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Evaluation tool for wider economic effects of railway investments: Making computable general equilibrium model results accessible

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Evaluation tool for wider economic effects of railway investments

– Making computable general equilibrium model results accessible

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Abstract

Transport sector has a long tradition of using the principles of practical cost benefit analysis (CBA) in project appraisal that analyses the primary impacts of transport investments. The standard transport project assessment is necessary but not sufficient for the estimation of the wider economic impacts, which are in increasing demand among decision makers.

Computable General Equilibrium models (CGE) have been proven to be powerful tools in the assessment of economic impacts of infrastructure investments. In this project, GEMPACK-based dynamic regional CGE-models (RegFinDyn and RegSweDyn) have been used in the assessment of rail investments in Finland and in Sweden. The models are fairly standard versions of the Australian TERM model, with some exceptions regarding labor market, migration, demography and agglomeration economies.

The use of these models is, however, rather expensive and requires specific skills, software and knowledge. This project tackled these contradicting needs for a complex CGE-modelling and the desired easiness and flexibility of the analysis: A freely available spreadsheet tool was developed with a streamlined interface that uses a large number of previously made CGE-model simulations as basis for the assessment.

The developed twin tools were named WebRailSwe and WebRailFin. The tools are made for a quantitative, first approximation of the wider economic impacts of large rail investments in the national areas of Sweden or Finland. The wider economic impacts calculated by this tool are supplementary to the results of a standard project assessment (CBA).

The tools use generalized results of RegSweDyn and RegFinDyn CGE-modelling, which could be termed as “model of a model” approach. CGE model results are used as observations to estimate regression equations where investment shock variables are used to explain the observed deviations from the base run. The four economic indicators calculated by the tools are real GDP, real household consumption, employment and population.

We show that it is possible to have an accessible tool that is relatively simple to use but gives results that are based on comprehensive CGE-modelling. This can be considered a promising start for a wider consideration of advanced modelling of economic impacts in the transport sector. However, the results of this project, WebRailSwe and WebRailFin, are only applicable to railway investments, and the results are calculated and presented on a spatial resolution that is rather coarse. Further work could be done to develop similar tools for road investments and other forms of transport improvements, and to increase the spatial resolution of the tools.

R13	General Equilibrium Analysis of Regional Economies
R42	Transportation Planning
C68	Computable General Equilibrium Models

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1 Background

This paper is based on the work carried out within the project 'Wider economic impacts of transport investments,' Activity 5.3 of the Work Package 5 of the Bothnian Green Logistic Corridor (BGLC) project (Metsäranta et al., 2014), led by Region Västerbotten in Sweden, carried out together with 28 other partners, and part-financed by the European (European Regional Development Fund).

BGLC was an international project working to develop the infrastructure on the Corridor and its connections. The Bothnian Corridor transport network connects northern Europe and its rich natural resources to the most densely populated areas in Europe. The Bothnian Corridor is a strategically significant artery for securing efficient raw material transport and sustainable economic growth in Northern Europe.

Work Package 5 of the BGLC-project aimed to increase the knowledge and understanding of the economic impacts of infrastructure development on industrial development and new potential, on their value chains, and on regional economy. The project report "*Wider economic impacts of transport investments*" was Activity 5.3 of the Work Package 5.

This paper concentrates on the presentation of the CGE models behind the excel tools and discusses the pros and cons of such stand-alone excel tools. However, a considerable part of this paper is based on the project report, which has the same authors as the present paper.

2 Introduction

Transport connects people, businesses and resources. The demand for transport is derived demand reflecting the economic activities of firms, households and individuals. Changes in the transport system, in turn, have impacts on the economic development, that can be defined by society's strategic economic goals and objectives (Littman 2010) concerning e.g. income, employment, competitiveness, business activity, property values, affordability, tax revenues, equity. These objectives have local, regional and national dimensions.

Investment decisions are key decisions in every long term development strategy. The main underlying reason to use economic resources now is to gain economic benefits in the future. Decisions concerning transport infrastructure are made by public agencies and governments, and are expected to support the public good. Therefore, project appraisal is used to investigate and reason the consequences of the decisions to assist the decision-makers to reach informed and rational choices.

Generally speaking, transport investments generate two categories of benefits (Berechman 2009): Direct, primary benefits within the transport system and secondary, externality benefits in the other sectors of society and the economy. The primary impacts of transport investments concern accessibility, traffic safety and transport related costs both internal and external. Environmental and

other restrictions and impacts are taken into account and may in some cases be of great importance and interest. However, the main motivation for transport investments comes down to economic goals and objectives.

Transport authorities in most countries have a long tradition of using the principles of practical cost benefit analysis (CBA) in transport project appraisal. The theoretical framework for such an analysis is broad, and therefore there are International (e.g. World Bank), European (EU) and nationally harmonized guidelines for transport project assessment. The CBA provides the decision-making with tools to analyze the primary impacts of transport project proposals.

According to Graham (2012), there is a strong theoretical case for extending conventional transport appraisal to cover wider economic impacts. Agglomeration economies form the largest component of these wider impacts, and there are differences between different kinds of transport projects in different regions. Therefore, the expansion of the transport project assessment to cover also the wider economic impacts is of significance in the decision-making. Agglomeration impacts can arise from small schemes as well as large schemes, and across different modes of investment. Further, the agglomeration benefits do not only arise in urbanized areas but any location may benefit from improvements in accessibility.

Significant improvements in accessibility may cause a strong growth impulse for a region. This is especially possible if new connections are created or two or more transport modes are developed simultaneously (e.g. fast railway and highway) for a region with growth potential but previously underdeveloped transport system (World Bank 2009). In this case the accessibility improvements function as a catalyst for growth but in the long run the larger size makes it possible for the region to create agglomeration benefits for firms and households which may lead to further growth.

