Summary

Variability of transport time and demand

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This report presents an analysis of and attempts to quantify variability in freight transport. This includes demand for transport and transport time for different modes of transport, as well as for distribution and long-haulage transport. We find that there is higher variability in demand for transport than in transport time. The variability is also higher for transport time of near distribution than for long-haulage, and for long-haulage, the variability is higher for foreign compered to domestic transports. The results of this work are input to a conceptual model developed in the project, designed to analyse how uncertainty affects consignor's choice of transport.

Introduction

The SCALE project has as its main objective to develop a better understanding of the consignor's decisions regarding transport options under uncertainty. Within the project, a theoretical model for consignor's choice of means of transport (Minken and Johansen, 2018) has been prepared, where the main contribution to state of the art of current transport models is that the model takes uncertainty in lead time and demand into account.

This report documents the empirical basis for the model with regard to delays and variability in transport time for different modes of transportation, as well as examples of variability in transport demand. Implementation of the empirical data in the theoretical model is documented in a separate report (Johansen et al., 2018).

In this work, six different data sources are used to measure variability in transport and transport demand. All of these sources have strengths and weaknesses, and a challenge has been that data sources provide different information for the variables we seek to measure.

Data sources

The analysis of variability in transport demand is based on the Norwegian commodity flow survey, that have information at shipment level about date and time of day of outbound transport. This is used as basis for analysis of variations in demand for transport during the day, week and year.

For rail, we have obtained data from the TIOS train operating system, for the years 2012-2015, from the Norwegian Railway Directorate. Statistics Norway's port statistics and AIS data for the years 2013-2015 form the basis for the analysis of variability for port calls. For road transport, the Norwegian Public Road Administration's (NPRA) travel time measurements for (shorter) stretches around the bigger cities in Norway are used as basis, while a smaller data set from Google Maps' API Distance Matrix has been used to illustrate variability in transport time at both shorter and longer distances. NPRA's travel time measurements do not differ between lorries and passenger cars and are only available for relatively short stretches associated with the major cities. While it is nearby to think that it is mainly on such shorter stretches into and out of cities there are delays, this lack makes it impossible to analyze variability over longer stretches. Data from Google Maps is therefore used for longer stretches. Moreover, the observations in the data set are far fewer and less representative than the travel time measurements of NPRA. Therefore, this analysis must be considered more as examples of using data from Google Maps' API Distance Matrix than a representative analysis.

Demand for transport

We have analyzed two cases and two stretches, respectively wholesale of clothes and grocery goods.

Oslo-Trondheim - Wholesale of clothing

With regard to variation in demand for working days, it is throughout the year sending mostly on Monday and Tuesday and only marginal amounts in weekends. However, this pattern varies considerably from quarter to quarter.

Variation over the day is mostly concentrated around normal working hours, with a peak around 13-14 , and are largely similar to the different business days. This is mainly true for all quarters, but Q3 (and, to a lesser extent, Q4) stands out with higher volumes before 13 on the day and greater proportion of outgoing shipments in the evening.

Oslo-Bergen - Wholesale of clothing

Viewed in 2014, the largest freight volumes was sent in February, followed by September. Compared to the Oslo-Trondheim stretch, there is also significantly more variation over all the months. During the summer months, very little goods are shipped, probably due to lower activity in the summer holiday and seasonal clothes.

The distribution of the working day shows that Tuesdays is the day with the highest volumes, and that the distribution for the other business days are relatively equal. Also on this stretch, very little volumes is sent on Saturdays and Sundays, while the number of shipments is highest on Fridays. When it comes to the daily distribution of shipments and the number of tonnes sent, we also see that most of the shipments are sent within normal working hours with a peak around 13. This may indicate that the transport from Oslo to both Bergen and Trondheim largely is delivered "over the night". This daily distribution is relatively consistent from quarter to quarter, but with a somewhat larger spread in the quarters with highest amounts of goods shipped.

Oslo-Trondheim - Foods (specialized)

Within this commodity group it is the first quarters and November that consists the highest cargo volumes. The months in which the least food is sent, is July, August and December. The low activity in the summer months is similar to the pattern we observed for wholesale trade in clothes. This can be explained by lower demand due to the summer vacation. The variation in the number of shipments appears to be somewhat less than the number of tonnes.

