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Does benefit/cost-efficiency influence transport investment decisions?

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Abstract
We explore how benefit-cost efficiency and electoral support affect road investment decisions in Sweden and Norway. In Norway, neither benefits nor costs seem to affect project selection. In Sweden, civil servants' decisions are strongly affected by projects' benefit-cost ratios, with a stronger effect for more expensive projects, while politicians' decisions are only weakly affected, and only for small projects. In both countries, governments tend to favour investments in regions where they enjoy strong local electoral support. Using cost efficiency as a final selection criterion seems to filter out many inefficient projects already at an early stage of the planning process. We argue that even if political decision-makers are apparently mostly governed by other concerns than cost efficiency, civil servants at the administrations should not shy away from preparing efficient project suggestions for decision makers to choose from.

Keywords: Cost-benefit analysis, project appraisal, public decision-making, transport investments.

JEL Codes: H43, R42, R48.

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1 INTRODUCTION

Investments in transport infrastructure account for a significant share of public spending in most countries. Various kinds of appraisal and forecasting methods are in widespread use to assess suggested transport investments, and many countries have official guidelines or handbooks for assessing suggestions before selecting which to build. There is an abundant research literature on transport modeling, appraisal and valuation of relevant non-market goods such as travel time and traffic safety, and guidelines and handbooks are also provided by other stakeholders such as the World Bank and the WHO. In fact, the widespread use and comparatively high status of quantitative and relatively objective decision support in the transport sector is sometimes seen as a model for other sectors of society.

In this paper, we investigate to what extent the results from transport investment appraisal actually affect decisions. We focus on road investments in Norway and Sweden, two countries which are reasonably representative for countries where quantitative assessments in general and cost-benefit analysis (CBA) in particular carry significant weight in official rhetoric and public debate. In both countries, considerable resources are spent on analyzing suggested investments: it is mandatory to use cost-benefit analysis following a standardized framework to evaluate nationally funded transport investments, and the CBA results are supposed to play a major role for prioritizing among the multitude of investment suggestions promoted by local and regional stakeholders. Appraisal methodologies are similar in the two countries, including the same type of benefits and applying similar transport forecasting models and benefit valuations.

Politicians' spending decisions may obviously be influenced by other considerations than objective benefits and costs. Hence, we also explore how electoral support for the national government in a region affects national infrastructure spending in that region.

Earlier studies have reached mixed conclusions regarding to what extent transport investment decisions are affected by benefit-cost efficiency. McFadden (1975, 1976) found that investment decisions by California Division of Highways were mainly explained by benefit-cost considerations. Eliasson and Lundberg (2012) found that CBA results seemed to influence project selection in the Swedish Transport Investment Plan 2010-2021, and Gómez-Lobo (2012) showed that a positive benefit-cost ratio is virtually a prerequisite for funding public projects in Chile. Annema, Koopmans and van Wee (2007) found some positive evidence from the Netherlands, showing that investments with negative CBA result to some extent were postponed and downsized. On the other hand, Nilsson (1991) found very limited correlation between CBA results and investment decisions in Sweden. Similar conclusions have been reached in Norway by Fridström and Elvik (1997), Nyborg (1998) and Odeck (1996, 2010), although the latter found that certain components of the CBA mattered. Nellthorp and Mackie (2000) studied UK road investment decisions, concluding that benefit/cost ratios did not seem to impact decisions, but components of the appraisal did.

Several studies have found that political decisions are influenced by electoral support. For example, Bombardini and Trebbi (2011) and Cadot et al. (2006) found that politicians tend to support nationally funded projects where benefits accrue to their own voting districts. Hammes (2013) found that the Swedish government tended to favour regions where it enjoyed electoral support. DelRossi and Inman (1999) found that the sizes of selected water projects are reduced as the share of the investment cost

paid by local tax payers increases. Knight (2004) showed that congress members showed higher support for transport projects in their own districts and a decreasing support for projects in other districts, the latter increasing the burden for tax payers in the own district.

Investment CBAs do not capture all possible relevant effects or considerations; some costs and benefits cannot be accurately valued or measured, and some considerations are deliberately left outside this framework, such as redistribution effects. Nevertheless, one would expect to find some correlation between benefit-cost ratios and investment decisions, especially given the high formal status of CBA in the two countries. But in Norway, we find no evidence that appraisal results affect project selection. In fact, before controlling for voting patterns, we cannot find any measure of benefits, cost or efficiency with a significant correlation with project selection. This holds both for the Government's and for the Road Administration's selection of projects. In Sweden, on the other hand, appraisal results seem to affect decisions. The Swedish Transport Administration's selection is strongly correlated with CBA results. The selection made by the politicians in the government, on the other hand, is only weakly correlated with CBA results, and only for small projects.