Agglomeration benefits refer to positive externalities by which economic actors (firms and households) benefit from the closeness of other economic actors and of the increasing number of them and output growth created by them. Agglomeration benefits can be divided to localization benefits and urbanization benefits (e.g. Laakso and Loikkanen 2004).

Localization benefits are based on the large size of a certain sector in the region. This makes it possible to exploit scale benefits in the input markets and logistics and supports the creation and distribution of innovations within the region. Urbanization benefits are based on the large size and diversification of the whole urban region. For firms urbanization means more competition, wider goods variation, better possibilities for specialization and cooperation. For households urbanization means a wider range of consumption possibilities. For labor markets large size of the urban region means better match of the demand for and supply of work. An important factor is the possibility to spreading of knowledge, innovations and technologies between the sectors.

There is a lot of research evidence about the benefits to firms of the location near other firms of same industries or other industries. Agglomeration benefits the economic and social interaction between firms and their employees. This increases the probability of innovations and flow of knowledge between firms. In addition growing urban areas provide urbanization benefits, like the benefits of the large market area, well working labor markets and benefits from the diversification of industries. At the same time, agglomeration can increase price level and congestion (Laakso and Loikkanen 2004; Laakso and Moilanen 2011).

Industries differ from each other with respect to the significance of the various dimensions of accessibility and the sensitivity to the changes in accessibility. According to Graham (2007; 2012) the productivity of firms increase with respect to the accessibility to a major economic center but the elasticity varies between industries. The elasticity is higher in services than in manufacturing or construction. The highest effect is in business services, finance, telecommunication and transport while in retail trade and accommodation and catering it is lower but still higher than in manufacturing.

This explains to the large extent the fact that in Finland more than three quarters of the jobs of business services, finance and telecommunication are located in the 10 largest urban areas with the biggest local market for their services and best accessibility to other concentrations. (Laakso and Moilanen, 2011).

3 The CGE models RegFinDyn and RegSweDyn

The twin regional CGE RegFinDyn and RegSweDyn¹ models are well designed for infrastructure impacts estimations and it has many advantages over the older, linear calculation methods such as input-output models. They are dynamic versions of the comparative-static RegFin model; influenced by famous Australian ORANI, MONASH, MMRF and TERM models (Wittwer and Horridge, 2010; Wittwer 2012). The family of RegFin models has been developed and used since 1998. The model is built on a neo-classical economic theory (Figure 1).

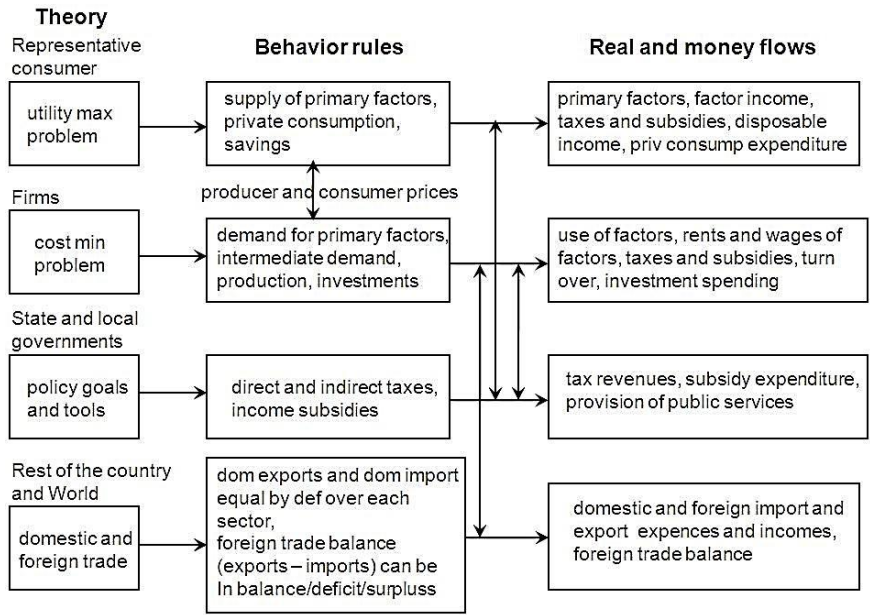
These models include and take into account a large number of economic factors, among others:

- constraints on total availability of factors of production (labor, capital, land)
- sectorial production and their demand for factors of production
- dependencies of producer sectors in expenditures and sales
- effects from differences in business structure between the regions
- transport services presented as three sectors (Rail, Road, Other)
- transport margins and productivity changes
- substitution guided by relative prices between Rail and Road transportation
- transportation infrastructure investments
- operation phase of transportation infrastructure investments,
- households', businesses' and public sector's non-linear decision-making
- investors' cautious profit-seeking behavior
- time dimension
- capital stock accumulation via net investments guided by the changes in the rate of return to capital
- wage differences between the regions
- regional population changes and demographics

¹ The basic CGE description is presented in publications Törmä (2008) and Rutherford and Törmä (2010). The detailed description of the model can be found in Törmä and Zawalinska (2010, 2011) and with emphasis on transport impact in Metsäranta (et al., 2012). See also <http://www.helsinki.fi/ruralia/research/regfin.htm>. RegSweDyn was developed within this project.

