THE ENVIRONMENTAL IMPACT OF SHOPPING VIA THE INTERNET

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Abstract
Shopping via the internet is booming. High growth figures can still be expected in the future. More and more customers buy their goods online; the goods are then delivered to their home. Online customers especially love convenience. On the Internet, the large assortment is at a glance, the selection is independent of time and place, furthermore many products are cheaper. In this way, the customer can save money, save time and avoid ways to the city center. But is online shopping also climate-friendly? Climate-conscious behavior is an aspect that is currently being discussed a lot. The rapidly growing e-commerce is publicly criticized in many places for not being sustainable. Reference is made in particular to increase packaging waste, high return rates (and presumably destruction of returned goods) as well as longer distances that have to be covered for items in e-commerce on the way to the customer. Studies come to very different assessments of the environmental impact of e-commerce compared to traditional retail. This paper focuses on traffic-related environmental impacts when evaluating e-commerce.

1. Booming E-Commerce

In 2018, retail sales in Germany amounted to a total of approximately 525 billion euros. Compared to the previous year, retail sales thus grew by a total of 2.3%. Shopping via the internet accounted for 53.3 billion euros (online trade with (new) goods B2C in Germany): Compared to the previous year, online trade thus grew by 9.1%. Online trade thus remains the growth engine in the retail sector. However, traditional retail still accounts for the bulk of total sales (approx. 89%). Across all sectors, the online share of retail sales in Germany is approx. 11%. [1]

There are two reasons for the high growth rates in online trading. Firstly, more and more consumers in Germany are buying via the internet. The number of online shoppers in Germany grew by five percentage points between 2016 and 2018, from 61% to 66%. Although their online affinity is still below average, the number of online shoppers among the 60+ generation has recently risen above average. More and more older people are discovering online shopping. This group of people is very interesting for online retailers, because they have a high purchasing power (on average). Secondly, the per capita expenditure of online shoppers is rising. The customers in Germany spent around 1,360 euros per person on their online purchases in 2018. [2]

The product groups clothing, electronic goods/telecommunications as well as computers/ accessories/games/software traditionally generate the highest online sales (see table 1). Online sales of fashion & accessories reached a sales volume of 13.2 billion euros in 2018. This corresponds to a 24.9% share of total online trade (amounting to 53.3 billion euros in 2018). Online sales of consumer electronics and electrical appliances (CE/Electro) reached a trade volume of 13.0 billion euros in

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2018. This corresponds to a share of 24.3% of the total online volume. Fashion and consumer electronics thus account for roughly half of online sales. However, growth rates for fashion and consumer electronics were below average in 2018.

	turnover	proportion
Fashion & Accessoires	13.2 billion euro	24.9 %
CE/Elektro	13.0 billion euro	24.3 %
Leisure & Hobby	8.0 billion euro	14.9 %
Home & Furnishing	4.9 billion euro	9.3 %
FMCG*	4.5 billion euro	8.4 %
Do-it-yourself & Garden	2.3 billion euro	4.3 %

Table 1: Industries and share in online trade [3]
(*FMCG: Fast Moving Consumer Goods)

On the other hand, lower sales are achieved in the food, office supplies and pharmaceuticals sectors. However, these branches show quite high growth rates, especially the food sector. Online sales of food rose by almost 16 % compared to the previous year, albeit starting from a very low level.

High growth rates in e-commerce are also expected in the next years. Online shoppers especially love the convenience and the large assortment at a glance. The large selection is quickly available regardless of time and place and many products are significantly cheaper online. The customer can save money and time. But is online shopping also climate-friendly? In many places, the rapidly growing e-commerce is publicly criticized for not being sustainable. What factors play a role here? Are there any differences between the various product types? What role does the behavior of the customer play? Particular reference is made to increased packaging waste, high rates of returns of goods (and presumably the destruction of returned goods) and the long distances that have to be covered on the way to the customer.

In the literature, a central focus of the analysis of sustainability of online trade is laid on the traffic-related environmental impacts. DHL (a German parcel and letter express service) points out that every parcel sent via the delivery system of Deutsche Post causes "only" 500 grams of CO2 emissions. Even with a shopping radius of more than 2 km, a customer would cause higher CO2 emissions with his car [4], because the average CO2 emission of a passenger car in Germany is 147 g/km. [5]

At first glance, Internet trade thus appears to be quite advantageous from an environmental point of view. However, scientific studies come to very different conclusions of the environmental impacts of e-commerce compared with stationary trade. For a genuine comparison, purchasing behavior, the logistical efforts of the trade and the suppliers must also be taken into account. In addition, the purchasing behavior of consumers, especially the return of ordered goods, negates a large part of the supposed advantages.