Both the Norwegian and Swedish governments tend to favour investments in regions where they enjoy strong local voter support. In Sweden, the national government instructed the Transport Administration to prioritise growing regions and specialized labour markets; in Norway, the national government prioritized investments in rural areas to try to promote growth there. In both countries, the respective principle benefited regions where the respective national governments enjoy strong local support.

In addition to ranking investments according to value-for-money, CBA also has a screening purpose, filtering out projects where costs exceed benefits. Comparing the distribution of benefit-cost ratios between the two countries, we find evidence that this screening mechanisms only works when CBA also matters for eventual decisions. Ensuring that eventual decisions are affected by benefit-cost efficiency hence also seems to have the added benefit that the least efficient suggestions never even enter the candidate shortlist.

Section 2 briefly describes the planning process and the appraisal methodology in Norway and Sweden. Section 3 explores how project selection in the two countries is affected by benefit-cost ratios, project size, types of benefits, electoral support and several other variables. Section 4 discusses the findings, what may cause them and their consequences. Section 5 concludes, arguing that even if politicians have both the freedom and responsibility to take other considerations than cost-efficiency into account, the experts and civil servants serving them cannot shy away from their responsibility to present decision-makers with efficient, or at least non-wasteful, alternative options to choose from.

2 THE PLANNING PROCESS IN NORWAY AND SWEDEN

Cost-benefit analysis is highly regarded in Swedish and Norwegian public debate and political rhetoric, especially in the transport sector. References to the social profitability or unprofitability of investments are common, and the general principle that transport investments should be socially cost-efficient is seldom gainsaid. Advocates of specific investments often argue that an investment brings additional

benefits not captured by traditional CBA, but they seldom question the basic principle that investments should be judged on the grounds of social profitability.

CBA plays its most important role in national transport investment planning. While local road networks are mostly a municipal responsibility, investments in major national and regional infrastructure is a government responsibility. This means that the government needs an objective and transparent process to compare suggested investments across the country, and this is where CBA is supposed to play an important role. Standardized national guidelines, scenario assumptions and traffic forecasting models have to be followed to ensure that CBAs of different projects are comparable, and it is the national infrastructure administrations that are responsible for carrying out the CBAs. Substantial resources are spent on preparing these CBAs.

In a European perspective, Swedish and Norwegian ministries are small. Instead, agencies under the government play a more active role in the infrastructure planning process. The Transport Administration (Sweden) and the Road Administration (Norway) – collectively called the Administrations – prepare and analyse candidate investments. When preparing the National Transport Investment plans, the government selects a number of projects that should be included in the investment plan from the outset. Then, the Administrations suggest additional projects to be included in the plan. The government then has the possibility to amend this suggestion.

The CBAs include the following types of benefits and costs:

- Accessibility benefits for private trips
- Accessibility benefits for business trips
- Accessibility benefits for freight transport
- Changes in emissions (CO2, NOx, SO2, particles)
- Traffic safety (fatalities, severe injuries, light injuries, material damage)
- Noise (often omitted due to the cost of calculating noise effects)
- Producer surplus for transport operators (change in fare revenues minus change in operations costs for trains and public transport)
- Maintenance costs
- Investment costs
- Changes in transport-related tax revenues (primarily fuel tax and road tolls)

Accessibility benefits include changes in travel times, travel costs, reliability and any other part of generalized travel costs. Safety and accessibility benefits make up the largest share of benefits by far for most transport investments.

CBAs are usually accompanied by so-called Comprehensive Assessments, which include verbal descriptions of any non-monetized effects, such as effects on the natural and cultural landscape. It also describes distribution effects and effects on the overall policy targets for the transport system (these are verbal targets set by the government, such as “an efficient and reliable transport system” etc.).

Table 1 presents the most important parameters in the CBA guidelines of the two countries. The table shows the parameters that were used for the appraisal studies in the current paper. Since then, both countries have revised their CBA guidelines.

Table 1. Central parameters used in the Swedish and Norwegian CBAs.