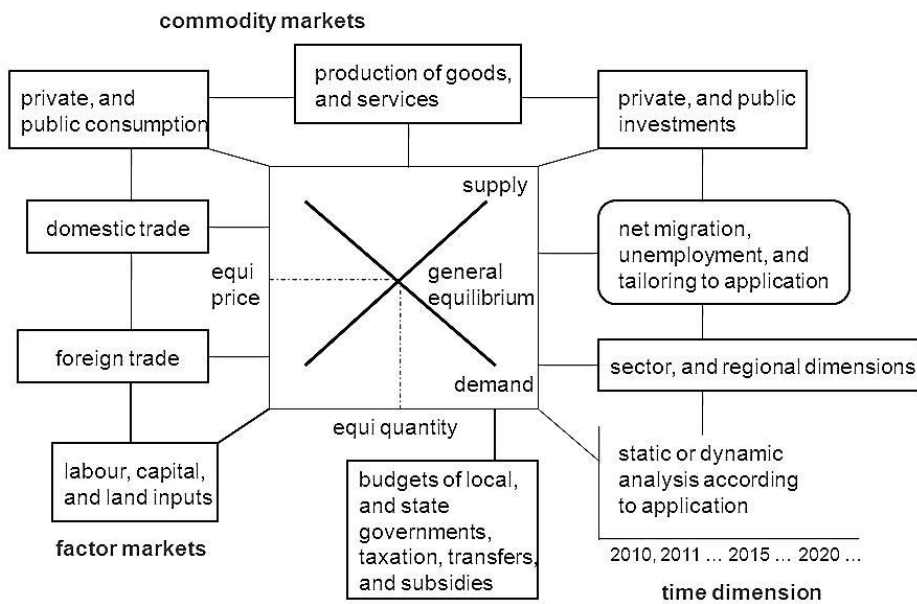
- money flows into-and out from the region through domestic and international trade.

Figure 1. The theory behind the models



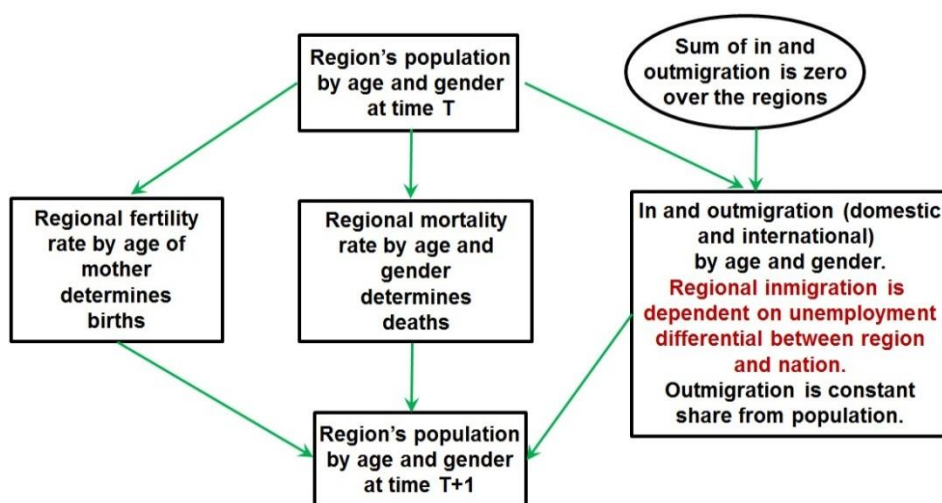
As for every dynamic model, the additional feature of RegFinDyn over the RegFin model is the time dimension. Economic impacts are calculated year by year for a specific time period, for example years 2007-2020. Dynamic calculations require setting up the baseline that is the image of the future without the considered changes. With the calculation over the time, the model shows the dynamics through the interdependence between sectorial investments and capital stocks.

Figure 2. Interdependencies of the different markets and actors



Another distinguish feature of RegFinDyn and RegSweDyn among other CGE models is the population module. The factors affecting the regional population in the model are fertility and mortality rates, as well as domestic and foreign net migration (in- minus out- migration). The model produces the population structure by gender in 1-year-cohorts up to 95 years of age. The importance of the population module lies in its link to the labor force, citizens' well-being as well as the high interest of public sector in anticipating demographic changes causing changes in the provision of public services.

Figure 3. Demographic module



The central equation for population dynamics is

$$(4) \text{POP}_{a,s,r,t+1} = \text{POP}_{a+1,s,r,t} + \text{BIRTHS}_{s,r,t} - \text{DEATHS}_{a,s,r,t} + \text{NINMIG}_{a,s,r,t} + \text{WINMIG}_{a,s,r,t} - \text{NOUTMIG}_{a,s,r,t} - \text{WOUTMIG}_{a,s,r} \text{ where:}$$

a = age 0, 1, 2 ... , 95+

s = gender

r = region

t = year

$\text{POP}_{a+1,s,r,t}$ Population in year t by age cohort, gender and region made one year older

$\text{BIRTHS}_{s,r,t}$ 0-year-olds by gender and region

$\text{DEATHS}_{a,s,r,t}$ Number of deaths by age cohort, gender and region

$\text{NINMIG}_{a,s,r,t}$ Persons moving in from other Finnish regions by age cohort and gender

$\text{WINMIG}_{a,s,r,t}$ Persons moving in from abroad by age cohort and gender

$NOUTMIG_{a,s,r,t}$	Persons moving out to other Finnish regions by age cohort and gender
$WOUTMIG_{a,s,r,t}$	Persons leaving Finland by age cohort and gender

Fertility levels by age of mother and by region are assumed to follow the assumptions of Statistics Finland's latest population forecast (2012). In other words, fertility rates are five-year cohort-wise regional averages that are assumed to be constant over the simulation period. Gender distribution of the newborn are assumed to follow the national average in every region. The number of newborn is thus dependent on the age structure of women in fertile age. Mortality rates are also based on the Statistics Finland's population forecast. Exogenous, individual trends are imposed to each cohort, gender and region. The number of deaths is thus dependent on the development of mortality rates and the age structure of the population.

