Christmas truck pollution

Methodological note

December 2022

1. Assessing Christmas emissions

The process of determining Christmas related CO_2 emissions consists of two steps. First, the demand for goods occurring during the period of interest was estimated. Second, this demand was translated into emissions.

1.1. Demand estimation

Estimating the demand for specific goods is always a challenging task in economic science due to lack of data. The approach followed here has been to try and isolate the percentage increase in demand occurring during the Christmas period compared to the average month in the same year. A dataset with monthly sales turnover data was extracted from EUROSTAT for the period 2005-2021[1]. It includes both wholesale and retail sales and excludes food and fuel products.While more food is consumed during the holidays themselves, it's mostly presents that are responsible for the spike in truck traffic throughout the holidays period.

Large manoeuvres to meet consumers' demand already start a few weeks before Christmas itself Therefore we decided to consider the entire month of December as our period of interest. The most meaningful index to look at is the percentage increase of sales in December compared to the average of January to November. The index is calculated according to the following formula:

$$\%.increase.dec = \frac{1}{16} \sum_{y=2005}^{2021} \frac{sales.dec_y}{sales_y}$$

Where $sales_y$ is the average sales for the January-November period in year *y*.

[1] https://ec.europa.eu/eurostat/databrowser/view/sts_trtu_m/default/table?lang=en

