Summary

A tool for projections and scenario analysis of train trips in Norway

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This report documents a model that predicts the amount and distribution of train trips for different scenarios. Explanatory variables include population growth, economic growth, change in the prevalence of home offices and changed competitive structure of transport modes that are not due to changes in the train service. The model is implemented in Excel and is suitable for generating reference matrices in the transport model Trenklin.

On behalf of the Norwegian Railway Directorate, TØI has established a tool that predicts growth in train trips (excluding freight transport) as a result of changes in society in the medium and long term. The Norwegian Railway Directorate wants a tool that is not very resource-intensive to use, but which captures more than just population growth. The tool should be able to break down the growth in demand at various train station relationships. This is important for later use in Trenklin, which throughout the model process operates at the train station origin-destination level.

Our level of ambition can be described as follows:

- Capture all important effects except for changes in train services
- As far as possible, make use of established forecasts from Statistics Norway
- Transparency
  - Documentation of all calculation mechanisms
  - Reasoning behind (pattern of) assumed values for underlying parameters
- Flexibility
  - Users are free to choose reference- and forecasting year (period 2014-2050)
  - Users are free to specify scenarios
  - Users are free to change/update input data
  - Users are free to change values of the underlying parameters
- User-friendly
  - Simple scenario specification in Excel
  - Fast calculation time
  - Easy transition from the tool from/to Trenklin
  - Automatic recognition of station names from reference matrices (independent of selection/sorting of matrices)
  - Possibility to use only parts of the model (growth model), e.g. when you do not have reference traffic on orgin-destination level available

The forecast model can be divided into 5 main elements

1. User-defined input
2. External input
3. Growth model

4. Distribution model
5. Printout of results

The calculation process in the model begins with a scenario definition (Figure S1).

	A	B
1	**Modellspesifering**	
2		**Spesifisere her**
3	Markedsområde	Oslo-Viken
4	Referanseår	2018
5	Prognoseår	2030
6	Antar generisk vekst over togstasjoner gitt reisehensikt (deaktiverer fordelingsmodell)	Nei
7	Bruk default innstillinger	Nei
8	Prognosebane befolkning SSB	Hovedalternativ (MMM) (default)
9	Antakelse om økonomisk vekst	Som prognostisert av SSB (default)
10	Antakelse om endring i (andelsvis) utbredelse av hjemmekontor	Samme nivå som i referanseår (default)
11	Generell konkuranseflate mot bil	Ingen endring (default)
12	Generell konkuranseflate mot fly	Ingen endring (default)
13	Generell konkuranseflate mot buss	Ingen endring (default)
14	Utvikling av tilbringertransport til tog (f.eks pga autnome kjøretøy)	Ingen endring (default)
15	Utvikling av flymarkedet (for tog som tilbringer til flyplasser)	Ingen endring (default)
16	Utvikling av tog som transportmiddel for turistnæring	Ingen endring (default)
17	Økt miljøbevissthet (i favør tog)	Ingen endring (default)
18		
19	**Trykk her for å kjøre modellen:**	**Kjør modell**
20		
21	**Resultater av vekstmodell (Se resultater oppsplittet over togstasjoner i separate ark)**	
22		**Relativ økning av togreiser**
23	**arbeidsreiser**	
24	**fritidsreiser**	
25	**tjenestereiser**	
26		

Figure S1: Screenshot of sheet for scenario definition

In the scenario definition, reference year and forecast year, geographical segment and various scenario settings are determined. Among the latter is the scenario for population projection and economic growth. These scenarios determine paths for population and economic growth that form - together with other assumptions - the data basis for the growth model.

The growth model calculates general growth factors for work, leisure and business travel.

The distribution model distributes growth factors from the growth model to different train station pairs. This is done based on 1) index for change in tour attraction 2) index for changed competitive structure and 3) reference traffic. The latter is used for calibration.