The treatment of migration makes the population outcome endogenous, and different from Statistics Finland's forecast, if not imposed to follow it under baseline. The main postulation is that the increase of employment opportunities will increase also migration to the region r , if the difference between the regional and the national unemployment rate becomes more favorable to the region r . This regional unemployment differential compared to the whole country will determine the development of in migration flows. Another important assumption is that the age and gender structure of in migrants is assumed to roughly follow the average structure of in migrants recorded in recent statistics of the region.

The outmigration flows are assumed to follow constant migration rates, estimated for each age cohort by gender in each region. The outmigration flows are then scaled with nation-wide shifter variables that ensure that the sums of national in- and out-migration flows are equal by age cohort and gender, as they must be by definition. The age structure is another determinant of migration flows. Regions with few young persons do not thus have extensive outmigration, as persons around 20-30 years are the most probable movers. The corresponding unemployment rate vs. in-migration elasticity value, which governs the sensitivity of migration flows to labor market situation, is set to 0.05. This parameter was estimated from a panel of regional migration and unemployment data of Statistics Finland. If the unemployment differential changes in favor to the region r by one percent unit, then it's in migration would increase by 0.05 percent.

Migration abroad is assumed to follow migration rates that tally with the Statistics Finland's forecast. In- migration follows again the recorded five-year averages, as in Statistics Finland's forecast. The national net migration level is set to follow the assumption of Statistics Finland's forecast. However, in future applications, this assumption could be revisited and set to follow the growth of the Finnish economy. However, as the model does not describe the economic situation in the rest of the world, even such a solution would be unsatisfactory. The Finnish history is ripe with examples how other than economic factors have governed the international migration flows to and from Finland. The allocation of international in migrants is assumed to follow past year's allocation, but it is affected by the population growth rates of each region. Fast-growing regions will get an increasing share of newcomers.

Labor supply is mainly dictated by the size of age cohorts and their participation rates. However, participation rate of each cohort is assumed under non-base scenarios to depend on the changes in the real wage rate from the base scenario values. In other words, base run wage increases are thought to represent a “normal” growth of wages over time, and thus they are not assumed to affect labor supply. Deviation from the base run wage growth may create a small reaction to labor supply, which is assumed to work through changes in the participation rate, and not through changing hours, which are not explicitly modeled. Age cohorts from 15 to 74 years are assumed to be potential participants in the labor market. Base year data on labor supply gives the initial participation rates by region, gender and age cohort. The maximum participation elasticity is set to 0.25. However, this parameter is multiplied with the share of currently non-active share of the age cohort. The intuition is as follows: the higher the share of those current active in the labor market, the harder it is for them to adjust their labor force participation due to institutional arrangements and their phase in their career. In contrast, those age cohorts that are less commonly active in the labor market have more “degrees of freedom” in their choice of participation to labor market. This intuition actually loosely follows the empirical results estimated by several researchers: labor supply of middle-aged men is less elastic than that of women, students and elderly have higher participation elasticity (see e.g. Kleven and Kreiner, 2006; Meghir and Phillips, 2010; an overview in Ministry of Finance, 2010; see also Bargain, Orsini and Peichl, 2012). In addition, our formulation fills in the gaps in empirical results, stretching few parameter values to both genders and to every age cohort. At the same time, it ensures that the participation rates do not surpass 100 per cent (for a similar application, see Kinnunen, Honkatukia and Rauhanen, 2011).

In the base run, real wages are growing around a national average growth rate. Under non-base scenarios, the growth in real wages is assumed to react to percentage changes in the unemployment rate of the region, which keeps the unemployment rate from changing too rapidly. Therefore, regional differences in unemployment rates are quite persistent, as in the real world. The unemployment rate becomes in this model setting just a comparison of labor supply and demand, which are determined elsewhere in the model code. However, the parametrization of the model needs to be such that the unemployment rate does not e.g. fall to zero or turn negative.

Agglomeration is measured in RegFinDyn and RegSweDyn through each region’s share of national labor costs compared to previous year. Thus, we use the share of regional labor cost as a simple proxy for effective density of economic activity. Regions increasing their share of labor use enjoy an additional increase in productivity. However, agglomeration impacts are assumed to vary by industry according to elasticity estimates reported by Kernohan and Rognlien (2011). The productivity gain from agglomeration is largest in knowledge-intensive services like financing (elasticity 0.08–0.09) and smallest in primary production (elasticity 0.03–0.04). In transport-related services the elasticity is 0.057.

The two models have the same structural design built on national and regional data from the respective country. The main data sources used for RegFinDyn and RegSweDyn were the national and regional accounts of Statistics Finland and Statistics Sweden, as well as Eurostat. National Supply and Use tables are available from both countries. They provide picture of the supply of goods and

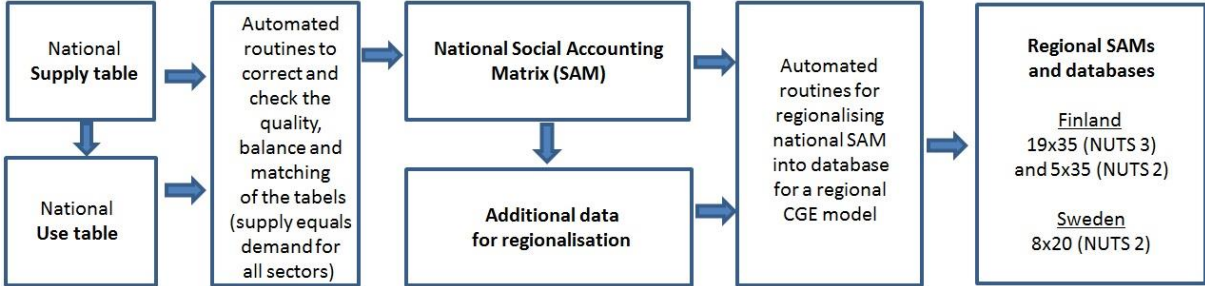
services by domestic production and imports and the use of goods and services for intermediate consumption and final use (private and public consumption, gross fixed capital formation, exports). The Use table also shows how the components of value added (compensation to employees, other net taxes on production, consumption of fixed capital, net operating surplus) are generated by industries in the domestic economy (Eurostat, 2008).