2. Returns of goods

One central selling point in online trading is the possibility of returning goods free of charge. According to § 355 BGB (Bürgerliches Gesetzbuch), consumers in Germany have the legal right of withdrawal within 14 days. Consumers can withdraw without giving reasons within two weeks and return the goods free of charge because they simply do not like them or because they do not fit. Online retailers even grant an average revocation period of 28.4 days, which is well above the legal minimum requirement. [6]

For years, there has been a discussion whether this - usually - free right of return does not tempt customers to order goods thoughtlessly and send them back carelessly. However, the retailers themselves do not want to change this, because this right of return is considered as an important sales argument. Especially in the fashion sector it is important to offer the customers the possibility to order several variants/sizes. Goods, if they do not fit or if the customers do not like them, can then be returned free of charge without any problems. Customers have got used to it. They do not want to change this practice. In order to prevent arbitrariness in the ordering and return process, return costs can be imposed on consumers since 2014. However, online merchants can continue to cover the return costs voluntarily, which is the common market standard.

Exact figures on the number of returns are not available, as many retailers are reluctant to provide information on this. The research group "Returns Management at the University of Bamberg" estimates that in Germany about 280 million parcels with about 487 million items were returned to online retailers in 2018. This is every sixth package delivered. The rate of goods sent back have hardly changed in recent years. They clearly correlate with the product groups. [6]

Shoes and clothing are returned particularly frequently, almost every second parcel is sent back (46%). Significantly less is returned in the segments of electronic equipment, media and books. For these product groups the return rate is in the low single-digit percentage range (see table 2) [7]. According to a Greenpeace survey for e-commerce, the return rate for electronic goods is 3% and 2% for furniture. [8]

The following return rates were determined for the three top-selling product categories Consumer Electronics, Fashion, Media/Books, which differ depending on the payment method. (see table 2) It is interesting to note that there is a clear correlation between the method of payment and the return rates. Orders on invoices show the highest return rates, whereas the return rate of goods is significantly lower for prepayment. In the fashion sector in particular, the majority of orders are placed on invoices, so that it can be assumed that approximately every second parcel is returned.

	Consumer Electronics	Fashion	Media/Books
Invoice	18,60%	55,65%	11,45%
E-Payment	13,68%	44,10%	8,08%
Prepayment	8,59%	30,15%	4,46%

Table 2: Rate of return depending on payment method [7]

There are significant gender differences. Studies by the University of Bamberg show that women return parcels significantly more often than men, especially in the fashion sector (see table 3). One of the main reasons for the high number of returns of goods in the fashion sector is that customers cannot see, touch, try or try on the goods in real life beforehand. Younger customers also return ordered goods significantly more frequently than older customers. Younger customers and women also tend to order clothes knowing conscious that they will send back (at least) parts of them. [8]

	Consumer Electronics	Fashion	Media/Books
Men	13,85%	40,29%	8,93%
Women	14,40%	54,27%	8,99%

Table 3: Gender-specific return rate of goods [7]

According to a representative survey of 1,054 online buyers commissioned by the digital association Bitkom, every fifth order (across all product groups) is sent back. This survey also concludes that

women and younger customers return goods more often. Women send back an above-average amount of goods with 15 percent, this is every seventh purchase. For men, the return rate is 9 %. Younger online shoppers return significantly more goods (18%) than older customers. This survey also shows that the return rates are enormously high in the fashion sector. In addition, every second online shopper (51%) states that they order goods via the Internet with the firm intention of returning them, for example to try on clothes in different sizes: 28% do so rarely, 17% sometimes and 6% even regularly. [9] The Otto Group for its part states a return rate of 27.5% for its online trading in 2014, mainly due to people not liking the product or because of wrong sizes. For comparison, the DCTI (Deutsches CleanTech Institut: one of the world's leading institutes driving the diffusion process for innovative environmental technologies) study stated an average rate of returned products of only 1.9% for stationary trading. [10]

Returns are quite expensive for the dealers. In a Greenpeace survey, retailers indicated that the average cost per return would be 10 euros. [8] The University of Bamberg states that a returned article would cost an average of 11.24 euros. The amount is made up of: 5.67 Euro transport costs + 5.57 processing costs. A returned parcel causes costs of 19.51 Euro: 9.85 Euro transport costs + 9.66 handling costs. With estimated 286 million parcels being returned each year, this results in costs of 5.5 billion euros in total which are borne by the customers due to higher market prices on the one hand and burden the margins of e-commerce merchants on the other hand. [6]

The returns are also accompanied by an enormous environmental impact. DHL states the average CO2 emission per parcel at approx. 500 gram. Multiplied by 286 million parcels returned, this results in an emission of 143,000 tons of CO2. If, in addition to the return transport, the associated processes are also taken into account, the University of Bamberg calculates an environmental impact of 238,000 tons of CO2 equivalents (CO2e). [6] With average CO2 emissions of a car (147 g/km) in Germany, this corresponds to the total greenhouse gas effects of 1.619 billion km travelled by car.