Friday is the day with the average highest number of tons, while Thursday has the highest amounts of shipments. There are fewer tonnes and shipments on Mondays, and there is no big differences between the number of shipments over the days .

For this segment it is even clearer than for clothes that mostly are shipped within the normal working hours (08-16). A similar breakdown per working day shows that Fridays have a peak earlier in the morning and less freight is shipped after 12. A possible reason for this may be that goods must be ready for delivery well in advance of the weekend as food is more dependent on the correct storage than for example clothes.

Oslo-Bergen - Foods (specialized)

On this stretch most goods was sent in March, measured in tonnes, closely followed by September and November. Compared to the other cases, there seems to be higher variation during the year, and it is not as clear that summer has least tonnes, and end of the year have most. No months differ in terms of number of shipments.

Viewed throughout the year is Thursday the day with the most activity, but this pattern varies somewhat from quarter to quarter. Mondays and Fridays have the least amounts.

With regard to the distribution of tons over the day, it is also sent here most during normal working hours with local peaks a bit earlier in the day and almost no shipments after 16.

Railway

The figures from TIOS (The Norwegian Railway Administration's rail operating system) show that 9,1 % of container trains was cancelled on average in the years 2012-2015, but does not distinguish between planned and unforeseen cancellations. The main reasons for the cancellations are damages and repairs after extreme weather, maintenance and improvements on track lines, insufficient landfills and slots that are systematically not used. Both the number and proportion of container trains have increased significantly throughout 2014 and 2015 and vary considerably between the lines. While the number of delayed trains has increased throughout the entire period on the Bergen track, the Dovre track had the highest amount of cancelled trains in 2012.

For all container trains, the delays have been reduced from an average of 13 minutes in 2012 to just over 11 minutes in 2015. For container trains to Trondheim, the number of delay minutes to the terminal was reduced to 1/3 from 2013 to 2015 (from 25 minutes to 9 minutes), while the number of delay minutes to the Bergen terminal increased significantly (from 9 minutes on average to 15 minutes) in the same period. Container arrivals at Alnabru has a small variation in average delays between 2012 and 2015, while the delays for border crossing trains are larger and varies more.

Regarding the variation in the arrival time, there is a significant decline in the spread of delays for Trondheim, while the Bergen terminal has had a significant increase. For Alnabru, there are only small variations in the spread of delays. For Bergen, delays appear to be lower on the last three business days at weekly basis for all four years, while for Alnabru, the spread in delays is quite similar over the four years and with a clear tendency that the variation in delays increases beyond the week.

Sea transport

With access to base data from Statistics Norway's port statistics and AIS data, we have analyzed the variation at the time of arrival of container ships in port of Oslo for the years 2013-2015. The distribution of calls over the day is volatile, but with the most calls between 03 and 16. For 2015, the average arrival time in the port statistics and AIS data is at 11:20 and 10:00. This indicates a preference to early unloading, with the opportunity to redistribute the goods during the day. The breakdown over months shows great differences between the years: 2013 shows a relatively equal distribution of calls over the year, while 2014 shows significantly more calls for the period January-June, compared to July-December. By 2015, the number of calls in the latter part of the year is somewhat higher than in the first half of the year.

Regarding the allocation of calls over business days, most calls are early in the week, reducing at Wednesday and Thursday, and with few calls on Friday, Saturday and Sunday. This pattern corresponds to some of the results from the demand analysis.

We have analyzed variations and deviations from the average arrival time, since a ship call is scheduled to a specific day rather than a specific time of the day. Average hourly disturbances are around zero for all years, and apply to both port statistics and AIS data, but the deviation increases beyond the period and is highest in 2015. Deviation from 'routing days' are highest in 2015, in both data sources.

Road transport, local distribution

Reliability of road transport is not only important for transport by truck, but truck is also included as distribution transport to/from ports and rail terminals. Reliability in intermodal transport chains is therefor also affected by unpredictable road transport. The challenge is that NPRA's travel time measurements do not differ between lorries and passenger cars and are only available for a limited number of relatively short stretches around the major cities in Norway. These data therefor only form the basis for an analysis of reliability in distribution to terminals or ports, and not for long-haul.