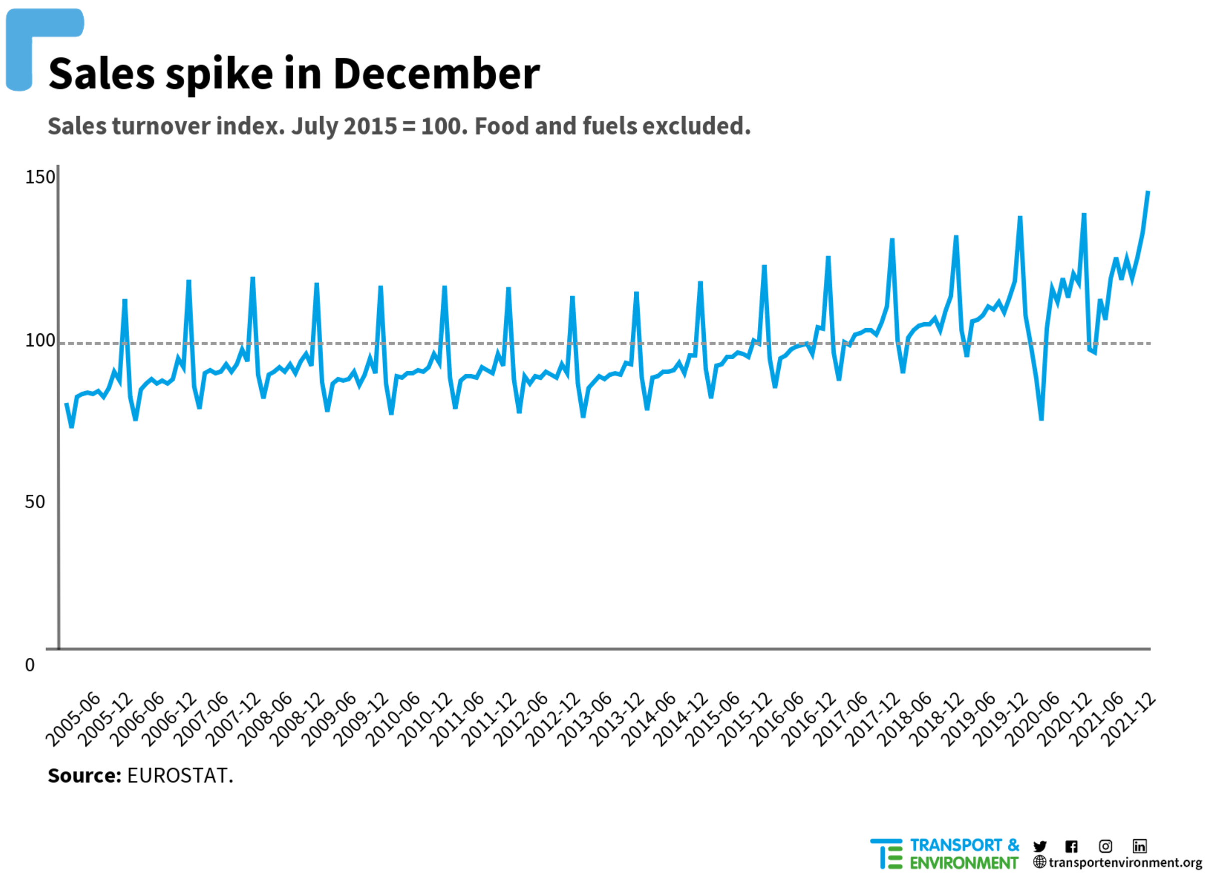

Figure 1: monthly sales turnover data

Figure 1 shows how sales spiked in December for the entire period considered. For the European Union, they are on average 29.5% higher than the rest of the year.

Before we consider this increase as representative of Christmas sales, we need to cancel out the effect given by the year-specific events. Therefore we look at the seasonal component, i.e. the deviation from the trend due to specific events occurring in the month under consideration. This new indicator (+28.3%) gives a reliable picture of the Christmas effect on sales turnover.

However, recall that the data used to extrapolate the index still take into account goods that are not usually subject to Christmas deals. An assumption is thus needed to properly isolate just the items of interest.

<u>Assumption 1</u>: the amount of transported goods equals the amount of sold goods.

We are interested in the emissions linked to the goods sold during Christmas, regardless of when they were transported to the store or warehouse. As the amount of transported goods must be greater than or equal to the number of sold goods (as warehousing or stockpiling may occur), in the worst case, the emissions are underestimated, since we don't consider goods which are transported but not sold for whatever reason.

Eurostat[2] reports yearly data for goods transported by heavy duty vehicles (non-food and non-fuel goods, 2016-2021 period considered). Goods are divided into 20 categories. Those of interest for Christmas are number 5 (textile, leather and derived products), 6 (wood, paper products, recorded media), 11 (computers, office machinery, watches), 13 (furniture), 15 (mails, parcels) and 16 (equipment used to transport goods). From Assumption 1, we divide the sales increase calculated above by the proportion of these goods' transport activity over the total (21%). This yields the increase in activity during the Christmas period and specifically due to Christmas sales: +133%.

From the same data, the activity in the average month is calculated[3].

Yearly activity	**Activity in average month**	**Increase due to Christmas**	**Activity in Christmas month**
385.34 Gtkm	28.90 Gtkm	+133%	67.39 Gtkm

Table 2: summary of Christmas activity (i.e. only good subject to Christmas deals) calculation.

1.2. Emissions estimation

With all the values on truck activity at hand, it is now possible to calculate Christmas emissions. In its European Transport Roadmap Model (EUTRM), T&E has calculated activity and fuel consumption for trucks in grams of CO_2 per tonne-km (gCO_2/tkm). It is then sufficient to multiply it by the truck activity related to Christmas goods to obtain the emissions. Truck activity due to Christmas goods is estimated to be emitting 5.88 Mt CO_2 in 2022.

	Fuel consumption (gCO_2/tkm)	**Activity share**
Heavy trucks	71.00	80.8%
Medium trucks	153.69	15.4%
Small trucks	207.68	3.8%
Total	88.96	100%

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https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_by_type_of_goods#Road_freight_transport_by_type_of_goods_.28NST_classifications.29

3 Total freight activity was taken from the EU Reference Scenario. The value for 2022 is obtained assuming linear growth between 2020 and 2025.

Table 3: fuel consumption, total and broken down by truck categories.

1.2.2 NOx emissions

Data on NO_x emission factors come from the European Environment Agency[4]. Emissions are obtained in the same way as for CO_2.

2. Emissions equivalents

Data sources and calculation tools used to convert emissions into relatable equivalents are listed below.
CO_2 emissions for the route were calculated using T&E's internal aviation tool for a one-way trip of 5,849 kilometres[5]. The aircraft considered for the analysis is a Boeing 777-300ER, widely used for long-haul flights, and full occupancy was assumed.