Unfortunately the author has no information about the mileage of an average package. However, the environmental costs can be calculated indirectly. The Umweltbundesamt (Federal Environmental Agency) in Germany has calculated the environmental costs (greenhouse gases and air pollution) per passenger kilometer for various types of vehicles in Germany. Table 4 shows the average environmental costs (greenhouse gases and air pollutants) per passenger kilometer calculated in this way (over all routes). [11]

automobile	petrol	€-Cent/km:	4.30
automobile	diesel	€-Cent/km:	5.05
automobile	electric	€-Cent/km:	4.09

Table 4: Environmental costs per person-kilometer for different vehicle types in Germany in € cent 2016 / per km

For example, one km with a petrol driven car causes environmental costs of 4.3 cents. At 1.619 billion km, the total environmental costs would amount to 69.6 million euros. An electric car causes slightly lower environmental costs (66.2 million euros). Although an electric car causes only relatively low ongoing environmental costs in operation but it causes quite high environmental costs in production. At 81.8 million euros, the environmental costs of a diesel are significantly higher.

The Pro-Rail Alliance has commissioned a study on the external costs of transport in Germany. The term "external costs of transport" refers to those costs that are caused by the mobility participants but not borne by them themselves. This study determines the external environmental, accident and health

effects of transport in Germany for the year 2017. The following costs were considered in the study: Climate, health and non-health damage caused by air pollution, accidents, noise, nature and landscape and upstream and downstream processes. Calculations include the costs of road transport (passenger cars). The following cost rates for passenger cars per person-kilometer of external costs were determined: [12]

Climate	1.73
Air pollutants	0.59
Accidents	5,08
Noise	0.35
Nature and landscape	0,92
Upstream and downstream processes	2.13
Total external costs	10.80

Table 5: External costs of passenger transport: Euro cents per car

The figure of 1.619 billion km times 0.108 euros, this corresponds to almost 174.9 million euros of external costs. It should be noted that a large part of the external costs in this calculation is due to accidents.

Apart from the handling of returns in e-commerce, however, it remains unclear how the handling of returns in stationary trade looks like in comparison. However, it can be seen that returns are much more common in e-commerce than in stationary trade. For example, the return rate at the online shoe shop Zalando is estimated at 50% [13]. In addition, both stationary trade and e-commerce may generate surpluses (e.g. unsold seasonal goods), for which no precise data is available. In stationary retailing the quota of exchanged goods is much lower compared to online retailing, because customers there can see, touch and, in the case of clothing, try on the goods. The main reasons for shopping in the stationary retail trade are characterized by the fact that the customer can see and try on the goods immediately, i.e. on the one hand he can check the quality directly and on the other hand he can take the purchased goods directly home. Another central aspect is personal advice, which is important for a lot of persons.

3. Destruction of returned goods

In addition to the environmental impact of returns in e-commerce through transport and packaging, the destruction of returned goods is subject of criticism in the media. In a ZDF magazine employees of Amazon were quoted as criticizing the systematic destruction of functioning goods as well as new goods such as mobile phones, trays, beamers, lawnmowers, fully automatic coffee machines or refrigerators. In many cases, the destruction is cheaper than storage. Exact figures on the destruction of returns in e-commerce (or in comparison with stationary trade) are unfortunately not available. Contrary to the usual reluctance of retailers, Zalando cites a returns destruction rate of only 0.05%. [13] However, the author considers this figure to be too low.

A recent study by Greenpeace refers to a non-public survey by the market research firm EHI Retail Institute among "105 well-known online retailers in the German-speaking area with total sales of 10.6 billion". In this survey, online retailers reported that on average 70% of returned goods went back to regular sales. The remainder would be resold at a reduced price, mostly to secondary sales outlets, occasionally donated and sometimes even destroyed. The reasons cited for this are that sorting, checking, possibly reprocessing and repackaging are too labor-intensive and therefore often not economically viable. [8] The University of Bamberg has also carried out research on the destruction

of returns. They estimate significantly lower destruction rates of goods compared to the disposal values stated in the media. [14]

According to the University of Bamberg, on average a return is recycled as follows:

- Direct resale as A-goods (79.0 %)
- Resale as B goods (13,0 %)
- Sale to external industrial recyclers (2.1%)
- Donations to charitable organizations (0.9 %)
- Disposal/scrapping (3.9 %)
- Other (1,1 %)

So 3.9 percent of returns in online trade were destroyed in 2018. That is about 20 million items. It is estimated that 7.5 million of these articles had no defects. This corresponds to 40% of the returned goods.