Based on NPRA's travel measurements data, we have analyzed various stretches in Oslo, Bergen and Trondheim. For Oslo, the delays, depending on the direction of transport, are highest in the morning and afternoon peak hours, with slight delays on weekends. Depending on the distance, the delays are on average lower in the summer than in the rest of the year. The variation in delays also varies over the year and is relatively large compared to transport time, indicating relatively high uncertainty. When it comes to day to day variation, there's little difference between Monday to Thursday, while for Fridays we cannot find an unique pattern. For Oslo, we find the coefficient of variation, i.e. the standard deviation of the average delays as ratio to the average transport time, to be between 44% and 54%. This means that the standard deviation seen over the year on average amounts to approx. half the normal travel time.

For Bergen average delays vary considerably throughout the year, without showing an unique pattern. Also, from day to day, there is some variation in delays, where Friday stands out with the highest delays out of Bergen and the slightest delays into Bergen. Variation coefficient for Bergen is somewhere between 11% and 23%, and is thus significantly lower than for Oslo.

For Trondheim, there are two major peaks in the morning and afternoon peak-hours, depending on the direction of the stretches we have seen. The variation in the standard deviation significantly follows the variation in average delays. For Trondheim there is relatively little variation in delays throughout the week and delays in the weekends are approximately the same level as the rest of the week, which was not the case for the routes in Oslo and Bergen. Also the variation in delays is relatively equal distributed throughout the week. This implies that on average, the uncertainty about transport times does not vary significantly from day to day. The coefficient of variation for Trondheim is 12% -16%, which is somewhat lower than for Oslo and Bergen.

Road transport, long-haulage

In addition to the analysis based on NPRA's travel time measurements, we have used a data set from Google Maps API Distance Matrix, that also opens for analyzing longer stretches.

It should be noted that observations in the data set are far fewer and less representative than the travel time measurements of NPRA. This part of the analysis must therefore be considered as examples of using the data from Google rather than a representative analysis.

The data set shows that the variation measured in proportion of average transport time is more than 3 times higher for (shorter) domestic distribution distances than for domestic long-haulage. This is not overwhelming considering that a much larger share of the itinerary for domestic distribution is exposed to rush hour traffic.

Furthermore, it is worth noting that within the category of domestic distribution there are major differences in the proportion of variation. On the routes in Oslo, these values are above 30%, while the proportion in Bergen is around 15% on average, and is even smaller in the other cities. This is reasonable in accordance with NPRA's travel time measurements.

Furthermore, it appears that the variation measured in the proportion of transport times is about twice as high as for foreign long-haulage compared to domestic long-haulage. One possible explanation may be that this (partly) is due to delays related to border crossings.

More specifically, the average transport time varies for different route options between Oslo and Bergen and Trondheim. For Oslo-Bergen the routes via RV7 and RV52 have the lowest average transport time, while the average transport time is highest for the Haukeli route. There are also indications that transport time via E16 varies to a lesser degree than through the other routes.

For Oslo-Trondheim, the transport time seems to vary less and to be more predictable via E6 than for the route via RV3. On the other hand, average transport time is lower for RV3.

Conclusions

With the work in this report, we have shown that there is considerable variation in demand for transport and transport time for different modes of transport, as well as for distribution and respectively domestic and foreign long-haulage. The work has also shown that it is difficult to carry out consistent analyzes between different means of transport, as different modes of transport are organized in different manners and contributes to different levels of information available. For example, rail have specific timetables, while shipping services have specific arrival days. Road transport do normally not have a specific departure time, but tailor the departures to when the customer needs transport. This differences made it challenging to make estimates for reliability that are consistent across modes.

Nevertheless, we have shown that there is a greater coefficient of variation in the demand for freight transport than it is for the transport time. Thereby uncertainty in demand plays a greater role in terms of uncertainty in the logistics costs than transport time. However, this latter is not shown in this report, but in the report that documents the model developed in this project (Johansen et al., 2018).