The databases for the two CGE models were created in two stages (Figure 4).

1. National data was used to create national databases. The national Supply and Use tables are useful, since they give detailed information on the production processes, the interdependencies in production, the use of goods and services and formation of income generated in production. Automated routines were used to check the quality, balance and matching of the tables. One important test is making sure that supply equals demand for all sectors. After checking, corrections and balancing, the Supply and Use tables provide coherent data linking industries, products and sectors. National Social Accounting Matrices or SAMs, together with corresponding national CGE databases are created in this process.

2. National databases are regionalized by using additional data from regional level. This requires sector and region specific data in matrix format for instance on production, investment, labor income, and population shares. Automated routines were used to create the regional SAMs and the corresponding CGE databases.

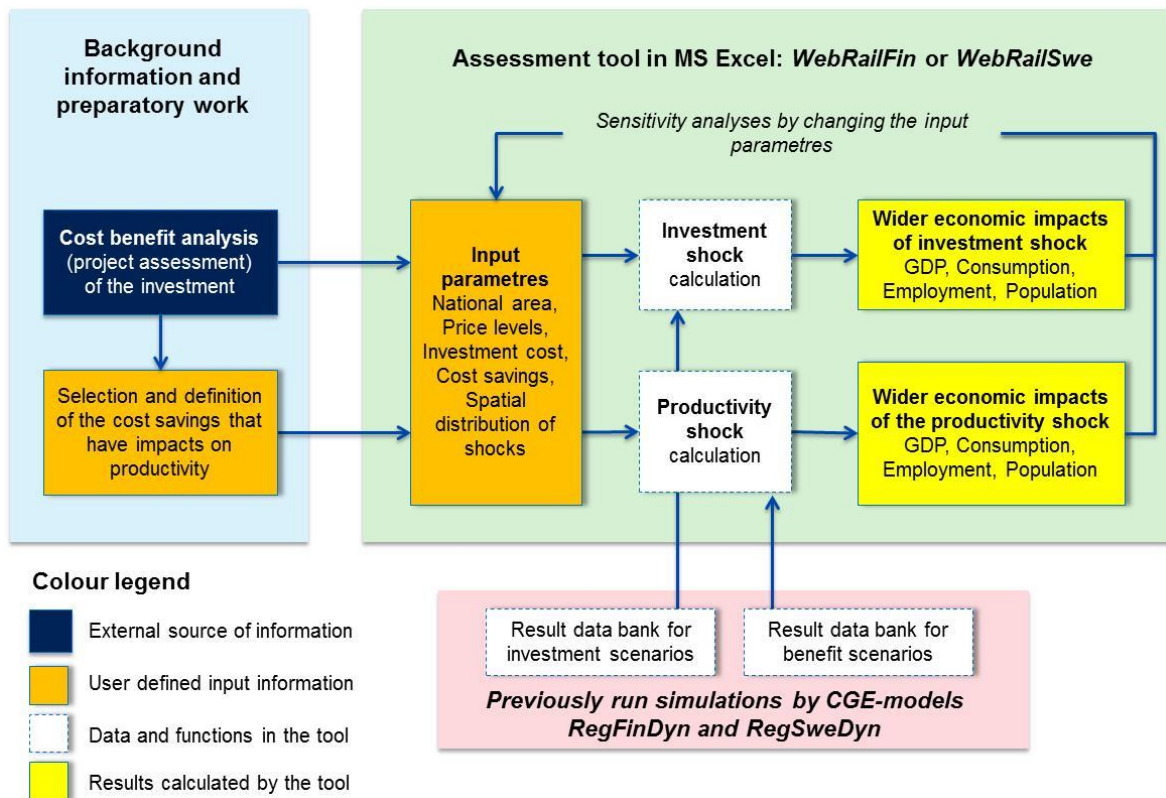
Figure 4. The process of creating the model databases



4 The twin tools WebRailFin and WebRailSwe

The development of the tool led to twin tools that were named WebRailFin and WebRailSwe – describing the purpose of the tools to estimate the wider economic benefits of rail investments in Finland and Sweden, respectively. An overview of the tools is presented in Figure 5.

Figure 5. An overview of the WebRailFin and WebRailSwe



The tools use generalized results of RegFinDyn and RegSweDyn. The Swedish tool covers 8 national areas (Nuts 2) and is based on a total of 64 scenarios of investment costs and 64 scenarios of benefits (cost savings). The Finnish tool covers 4 national areas (Nuts 2) and is based on a total of 160 scenarios of investment cost simulations and 40 scenarios of benefits (cost savings). After running through all the scenarios, a separate regression analysis was carried out for each outcome variable. The explanatory variables of the regression analysis were the size of the shocks in relation to region's GDP, the length of the shock, regional dummies and several interaction variables combined from these.

The user must insert the relevant input parameters into the assessment tool (Figure 6). The necessary information should be available in the project assessment (CBA) of the investment project in question. If the user wants to assess a project that's planning is on a very preliminary stage, the input parameters have to be defined based on user's own expertise based on e.g. project assessments of previous projects.