4. Some studies

There are currently a number of studies dealing with the environmental impact of online trade. A German study "Climate-friendly shopping - a comparative view of online and stationary retail" was presented by the German CleanTech Institute in 2015. The conclusion is that the (negative) environmental impacts of e-commerce are lower than the (negative) environmental impacts of stationary retail. This study was supported by the Otto Group as well as by the logistics company Hermes, both providing data. The environmental impacts were examined on the basis of CO2 emissions. The study examines the transport emissions of a product from the dealer to the customer (and back if necessary). As a result of this study, it was found out that, despite possible high return rates in terms of CO2 emissions, purchases in e-commerce tend to be more environmentally friendly than purchases in stationary trade with regard to transport routes. The decisive factors for the CO2 balance of e-commerce compared to stationary trade are the choice of the means of transport, the length of the distance covered by the consumers and the frequency of purchases. For the environmental balance, the trips to the stationary business are more crucial than the delivery of the packages home. [15] According to the study, when shopping “traditional”, the car is the most frequently chosen means of transport at 62%, followed by walking or cycling (18%) and public transport (11%). On average, respondents travel 13.4 km by car (total outward and return journey). [15] For a total distance of 13.4 km of private transport (13.4 km * 147 g CO2), this means that just under 2 kg of CO2 is generated. The calculation of the DCTI also took into account that not all shipments can be delivered at the first attempt. According to the Otto Group, the average delivery rate at the first attempt is allegedly around 96%, at the second attempt around 3% of parcels are delivered, 0.4% at the third attempt and 0.1% only at the fourth attempt. If the recipient is then not found, the parcels are returned. At the Otto Group this applies to 0.5% of parcels.

According to this study, online purchases could be less harmful to the climate despite the relatively high return rates in some cases. This is particularly true if customers live in rural areas and have to travel long distances to their preferred stationary retailers. Delivery by parcel services to the customer's home could be made more climate-friendly by pooling the consignments in comparison to the situation if each customer drive into town individually by car to a stationary retailer. Private procurement trips would thus become increasingly unnecessary through e-commerce, which would reduce the total number of kilometers travelled and their energy consumption.

The Öko-Institut (an independent research and consulting institutions for a sustainable future in Freiburg, Germany) also comes to the conclusion that e-commerce could have environmental benefits. Using a single shipment as an example, the Institute compared the greenhouse gas balances. The costs of the various journeys, storage costs and energy costs in the stationary shop were taken into account. They were compared with the costs of online ordering (with and without returns). For online purchases, the effects were compared for three travel options (bicycle, public transport, car). [17] [18]

For example, an online purchase of a package in a large city:

Online order without return:	660 g CO2
Online order with return:	1,030 g CO2
Purchase from local dealer by bicycle:	1,270 g CO2
Purchase from local dealer: by public transport:	1,710 g CO2
Purchase from local dealer by car:	3,270 g CO2

The calculation emphasizes that in e-commerce, especially the compact storage per product unit has a considerable influence on energy consumption, even when returns are taken into account. In large logistics warehouses, less electricity and heating would normally be required compared to stocking the goods in a shop. Shipping by mail is also often more climate-friendly than, for example, driving to the retailer by car. It should be noted that this survey was not published in the form of a comprehensive study, but only as a graph with reference to a short article on the Institute's homepage.

A recent Austrian study examined environmental pollution and resource consumption as possible effects of the increasing use of online commerce by the inhabitants of the city of Vienna. The study looked at traffic-related environmental effects of e-commerce, but did not consider other emissions from, for example, ordering processes or exhibition space. In the analyzed year 2013, e-commerce would cause additional emissions of more than 2,000 tons of CO2 per year - compared to pure stationary trade. In essence, the study, which focuses on the transport-related environmental impacts of e-commerce, shows additional emissions and thus negative environmental impacts in all scenario considered. Pfaffenbichler concludes that the balance of environmental impacts of e-commerce in Vienna is very likely to be negative overall. Only in the peripheral districts of Vienna, with a relatively high share of cars in shopping traffic, positive environmental effects are possible. According to Pfaffenbichler, it is hardly possible to make generally valid statements about the environmental effects of e-commerce compared to stationary trade beyond the case of Vienna. These depend very much on individual purchasing behavior and local conditions. In densely populated areas with a low proportion of cars in shopping traffic, the environmental effects are very likely to be negative. In less densely populated regions with a high proportion of cars, however, the environmental impact can be positive. This is mainly due to the fact that doorstep delivery can be carried out in a more climate-friendly way by pooling the consignments than an individual journey to the city by car. Particularly in rural areas, customers often have to travel long distances to their preferred place of purchase. [19] [20]