3. Future CO_2 savings

The last step is to look at the emissions savings in case T&E's proposal for the review of the heavy duty vehicles CO_2 standards were adopted: 100% of new sales to be zero-emission in 2035[6]. According to the scenario simulation on the EUTRM, CO_2 emissions would drop by 11% in 2030 and 48% in 2035 as a consequence of this policy measure. It is sufficient to reduce the above-calculated emissions by the same factor to obtain Christmas related emissions savings for trucks under T&E's proposal.

4. The route

Truck pollution is not only significant on its own, it is also disproportionate compared to their relative mileage with respect to other transport modes. To highlight this, we looked at a truck carrying Christmas gifts and evaluated the emissions breakdown along the whole transport process, from the

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[4] http://efdb.apps.eea.europa.eu/?source=%7B%22query%22%3A%7B%22bool%22%3A%7B%22must%22%3A%5B%7B%22term%22%3A%7B%22Pollutant%22%3A%22NOx%22%7D%7D%5D%7D%7D%2C%22display_type%22%3A%22tabular%22%2C%22from%22%3A70%7D

[5] https://www.airmilescalculator.com/distance/jfk-to-cdg/. Our total emissions differ slightly from those calculated in the source as we also consider non-CO_2 effects.

[6] Here is the link to T&E study https://www.transportenvironment.org/wp-content/uploads/2022/09/2022_09_Addressing_heavy-duty_climate_problem_final.pdf

factory in China[7] to the retail store in Europe. A look into different European destinations gives a clear picture of the overall impact of trucking on both EU and global CO_2 emissions.

4.1. Methodology and sources

The main inspiration for building the route comes from an ICCT paper[8], where they perform a similar study for transport between China and the US. Following their methodology, we divided the route from the Chinese factory to the European stores into segments according to the transport mode performing them. The key parameters evaluated per segment were transport mode, distance in km and carbon intensity (g CO_2/tkm), which allow to calculate overall emissions and their share in the transport process. Emissions are calculated for a container whose weight equals the average payload for heavy duty trucks in their respective destination country (e.g. if Italian heavy lorries are carrying 13.8t on average, the emissions for Italy will refer to a 13.8t load transported from the Chinese factory to the stores in Rome).

4.1.1. China drayage

This initial segment refers to the trip travelled from the factory to the port of Shenzhen. It is assumed to be travelled on a drayage truck, which is a specific vehicle for transporting containers. The segment and its inputs are taken from the ICCT study.

4.1.2. Maritime

The route from Shenzhen to the European ports under consideration is calculated using the online tool from Ports.com[9].. For each country, a single destination port was chosen based on the highest activity between such port and the city of destination[10]. Though not ideal from a methodological point of view, this is a conservative choice for the purpose of this study as the most common logistic routes usually choose the port that is closer to the city of destination, hence shifting mileage and emissions from trucks to ships. Assumptions on the vessel used and its carbon intensity (Neopanamax, 8g CO_2/ton-km) are from the ICCT.

4.1.3. EU drayage

Drayage in the EU is assumed to occur between the ship's unloading centre and the port's transload facility. This refers to a temporary storage facility for containers that are subsequently loaded on long-haul trucks. The inputs are the same as those used for the Chinese drayage.

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[7] Oliver Wyman report assumes 90% of fashion and consumer electronic goods are shipped from Asia. Source: 'Is E-commerce good for Europe?', Oliver Wyman, Appendix B. https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2021/apr/is-ecommerce-good-for-europe.pdf

[8] https://theicct.org/sites/default/files/publications/ICCT_Toward-Greener-Supply-Chains_201909.pdf

[9] http://ports.com/sea-route/

[10] Data come from T&E's internal database used for the TEN-T nodes study. More information here https://www.transportenvironment.org/wp-content/uploads/2021/07/202102_pathways_report_final.pdf

4.1.4. EU inland heavy duty trucks

From the transload facility, goods are loaded into long-haul trucks (i.e. heavy trucks in T&E's classification) to be transported to the destination city's warehouse or distribution centre. For each destination city, we took the average distance from all the ports connected to it, weighted by the activity in tonnes. Data on heavy trucks' carbon intensity are from the EUTRM, cfr. section 1.2. In this case we use country-specific values, rather than the EU average.