		Sweden	Norway
Travel time savings	Private trips <100 km	51 SEK/h	84 NOK/h
	Private trips >100 km	102 SEK/h	160 NOK/h
	Business trips	275 SEK/h	415 NOK/h
Traffic safety	Life	22.3 MSEK	33 MNOK
	Severe injury	4.15 MSEK	8,9 MNOK
	Light injury	0.2 MSEK	0,67 MNOK
Emissions[1]	Carbon dioxide	1.50 SEK/kg	0,23 NOK/kg
	Particles	11 494 SEK/kg	4 392 NOK/kg
	VOC	68 SEK/kg	-
	SO2	333 SEK/kg	-
	NOx	36 SEK/kg	55 NOK/kg
General parameters	Discount rate	4%	4.5%
	Appraisal period	40 years	25 years
	Producer/consumer price conversion factor	1.21	*n/a*

3 DETERMINANTS OF PROJECT SELECTION

3.1 Description of data and decision processes

Our analysis uses data from the preparation of the Swedish national transport investment plan decided in 2010 and encompassing the period 2010-2021, and the corresponding Norwegian plan decided in 2012 and encompassing the period 2014-2023. Very simplified, the selection of projects to the National Transport Investments Plans consists of three steps. First, project ideas are suggested by various stakeholders, and the Administration (the Transport Administration in Sweden, the Road Administration in Norway) compiles a subset of all suggestions into a shortlist of candidate projects, including estimates of benefits and costs. Next, the government selects some of the candidate projects, and finally the Administration selects additional investments from the remaining list of candidates. (In a fourth step, the government amends or changes the Administration's suggestion, but that step is not analysed here.)

Throughout the paper, we will use the *net benefit-investment cost ratio* (NBIR) as a measure of cost efficiency. The NBIR is similar to the benefit-cost ratio (BCR), but the nominator is the net benefits rather than total benefits, while the denominator is the investment cost, rather than the present value of all costs[2].

Table 2 summarizes some characteristics of projects. As the table shows, the Norwegian projects are more expensive on average than the Swedish ones. This seems to be because the Swedish projects are usually smaller; in Norway, several such small projects would have been combined into a larger package and treated as one project.

[1] Values depend on geographical area (except for carbon dioxide). The values in the table relate to the central parts of Stockholm.

[2] The denominator should correspond to the relevant budget constraint, which in this case are total investment costs.

Table 2. Summary of project characteristics.

		Norway	Sweden
Number of projects	All candidates	216	417
	Selected by Govt.	35	67
	Selected by Adm.	18	135
Total project cost (bill. NOK, bill. SEK)	All candidates	211	128
	Selected by Govt.	28	70
	Selected by Adm.	18	25
Average project cost (MNOK, MSEK), excl. 5 most expensive	All candidates	797	202
	Selected by Govt.	814	403
	Selected by Adm.	717	186
Average NBIR (*not weighted with project costs)*	All candidates	-0.18	0.36
	Selected by Govt.	-0.18	0.50
	Selected by Adm.	-0.17	0.83

The two most striking differences between the two countries is, first, that the Norwegian projects have much lower average NBIR than the Swedish ones (why is further explored in section 3.3), and second, that while the selected Swedish projects have higher average NBIR than the non-selected ones, this is not the case for the Norwegian projects. The second observation indicates that the NBIR affects project selection in Sweden, but not in Norway. This is further explored in the following sections.

3.2 Impact of benefit/cost efficiency

Table 3 displays the share of projects selected by the Governments and Administration, grouped with respect to NBIR. For example, the first row contains the projects with the highest value-for money, and the table shows that the Norwegian government selected 20% of the projects in this group, while the Norwegian Administration selected 19% of the remaining projects in that group. Similarly, the last row contains the projects with the lowest value-for money, and the table shows that the Norwegian government chose 18% of these projects while the Norwegian Administration chose 8% of the remaining projects.

Table 3. Selection probabilities for different classes of projects.

	Norway		Sweden	
	Govt. selection	*Adm. selection*	*Govt. selection*	*Adm. selection*
Very high value for money (NBIR>1)	20%	19%	23%	63%
Good value of money (0.5<NBIR<=1)	10%	0%	17%	57%
Some value for money (0<NBIR<=0.5)	21%	5%	16%	41%
Low value for money (-0.5<NBIR<=0)	11%	17%	16%	24%
Very low value for money (NBIR<= -0.5)	18%	8%	9%	19%

If the NBIR affects project selection, the numbers in the upper rows should be higher than those in the lower rows. There is no sign of this in the Norwegian columns, whereas some effect is visible for the Swedish government's selection, and a strong effect in the Swedish Administration's selection.

Figure 1 confirms this finding with a nonparametric kernel regression. The NBIRs of projects are plotted on the *x*-axes against smoothed selection probabilities on the *y*-axes. The diagram for the Swedish projects indicate that the Administration's selection is highly correlated with the NBIR, while the government's selection only seems to be slightly affected for low NBIRs – the government seems to avoid the really inefficient projects, while there is no discernible effect for higher NBIRs. In the Norwegian diagram, no correspondence between the NBIR and selection probability is indicated.