A similar study, which examines the effects of e-commerce on the transport system with a view to whole Austria, was presented by Lengauer (2015). The results show a similarly environmentally harmful trend in the volume of traffic (CO2, NOx and particulate matter) caused by e-commerce compared to stationary trade. [21]

Whether the environmental impacts are positive or negative depends on the purchasing behavior of the customers. The abundance of suppliers of products that can be found online (and in some cases far away) can also induce customers to visit the respective shops in person, which does not necessarily have to be linked to a purchase. Often, customers inform themselves at the stationary retail trade (which means additional distances), but buy online because it is cheaper there. In these cases, additional and in some cases significantly longer shopping distances arise in total with ecological damages. On the other hand, however, the information offered by the internet in particular can eliminate a large number of routes. Survey results show, for example, that about half of the people who obtain information about products online would otherwise have gone to a stationary shop to obtain this information. The Internet enables the targeted search for available products and their prices and can replace unnecessary search and comparison paths from shop to shop. [22]

5. Conclusion

Online trade is booming. One aspect that has come into focus in recent years is the question of the environmental impact. Decisive factors for the CO2 balance of e-commerce compared to stationary trade are the choice of the means of transport, the length of the distance covered by consumers to the place of purchase and the frequency of purchases.

Some studies have attempted to classify online trade in terms of its environmental effects. The focus here has been placed primarily on traffic pollution. Some earlier researches came to the conclusion that online trading can reduce the burden on the environment. More recent studies show that the environmental effects of e-commerce are likely to be negative in the majority of scenarios. In some scenarios however, the environmental impacts may also be positive compared with stationary trade, this is particularly true for rural areas. The spatial context plays a decisive role. Under certain conditions in rural areas, transport companies can carry out their loads and routes more efficiently and in a more environmentally friendly manner than private buyers. The traffic streams of nearby households could be bundled more efficiently, thus reducing the volume of transport. A condition for such bundling, however, is that a critical mass of local consumers can be supplied at the same time by the same company or logistics service provider. The volume of traffic generated by transports depends largely on the degree of bundling. Only once a critical mass of customers and shipments has been reached in an area, the logistical processes of online trading can be handled so efficiently that the positive environmental effects outweigh the negative ones. It is doubtful whether this always works so optimally.

Possible positive environmental effects are often cancelled out by the customers themselves, however. Customers love convenience and they very often use the opportunity to return goods if they are not satisfied. In addition, there is a trend towards more individualized deliveries in ever shorter delivery times and at times when customers want them. These cause a higher logistical effort. As a result, suppliers are far from being as economical on the road as they could be. These “prime-services” cause particularly high logistical efforts and have particularly negative effects on the environmental balance. Appeals to customers should be used to try buying without prime services. However, the author is skeptical that a "mere enlightenment" could have great success.

In order to reduce waste and to protect the climate, a legally prescribed return fee should be introduced. Only 15% of online retailers charge return shipping fees. These are mainly smaller dealers. The majority of small retailers would like to cancel postage-free returns, but fear competitive disadvantages compared to big companies. However, with a statutory minimum fee and same rules for small and big retailers could significantly reduce the number of returns of goods. It must be

ensured that the customer pays the return fee really and not the company. The state must control this. The prices could fall, as retailers take the cost of returns into account. This would be an advantage for those customers who buy carefully and do not deliberately think about sending goods back.

Furthermore, a large proportion of returns of goods, especially for clothes could be avoided by providing size information that is binding for all clothing manufacturers and a functioning online size advice service. Changing this would, however, mainly be up to the manufacturers. Mobile phone cameras for body measurement, data analysis and artificial intelligence could also make many returns superfluous in future when advising on size.

Online retailers in Germany disposed of 7.5 million returned items in 2018, although they could have donated or recycled them. Returned products that can no longer be sold should be given away, for example through social department stores. Throwing article away that are still good should be prohibited by law. However, this is difficult to control. Companies could always claim to have only disposed of items that were defective.

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