The CBA results enter our CGE model through the following parameters:

- 1) Public consumption: changes in maintenance and investment costs
- 2) Productivity of railway traffic: reduction in traffic costs
- 3) Change in consumer preferences: change in traffic consumption (in favor of railway traffic away from road traffic)

4) Productivity of labor: time savings, reduction in accident costs (loss of life).

In Sweden, a major rail investment within the Bothnian corridor is The North Bothnia Line (Norrbotniabanan), a new railway between Umeå and Luleå (270 km). The estimated investment cost is 21,725 million SEK (2,508 million euros). According to the project assessment (Banverket 2009), the major benefits of the investment are time savings (net present value 8,639 million SEK), transport cost savings (4,098 million SEK) and increased ticket revenues for rail operators (2 397 million SEK). The total net present value of the investment is 208 million SEK meaning that the investment is feasible with a very small margin.

Earlier calculations of the Norrbotniabanan show, that the increased accessibility increases the number of employees (+0.0..+0.3 %) in the region and on the total income of the households (+650 million SEK per year ten years after opening). On the other hand, there are negative impacts on the built and natural environment. The overall conclusion of the project assessment is that the positive margin of the benefits is stable. As regards the non-monetized impacts, the positive impacts on the regional economy are considered more valuable than the negative impacts on the environment (Banverket, 2009).

This case was assumed to be a typical one. By using the cost and consumption pattern changes estimated for it, the project was replicated in each of the NUTS2 regions by changing two critical parameters: the size of the project and the duration of construction period. The relative importance of different cost and benefit items were kept unchanged. In the construction of the shock variables of each run, the results of the base run for the area in question were used as the basis of comparison. Thus, the same monetary values of the original project produced different size of relative shocks in each area.

The results of the CGE-modelling are stored in the planning tool. By using them as observations, the wider economic impacts were estimated. The regional economic effects of rail investments can be evaluated separately for both the investment and operation period. The main interest is on the results related to economic growth and labor markets.

Regarding investments, it is assumed that the cost of investment is financed through an increase in VAT for a period of 20 years. Thus, the investment cost is borne by the whole country. The monetary values of CBA are compared to baseline results for the corresponding year in order to get a percentage change value that is introduced to the model. Once all the necessary inputs are in place, the user gets the results immediately in form of tables and graphs. Thus, it is easy to test the impact of different assumptions on the outcome, within the predefined domain of the application. Figure 7 depicts a view of the results graphs of the WebRailSwe tool. Figure 8 depicts one of the results tables of WebRailSwe. The WebRailFin tool has all the corresponding items (save conversion from national currency to euro).

Figure 6. Excerpt from WebRailSwe: sheet for user inputs

CALCULATION OF THE WIDER ECONOMIC IMPACTS

Insert/choose values to cells with this color ---->

INSERT INPUT VALUES FROM THE CBA OF THE INVESTMENT IN QUESTION

Project name: Umeå - Luleå railway

1. The national area in focus	SE33
2. The year of the price-level in the assessment	2006
3. The investment cost (million SEK)	21 000
4. The first year of the construction work (max 2020)	2010
5. Length of the investment period, years (max 10)	9
6. The year of annual impacts from the CBA	2020
7. Direct economic impacts from the CBA per year in 2020	
<i>Indicate benefits as positive values (+) and disbenefits as negative values (-)</i>	
Infrastructure maintenance cost savings	
Maintenance of railways (million SEK)	-13,0
Maintenance of roads (million SEK)	38,0
Replacement investments in railways	69,0
Benefits for the goods transport operators	
Operating cost savings and time-cost savings (million SEK)	256
Benefits for the passenger transport operators	
Increase of ticket revenues (million SEK)	140,0
Operating cost savings (million SEK)	-92
User benefits	
Time savings for business trips (million SEK)	200
External benefits	
Accident cost savings regarding the loss of production (million SEK)	1,6
The reduction of wear and tear of roads	8

Figure 7. Excerpt of the result sheet figures of the WebRailSwe tool



Figure 8. Excerpt of the results table of the WebRailSwe tool

THE WIDER ECONOMIC IMPACTS OF Oulu-Seinäjoki		
Pohjois-Suomi		
Northern Finland	Impacts of the investment spending, 10th year from start	Impacts of the user benefits, 10th year
Annual impact	2017	2027
Real GDP of the area, <i>million EUR</i>	80,0	1,1
Household consumption, <i>million EUR</i>	38,8	0,6
Employment change, <i>persons</i>	37,3	3,9
Population change, <i>persons</i>	175,0	2,1
Cumulative impact, first ten years	2008 - 2017	2018 - 2027
Real GDP of the area, <i>million EUR</i>	561,9	9,4
Household consumption, <i>million EUR</i>	270,6	5,1
Employment change, <i>persons</i>	-257	33
Population change, <i>persons</i>	n.a.	n.a.

Exploring the tools

The wider economic impacts vary between the national areas, because the economic and demographic characteristics of the areas are different. These differences can be assessed with the WebRailSwe -tool by locating a same sized investment shock or a same sized productivity shock in different national areas of Sweden. For this demonstration we assume first a rail investment of 10 000 million SEK, and then an accessibility improvement worth 200 million SEK (time savings in business travel). The question of regional differences of economic impacts is of interest when there are competing investments of similar magnitude and impacts in various parts of the country.

The results of the investment shock calculations are summarized in Table 1. The absolute values of the economic impacts are larger in the large economies like Stockholm and West Sweden. On the contrary, the relative size of the economic impacts is larger in the smaller economies like Upper Norrland and Middle Norrland.

