *37*, 3 (1996), 60–75.

49. Rabinovich, E.; Rungtusanatham, M.; and Laseter, T.M. Physical distribution service performance and Internet retailer margins: The drop-shipping context. *Journal of Operations Management*, *26*, 6 (2008), 767–780.

50. Reichheld, F.F., and Schefter, P. E-Loyalty. *Harvard Business Review*, *78*, 4 (2000), 105–113.

51. Rust, R.T., and Oliver, R.L. Service quality: Insights and managerial implications from the frontier. In R.T. Rust and R.L. Oliver (eds.), *Service Quality: New Directions in Theory and Practice*. New York: Sage, 1994, pp. 1–19.

52. Saeed, K.A.; Grover, V.; and Hwang, Y. The relationship of e-commerce competence to customer value and firm performance: An empirical investigation. *Journal of Management Information Systems*, *22*, 1 (2005), 223–256.

53. Sims, C.A. Money, income and causality. *American Economic Review*, *62*, 4 (1972), 540–552.

54. Srinivasan, S.S.; Anderson, R.; and Ponnavolu, K. Customer loyalty in e-commerce: An exploration of its antecedents and consequences. *Journal of Retailing*, *78*, 1 (2002), 41–50.

55. Techatassanasoontorn, A.A. The state-based and regional contagion theories of technology diffusion. Ph.D. diss., Carlson School of Management, University of Minnesota, Minneapolis, 2006.

56. Tinbergen, J. *Shaping the World Economy: Suggestions for an International Economic Policy*. New York: Twentieth Century Fund, 1962.

57. Van Heel, B.; Lukic, V.; and Leeuwis, E. Cross-border e-commerce makes the world flatter. http://www.bcgperspectives.com/content/articles/trans portation_travel_tourism_retail_cross_border_ecommerce_makes_world_flat ter/ (accessed on September 18, 2014).

58. Voss, G.B.; Parasuraman, A.; and Grewal, D. The roles of price, performance, and expectations in determining satisfaction is service exchanges. *Journal of Marketing*, *62*, 4 (1998), 46–61.

59. Weber, M. Die Grenznutzlehre und das „psychophysische Grundgesetz." 1908. Translated by L. Schneider, Marginal utility theory and "the fundamental law of psychophysics." *Social Science Quarterly*, *56*, 1 (1975), 21–36.

60. White, H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*, 4 (1980), 817–838.

61. Wolf, H. International home bias in trade. *Review of Economics and Statistics*, *82*, 4 (2000), 555–563.

62. Zamparini, L., and Reggiani, A. Freight transport and the value of travel time savings: A meta-analysis of empirical studies. *Transport Reviews*, *27*, 5 (2007), 621–636.

63. Zeithaml, V.A. Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *Journal of Marketing*, *52*, 3 (1988), 2–22.

64. Zeithaml, V.A. Service excellence in electronic channels. *Managing Service Quality*, *12*, 3 (2002), 135–138.

65. Zwass, V. Electronic commerce: Structures and issues. *International Journal of Electronic Commerce*, *1*, 1 (1996), 3–23.

THAI YOUNG KIM (thaiyoung@gmail.com) is a senior manager in the logistic innovation department at Samsung Electronics Europe, Netherlands. He received his M.Sc. in maritime economics and logistics at the Erasmus University Rotterdam. His work centers on optimizing logistic cost and efficiency of European central distribution centers. His research interests are warehouse labor efficiency management, spare parts demand forecasting through installed base models, and cross-border e-commerce implementation.

ROMMERT DEKKER (rdekker@ese.eur.nl) is a professor of quantitative logistics and operations research at the Econometric Institute of the Erasmus School of Economics in Rotterdam, Netherlands. He received his Ph.D. in mathematics from the University of Leiden. His research interests lie in maintenance, service and reverse logistics as well as in transport optimization and supply chain management. He has published some 100 papers in *Management Science, Production Operations Management, Transportation Science, IIE Transactions, European Journal of Operations Research*, and others. He has also conducted research for many companies, including ECT Container Terminal, Shell International, Fokker Services, Ortec Consultants, and, at present, ProSelo, which is sponsored by the Dinalog Institute.

CHRISTIAAN HEIJ (heij@ese.eur.nl; corresponding author) is an assistant professor in statistics and econometrics at the Econometric Institute of the Erasmus School of Economics in Rotterdam, the Netherlands. He received his Ph.D. in mathematics and natural sciences from the University of Groningen, Netherlands. His research interests are focused on econometric and statistical research methods and applications in economics and business. He has published in a wide range of journals, including *International Journal of Forecasting, Transportation Research, SIAM Journal on Control and Optimization, Automatica*, and *Archives of Surgery*. He has authored or coauthored several textbooks, including *Econometric Methods with Applications in Business and Economics* (Oxford University Press).