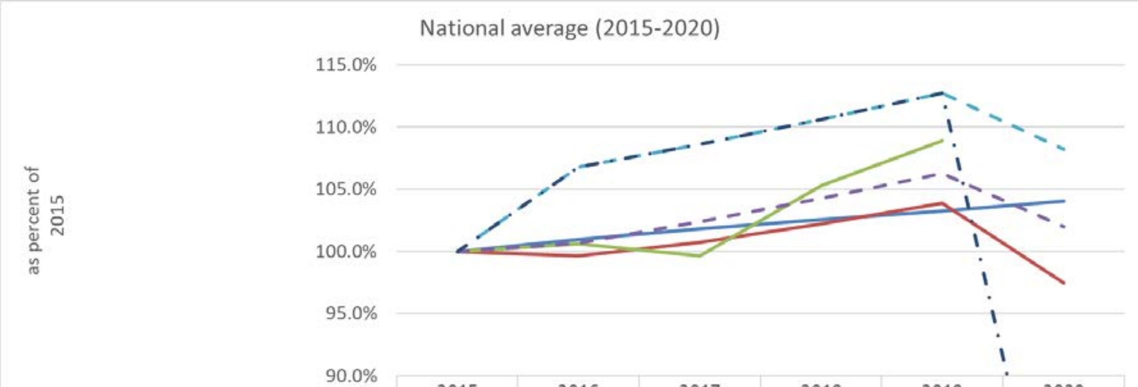
The index for change in tour attraction is based on population growth and working places around train stations and user-defined assumptions about growth in the aviation market and the tourism industry. The index for changed competitive structure is based on changes in generalized costs (GK) for trains and cars as a consequence of economic growth (increasing value of time and lower price sensitivity) and user-defined changes in car competitiveness.

The model is segmented into three travel purposes: commuting, business travel and leisure travel (other travel). Furthermore, the model is run for an underlying geographical area/market. These are:

1. National average
2. Oslo/Viken
3. Long-distance train
4. Customised

The underlying data and parameters vary for each segment (combination of geographical area and travel purpose). The exception is "Customised" where users enter their own parameter values). Parameter values in the model are determined based on literature review, theoretical considerations and/or expert judgment assessments. Some parameter values were adjusted and calibrated based on a historical comparison and scenario analyses.

Figure S2 shows three predictions for growth in train traffic for the whole of Norway between 2015 and 2020 and compares with actual figures from Statistics Norway (figures for train passengers in 2020 are not yet available at the time of writing).



	2015	2016	2017	2018	2019	2020
SSB-population growth	100.0%	101.0%	101.8%	102.6%	103.2%	104.0%
SSB-economic growth	100.0%	99.6%	100.7%	102.2%	103.9%	97.5%
SSB- train passengers	100.0%	100.6%	99.6%	105.3%	108.9%	
VM (Default)	100.0%	100.7%	102.4%	104.3%	106.3%	102.0%
VM (+ car sowehat more attractive)	100.0%	106.8%	108.6%	110.6%	112.7%	108.2%
VM (+much more home office in 2020 2020)	100.0%	106.8%	108.6%	110.6%	112.7%	70.3%

Figure S2: Comparison of predictions with the growth model (VM) against actual figures for segment «national average». Base year 2015.

In principle, the model can be used for all types of model runs in Trenklin where reference matrices in Trenklin must be forecast from previous years.

The forecast model is able to capture the «corona year 2020». There is an economic decline for 2020 in the model (according to the economic report) and users can change conditions such as the use of a home office. Nevertheless, users should be careful about using 2020 as a reference or forecast year, and double-check whether the predictions seem reasonable.

The model can in principle be used in all types of scenarios. When creating "extreme" scenarios, which give very high growth rates, one must interpret this as a theoretical result of the effect of exogenous factors. In reality, high growth rates will lead to "endogenous effects" in the form of increased congestion costs. This will have a dampening effect on demand and will result in a lower effective growth rate than calculated by the forecast model. This is important to keep in mind when creating reference traffic far into the future for Trenklin runs, or when using the forecast model outside of Trenklin.

This first version of the forecast model has some known weaknesses that could be improved in future versions:

- Data on the development for workplaces are only available for Oslo/Akershus (RTM23+ area). This may lead to some biases in distribution factors for model areas that affect both relationships within and outside Oslo/Akershus. We have "solved" this problem by taking out the effect of increased number of jobs for the "National average segment" and the "Long-distance train" segment. Thus, the effect is only active for the Oslo/Viken segment. It is recommended to work with this part of the input at a later update of the forecast model.

- The effect of the airport and tourist industry on the growth model is not entirely optimal since the effects will in reality depend on the number (share) of train stations defined as airport- and tourist related. Future versions should, when reading reference matrices, identify the number of relevant train stations and adjust the parameter values accordingly.
- Many of the parameters had to be determined by expert judgment. A more empirical determination of parameter values is desirable. This requires that we can check for changes in the train services over time, which presupposes that consistent LoS or GK matrices are created.
- The forecast model normalizes distribution factors over all train station relationships that are included under the «input sheets». Such a mathematical specification means that the results of a given station-pair depend on other station-pairs in the matrix. With this assumption, it is not guaranteed that you get identical results for two different runs with different "size" of input matrices. It is not obvious how to solve this, but further work should look more closely at this issue.