4.1.5. Warehouse to stores

The last segment describes the route from the warehouse/distribution centre to the retail stores located in the selected city. Data on within-city activity and average distance travelled are taken from the same database used for ports. Country-specific data on carbon intensity are from the EUTRM. We assumed that the only transport mode performing urban transport is a rigid truck of 7.5 tonnes[11]. The length of the trip is calculated as the city distance travelled multiplied by the number of trips a small truck needs to perform in order to deliver a heavy truck's load. This number is equal to the ratio of the two payloads. Our database for Poland does not report within-Warsaw activity. Therefore, the shortest reported route has been used instead: from the city of Łódź to Warsaw, 92 km per trip.

4.2. Country-specific data

Tables with country-specific data are reported below. Shares may not sum up to one due to rounding.

SPAIN	**Average distance (km)**	**Distance share**	**Carbon intensity (gCO_2/tkm)**	**Emissions (kg CO_2)**	**Share of CO_2 emissions**
China drayage	92	0.5%	170	216.28	5%
Maritime	17038	92.6%	8	1884.91	40%
EU drayage	37	0.2%	170	86.98	2%
EU inland	642	3.5%	54	482.78	10%
Warehouse to stores	598	3.3%	245	2023.23	43%

Table 4: route breakdown for Spain.

POLAND	**Average distance (km)**	**Distance share (km)**	**Carbon intensity (gCO_2/tkm)**	**Emissions (kg CO_2)**	**Share of CO_2 emissions**

[11]Assumption from OW report, see footnote 8.

China drayage	92	0.4%	170	314.29	5%
Marine	20664	92.3%	8	3321.94	49%
EU drayage	37	0.2%	170	126.40	2%
EU inland	660	2.9%	38	497.50	7%
Warehouse to stores	925	4.1%	178	2561.99	38%

Table 5: route breakdown for Poland.

ITALY	**Average distance (km)**	**Distance share (km)**	**Carbon intensity (gCO_2/tkm)**	**Emissions (kg CO_2)**	**Share of CO_2 emissions**
China drayage	92	0.5%	170	217.42	7%
Marine	16388	95%	8	1822.56	55%
EU drayage	37	0.2%	170	87.44	3%
EU inland	362	2.1%	55	276.38	8%
Warehouse to stores	374	2.2%	177	919.00	28%

Table 6: route breakdown for Italy.

FRANCE	**Average distance (km)**	**Distance share (km)**	**Carbon intensity (gCO_2/tkm)**	**Emissions (kg CO_2)**	**Share of CO_2 emissions**
China drayage	92	0.4%	170	128.47	7%
Marine	20192	97.7%	8	1326.92	70%
EU drayage	37	0.2%	170	51.67	3%
EU inland	278	1.3%	92	210.56	11%
Warehouse to stores	60	0.3%	354	173.44	9%

Table 7: route breakdown for France.

<u>GERMANY</u>	**Average distance (km)**	**Distance share (km)**	**Carbon intensity (gCO_2/tkm)**	**Emissions (kg CO_2)**	**Share of CO_2 emissions**
China drayage	92	0.4%	170	156.80	6%
Marine	21179	97.2%	8	1698.66	67%
EU drayage	37	0.2%	170	63.06	2%
EU inland	331	1.5%	77	254.82	10%
Warehouse to stores	149	0.7%	246	365.75	14%

Table 8: route breakdown for Germany.

Country	**Heavy trucks payload (ton)**	**Small trucks payload (ton)**	**Port of destination**	**Within city distance (km)**	**Number of trips to deliver full load**
Spain	13.8	1.2	Barcelona	50.6	11.8
Poland	20.1	2.0	Rotterdam	92.0	10.1
Italy	13.9	1.5	Civitavecchia	41.3	9.0
France	8.2	0.8	Le Havre	5.8	10.3
Germany	10.0	1.1	Hamburg	16.8	8.8

Table 9: additional data.