Table 1. Wider economic impacts of a 10 billion SEK investment (2010–2019) shock in Sweden in 2019

Impacts	Stockholm	East Middle Sweden	Småland and the islands	South Sweden	West Sweden	North Middle Sweden	Middle Norrland	Upper Norrland
Real GDP of the area, million SEK	1 925	1 840	1 794	1 877	1 862	1 772	1 692	1 747
<i>% of Base scenario</i>	<i>0,19 %</i>	<i>0,36 %</i>	<i>0,64 %</i>	<i>0,39 %</i>	<i>0,27 %</i>	<i>0,66 %</i>	<i>1,39 %</i>	<i>0,98 %</i>
Household consumption, million SEK	1 148	1 344	1 249	1 288	1 293	1 250	1 225	1 247
<i>% of Base scenario</i>	<i>0,27 %</i>	<i>0,52 %</i>	<i>0,91 %</i>	<i>0,56 %</i>	<i>0,39 %</i>	<i>0,94 %</i>	<i>1,97 %</i>	<i>1,40 %</i>
Employment change, persons	469	614	589	599	568	568	580	546
<i>% of Base scenario</i>	<i>0,04 %</i>	<i>0,08 %</i>	<i>0,15 %</i>	<i>0,09 %</i>	<i>0,06 %</i>	<i>0,15 %</i>	<i>0,35 %</i>	<i>0,24 %</i>
Population change, persons	477	653	577	651	586	588	523	524
<i>% of Base scenario</i>	<i>0,02 %</i>	<i>0,04 %</i>	<i>0,07 %</i>	<i>0,04 %</i>	<i>0,03 %</i>	<i>0,07 %</i>	<i>0,14 %</i>	<i>0,10 %</i>

The results of the productivity shock calculations are summarized in Table 2. The general observation is that the relative sizes of the economic impacts are not so different between the national areas. One main explanation for this is that the accessibility benefits of rail investment are generally widely spread.

What could be concluded from this kind of an analysis if we had two equally efficient competing projects - one in the South Sweden area and the other in the Middle Norrland area, for example? From a national point of view, a larger positive effect would be achieved by allocating the investment spending to the South Sweden area. From a regional policy point of view, on the other hand, investing in Middle Norrland would reduce the economic gaps between the national areas of Sweden.

Table 2. Wider economic impacts of an annual accessibility improvement worth 200 million SEK in Sweden year 2019

	Stockholm	East Middle Sweden	Småland and the islands	South Sweden	West Sweden	North Middle Sweden	Middle Norrland	Upper Norrland
Real GDP of the area, million SEK	91,8	46,8	33,6	46,9	93,2	28,9	15,7	22,8
<i>% of Base scenario</i>	<i>0,0089 %</i>	<i>0,0092 %</i>	<i>0,0119 %</i>	<i>0,0098 %</i>	<i>0,0135 %</i>	<i>0,0107 %</i>	<i>0,0129 %</i>	<i>0,0128 %</i>
Household consumption, million SEK	26,7	16,7	11,5	15,8	31,6	10,0	5,6	8,0
<i>% of Base scenario</i>	<i>0,0062 %</i>	<i>0,0065 %</i>	<i>0,0084 %</i>	<i>0,0069 %</i>	<i>0,0095 %</i>	<i>0,0075 %</i>	<i>0,0090 %</i>	<i>0,0090 %</i>
Employment change, persons	19,0	13,1	9,0	12,5	24,0	7,6	4,1	5,7
<i>% of Base scenario</i>	<i>0,0017 %</i>	<i>0,0018 %</i>	<i>0,0023 %</i>	<i>0,0019 %</i>	<i>0,0026 %</i>	<i>0,0021 %</i>	<i>0,0025 %</i>	<i>0,0025 %</i>
Population change, persons (stock)	6,4	4,7	3,1	4,6	8,2	2,8	1,5	2,0
<i>% of Base scenario</i>	<i>0,0003 %</i>	<i>0,0003 %</i>	<i>0,0004 %</i>	<i>0,0003 %</i>	<i>0,0004 %</i>	<i>0,0003 %</i>	<i>0,0004 %</i>	<i>0,0004 %</i>

As regards Finland and the WebRailFin -tool, we assumed a rail investment of 200 million euros, and then an annual accessibility improvement worth 5 million euros (time savings in business travel). The results of the investment shock calculations are summarized in Table 3. The economic impacts vary with the size of the economy: the larger the economy, the larger the absolute economic impact. In contrast, the relative size of the economic impacts increases when the size of the economy decreases.

Table 3. Wider economic impacts of a 200 million euros investment (2015–2019) shock in Finland year 2024

	Southern Finland	Eastern Finland	Western Finland	Northern Finland
Real GDP of the area, million EUR	189,30	37,32	87,61	58,64
<i>% of Base scenario</i>	<i>0,16 %</i>	<i>0,21 %</i>	<i>0,18 %</i>	<i>0,28 %</i>
Household consumption, million EUR	81,44	20,41	37,43	27,77
<i>% of Base scenario</i>	<i>0,13 %</i>	<i>0,22 %</i>	<i>0,15 %</i>	<i>0,25 %</i>
Employment change, persons	31,47	68,57	25,94	47,73
<i>% of Base scenario</i>	<i>0,003 %</i>	<i>0,032 %</i>	<i>0,005 %</i>	<i>0,02 %</i>
Population change, persons	208,04	55,80	131,38	93,64
<i>% of Base scenario</i>	<i>0,007 %</i>	<i>0,009 %</i>	<i>0,009 %</i>	<i>0,014 %</i>

Table 4. Wider economic impacts of an annual accessibility improvement worth 5 million in Finland year 2019

