

Summary:

Commodity flow matrices for Norway as of 2008

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This report describes the development of commodity flow matrices for all shipments in Norway, both domestic and border-crossing. The primary purpose of these matrices is as input for the national freight model for Norway, but the dataset on which they are based, is of more general interest. The matrices can be used for commodity flow analyses on detailed levels. The base year of the matrices is 2008, the year when Norwegian transport experienced its highest activity level ever as measured in tonnes and tonne-kilometres.

Background

Commodity flow matrices are important components of the national freight model for Norway. They are measured in tonnes and represent the total sum of commodity flows in Norway between suppliers (producers, importers and wholesalers) and the end-use sectors (exporters, wholesalers and retailers).

Base year

In 2009, Statistics Norway (SSB) conducted a commodity flow survey of industry and wholesalers in Norway (Wethal, 2012) – a dataset that is crucial in establishing commodity flow matrices. Since the base year for the survey was 2008, it was natural that that year was selected as the base year for matrices for most commodities. Matrices for industries that are not part of the survey are based on other available datasets, and for some commodities, petroleum for example, the data are more recent. However, the highest commodity flow activity in tonnes and tonne-kilometres ever measured was in 2008, according to statistics of transport performance in Norway (Vågane 2012). This was an effect of the financial crisis affecting Norway from August 2008 and reduced foreign trade transport volumes during the following year. In 2011, however, foreign trade measured in tonnes was higher than in 2008, resulting from increased Norwegian exports of gravel for infrastructure projects on the continent.

Classification of commodities

The commodities are classified within 32 different aggregated groups based on characteristics such as quality and duration in transport. The most important principles for classification are requirements for transport quality and the part of the

associated value chain that the commodities belong to. Regarding the latter, the most important division is between intermediate goods and consumption goods.

Spatial structure

Origins and destinations for commodity flows are aggregated to zonal levels. The six largest cities in Norway have one zone per district, while the remaining domestic municipalities are each represented by one zone. There is one zone per country in Europe, while the rest of the world is in most cases represented with one zone per continent. Countries geographically close to Norway are exceptions in that they are often spatially divided; Sweden, for example, with thirteen zones has the most detailed division.

Data used

Three main types of statistics are used when establishing commodity flow matrices: (1) mode specific statistics, (2) statistics on industrial activities, and (3) data from the commodity flow survey, which is a combination of types (1) and (2).

Mode specific statistics contain information about volumes of transport with an indication of locality for loading and unloading. Statistics on industrial activities contain data on what is being produced and sold in Norway; this is usually measured in values, and does not contain information about the underlying trading pattern. Foreign trade statistics contain data on the trading country. The main purpose of commodity flow surveys is to map commodity flows (measured in tonnes and value) in accordance with localities for production, consumption and potential wholesaling, in addition to the underlying delivery pattern.

Mode specific statistics are only used as a basis for establishing matrices for commodities in cases where the majority of shipments are unimodal, e.g. bulk articles such as soil, gravel, sand and rocks. The remaining commodity flows are based on data from the commodity flow survey or industrial activity data.

Methodology

In establishing commodity flow matrices, there is a division in both the methodology and data used, depending on:

1. Whether shipments are transported from primary sectors, including mines and quarries.
2. Whether shipments are transported from industry sectors and wholesalers for domestic consumption.
3. Whether shipments are transported from industry sectors and wholesalers to foreign countries for consumption, or from foreign countries to industry sectors and wholesalers in Norway for domestic consumption (foreign trade).

Firms in the model are categorised within three groups: producers, wholesalers and consumers. With the exception of wholesalers, all firms receiving shipments are defined as consumers, which means that shipments of intermediate goods to both industry and retailers are defined as shipments to consumers. Flows arising from

goods driven from retail stores to households are not included in the freight model, since these are defined as passenger transport. In the model and the matrices there is a division between three types of delivery:

- PW: producer to wholesaler
- PC: producer to consumer
- WC: wholesaler to consumer

Shipments from primary sectors

Commodity flows from primary sectors are mainly based on primary sector statistics of production volumes in different zones as recorded by Statistics Norway. Supplementary information regarding receiver zones (for instance slaughterhouses, dairies, etc.) has also been collected and, based on this, a GIS-based distance minimising algorithm is used for determining destination zones. This is done for each of the commodities described in the available data. Relevant commodities are then merged with the aggregated commodity groups described above.

Lumber is an exception, because data regarding the delivery pattern are available from Skog-Data. All shipments are listed in this database, and the loading and unloading locations are mapped with coordinates matched to the corresponding zones using GIS.

Since shipments from mining production are to a large extent unimodal, the commodity flows are based on data from mode specific statistics. Regarding lorry surveys, the 2007-2009 period average is utilised as an attempt to even out potential sample biases. Moreover, mode specific data are combined with statistics from mines and quarries from NGU, the national institution for geological surveys. This is done to ensure that shipments from the most important municipalities in which there are mines and quarries are represented.