	Southern Finland	Eastern Finland	Western Finland	Northern Finland
Real GDP of the area, million EUR	5,02	0,92	2,12	1,05
<i>% of Base scenario</i>	<i>0,0042 %</i>	<i>0,0051 %</i>	<i>0,0044 %</i>	<i>0,0051 %</i>
Household consumption, million EUR	2,63	0,50	1,11	0,58
<i>% of Base scenario</i>	<i>0,0043 %</i>	<i>0,0053 %</i>	<i>0,0046 %</i>	<i>0,0052 %</i>
Employment change, persons	15,70	3,20	7,47	3,68
<i>% of Base scenario</i>	<i>0,0013 %</i>	<i>0,0015 %</i>	<i>0,0014 %</i>	<i>0,0015 %</i>
Population change, persons (stock)	7,00	1,85	3,67	1,98
<i>% of Base scenario</i>	<i>0,0002 %</i>	<i>0,0003 %</i>	<i>0,0003 %</i>	<i>0,0003 %</i>

The results of the productivity shock calculations are summarized in Table 4. The relative economic impacts are larger in peripheral Eastern Finland and in Northern Finland than in Southern Finland and Western Finland, while the absolute sizes of impacts are larger in the thriving, central regions.

Thus, a well-known trade-off between equity and efficiency often present in new economic geography model analyses shows up in our results as well (see e.g. Honkatukia et al, 2013; Honkatukia et al, 2012; Meyer and Lackenbauer, 2005; Ottaviano and Pinelle, 2004). Investments in central, thriving regions generate higher overall national growth than investments in peripheral regions. However, as long as territorial equity remains on the political agenda, investments in periphery are important.

Final remarks

The concept of an assessment tool was defined here to be a quantitative model system that uses direct cost estimates from the CBA as input parameters and calculates the wider economic impacts on a regional level. The original, to our knowledge earlier unproven idea was to use the RegFinDyn CGE-model in the assessment, and to develop its twin model RegSweDyn for Sweden in order to build the relatively simple user interface in MS Excel workbook instead of using directly the complex CGE models which need special, licensed software solutions.

In the process of building the tools, we had to make many hard choices that restrict the flexibility and the domain of applicability of the tools. In order to keep the number of necessary simulations down at a manageable level, we had to fix the relative importance of the different shock parameters and bundle them together. What is more, it would have been beneficial for the analysis to use a more disaggregated industrial and regional structure. In addition, different closures and public financing options would have benefited the usability of the tools. Likewise, the number of outcome variables

had to be kept low. In short, we were left with a feeling of falling short of covering all the possible development paths regarding the tools.

However, our excel worksheet based tools have a proven potential to make accessible the cumbersome CGE analyses to a broader public. Still, the dissemination of the results and the tools remains a challenge of its own. As the EU project financing the development of our tools was to end more or less simultaneously with the publication of our results, the dissemination activities within the project were minimal. Thus, we would appreciate any comments and suggestions you, the reader of this paper may have. Please send them to:

jouko.kinnunen@asub.ax

The excel tools (and the project report) can be downloaded from the following web addresses:

https://www.researchgate.net/profile/Jouko_Kinnunen

or:

<http://files.strafica.fi/WEBRAIL/>

or:

<http://www.pirkanmaa.fi/fi/bgic>

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Appendix 1. A guide for user inputs in the WebRailFin and WebRailSwe tools

The national area in focus

Choose the national area (Nuts 2) in focus. The tool calculates the results for only one area at one time.

The year of the price-level in the assessment

Insert the price-level used in the cost benefit analysis of the investment. The basic rule in CBA is that the investment cost and the monetized benefits are at the same price level.

The investment cost

Insert the investment cost used in the project assessment. The amount of actual spending during the construction will usually be more than this, but the important sum here is the difference between the investment and the reference alternative (that is assumed to be part of the base scenario). Our tool assumes that the investment is carried out in equal shares during the investment phase. Another assumption is that the state finances the investment by raising VAT during 20 years' time, and thereafter lowers VAT to its original level. This assumption is made to avoid giving a too optimistic view on the infrastructure investments. Unfunded "helicopter money" financing will always look beneficial to economy in this kind of models.

The first year of the construction work

Insert the year when the construction works of the project will start. In this version of the tool, the latest possible year to start the construction in the tool is 2020, so that the model has enough years in the base run for calculation of the impacts which accumulate during many years before reaching the maximum effect. However, if the user is only interested in relative results (% change from the baseline), one can apply time frames that go beyond year 2040, as then baseline values are not needed in the calculus of the absolute effects.

Length of the investment period

Insert the duration of the construction period in years. The maximum length of the construction period in this version of the tool is 10 years.

The first year of user benefits

Insert the first full year of operation after the construction.

Direct economic impacts from the CBA per year

Insert the annual (per one year) benefits from as positive values (+) and disadvantages as negative values (-). The annual value of economic benefits should be from first years of operation i.e. excluding the impact of traffic growth.

Infrastructure maintenance cost savings

- Maintenance of railways: Directly from the project assessment.
- Maintenance of roads: Directly from the project assessment.
- Replacement investments in railways: Directly from the project assessment.

Benefits for the goods transport operators

- Operating cost savings and time-cost savings: Directly from the project assessment.

Benefits for the passenger transport operators

- Increase of ticket revenues: Directly from the project assessment.
- Operating cost savings: Directly from the project assessment.

User benefits

- Time savings for business trips: Only the share of business trips must be considered here taken also into account the higher unit cost of time savings. One important point in costing of the time savings is that they should be valued in terms of labor costs to employer, not as net wages to employees.

External benefits

- Accident cost savings regarding the loss of production: The share of production loss is approximately 3 % - 5 % of the total monetary value of accidents involving personal injuries. The loss of production should be valued in terms of labor costs, not as net wages to employees.
- The reduction of wear and tear of roads: Directly from the project assessment.