Shipments of crude oil and natural gas are based mostly on data from the Norwegian Petroleum Directorate. Only the number of tonnes shipped is utilised for establishing the matrices, because pipelines are currently not available as a modal choice in the freight model.

Domestic shipments from industry sectors and wholesalers

Shipments from industries and wholesalers for domestic consumption are based mainly on the commodity flow survey of Statistics Norway, where these shipments are mapped in tonnes. For both supply and demand firms, business activity is classified on a very detailed level (4-digit NACE code), so that commodity groups can be defined based on business activity. All shipments are mapped with locations for loading and unloading at postal zone level. Postal zones are aggregated to district level for the six largest cities and to municipal level for the rest of Norway.

A close review of the data material from the commodity flow surveys indicates that some sectors with high freight volumes are either lacking completely or are inadequately covered. This concerns shipments from:

1. Breweries and producers of mineral water
2. Dairies
3. Cement manufacturers

4. Fertilizer manufacturers
5. Petroleum refineries

Supplementary data material having been used for these industries, the methodology is to a large extent analogous to the one described for primary industries.

Foreign trade

The foreign trade statistics provide information on number of tonnes, trading country, type of commodity and mode choice at the border, but no information about origin and destination at a more detailed level than country level. Volumes from the foreign trade statistics are allocated to domestic and foreign zones based on the following information:

1. A Swedish commodity flow survey from 2009 conducted by Statistics Sweden
2. Statistics Norway's and Eurostat's lorry surveys for shipments crossing the Norwegian border
3. Statistics Norway's freight flow survey for ships
4. Statistics Norway's commodity flow survey

There is an order of priority when deciding which source to use in each case, and, based on this, there are indicators on how the commodity flows should be spread between the different Norwegian zones.

Validation

Data material not used for establishing the commodity flow matrices is used for validation of the model. The following statistics were available:

1. Transport performance in Norway (published by Statistics Norway and in an annual publication by TØI).
2. Maritime transport statistics from Statistics Norway.
3. Regional railway statistics from Statistics Norway and terminal statistics from CargoNet.
4. Modal distribution at the border crossing from Statistics Norway's foreign trade statistics.

The freight model has been validated on different levels of aggregation and the reliability of the matrices and the freight model system itself have been tested (if large deviations are found, both the model and the matrices have to be checked). This has been meticulous work resulting in: (1) a redistribution of commodity flows (in particular for foreign trade, where indicators for domestic spread had to be used) and (2) concrete corrections in the framework and input files of the model, e.g. the cost files.

Uncertainty

The commodity flow matrices are simplifications of all shipments within Norway and to/from other countries, which means that assumptions have to be made in particular for (1) sub-matrices where delivery patterns are deduced from minimising

the transport distances and (2) where the aggregated consumption in each zone is based on total consumption averaged over the population.

According to the commodity flow survey, shipments from wholesalers amount to the largest volumes (about 60%), while shipments from industry sectors constitute about 33%. This distribution indicates that there is uncertainty in the data, i.e. shipments to domestic wholesalers that are not covered by shipments from industry sectors have to be covered by either imports or shipments from primary sectors. Shipments to wholesalers (resulting from imports and shipments from primary sectors) sum to less than the shipments from wholesalers, even when the shipments between wholesalers are subtracted. We therefore know that the data from the commodity flow survey are not entirely accurate.

Domestic locations for foreign trade commodity flows are estimated based on indicator values generated from other official statistics. There is therefore a considerable amount of uncertainty tied to the locations for foreign trade commodity flows in Norway.

The uncertainty in the matrices cannot be quantified. However, their use in detailed analyses requires a new validation based on available information in that specific area. It is through usage that deviations are revealed and the matrices improved based on local expertise. However, since the sum of foreign trade flows is consistent with the foreign trade statistics, changing one cell requires contrary adjustments of other cells for this still to hold.

Possibilities for analysis

In most analyses in which the national freight model is used, the commodity flow matrices are held constant throughout the different scenarios. In that way, only alterations in mode choices and transport costs are regarded as effects of changing networks or economic conditions. In some analyses, however, it may also be relevant to consider changes in the matrices themselves, for instance:

1. For forecasting purposes
2. For analysing the effects of different locations for industry or wholesalers
3. For analysing the effects of varying the distributional pattern for imports

Each of these possibilities is discussed in chapter eight of the report.

Further development

The dataset from the commodity flow survey is used directly for shipments from industries and wholesalers even though it produces selection bias when scaled up appropriately. This is not corrected because of budget limitations. A possible development is therefore to utilise the data better by connecting them to industry and wholesale statistics, and to use the population of firms as the basis for distributing the commodity flows between all zones where firms are located. The volumes can then be scaled using the firm's turnover or number of employees as explanatory variables. Since the commodity flow survey specifies industry classification on a detailed level, it enables use of a range of differentiated parameters in the estimation.