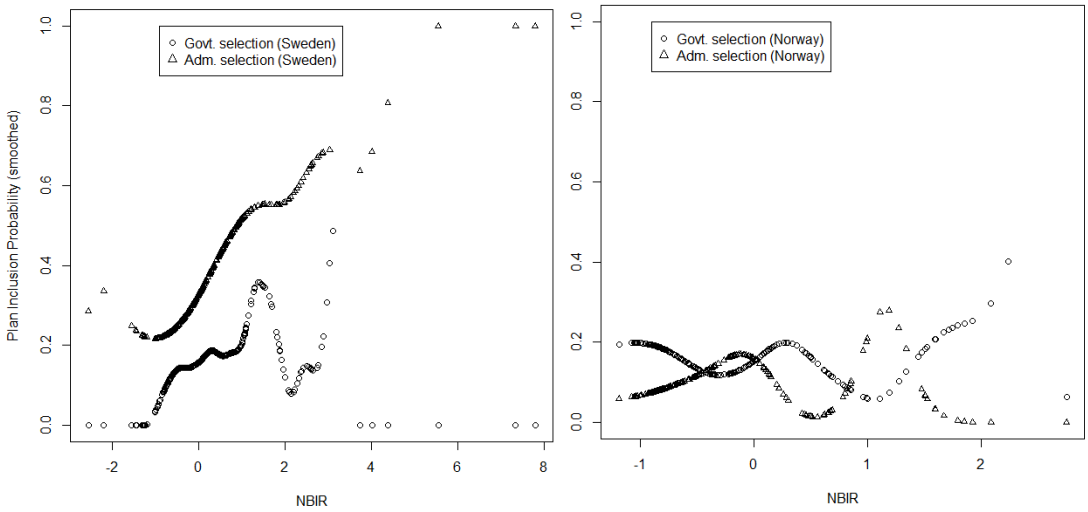

Figure 1. Relationship between NBIRs and selection probabilities.

To further test hypotheses concerning the influence of costs and benefits on project selection, we estimate binary logit models for each of the four decision makers. Assume that decision makers select projects at least partly based on variables in a vector **x**. The vector **x** includes a constant adjusting the aggregate selection probability. Let y be an indicator variable which is 1 if the project is selected and 0 otherwise. We estimate a parameter vector $\boldsymbol{\beta}$ in the model[3]:

$$y = 1\{\boldsymbol{\beta}\mathbf{x} > \varepsilon\},$$

where ε is an error term taken to be iid standard logistic, resulting in a logit model. The error term includes the net effect of all variables determining the selection probability omitted in **x**, which might include distributional concerns and other considerations.

Table 4 summarises variables and hypotheses. The first and most natural hypothesis is that NBIR influences the selection probability. We also test whether this influence (if any) is different for small and large projects (where "large" is defined as the 40% most expensive projects on the candidate list of each country; >620 MNOK and >130 MSEK, respectively), and whether it differs below and above NBIR=0 (i.e. where projects become profitable).

[3] 1{x>y} is defined to take the value 1 if x>y and 0 otherwise.

Table 4. Variables and corresponding hypotheses.

Variable	**Hypothesis**
NBIR	NBIR increases selection probability
$NBIR^+$ = max(NBIR,0) $NBIR^-$ = min(NBIR,0)	The influence of NBIR may be different below and above the profitability threshold NBIR=0
Safety benefits/accessibility benefits	The relative weights of safety and accessibility benefits equal the guidelines'.
accessibility benefits for person trips	High accessibility benefits for person trips increases selection probability
accessibility benefits for freight	High accessibility benefits for freight transport increases selection probability
safety benefits	The weight put on safety benefits equals the one guidelines'
maintenance costs	Low maintenance cost reduce selection probability
investment costs	Low investment cost increases selection probability
log(investment cost)	Low investment cost increases selection probability
Traffic volumes on the object	Large traffic volumes increase selection probability because more travellers benefit from the investment.

After testing all the hypothesis in the table, and excluding insignificant variables, the final models include four variables: $NBIR^+$ = max(NBIR,0); $NBIR^-$ = min(NBIR,0); log(investment cost); and the ratio of safety benefits to accessibility benefits.

Table 5. Estimation results: binary logit models of project selection (variable explanation in text). Significant parameter (95% level) in bold

	Norway				**Sweden**			
	Govt.		**Adm.**		**Govt.**		**Adm.**	
Variable	Parameter	*t-stat*	Parameter	*t-stat*	Parameter	*t-stat*	Parameter	*t-stat*
$NBIR^+$ small	-0.221	*-0.3*	-0.175	*-0.2*	-0.084	*-0.5*	**0.512**	***2.6***
$NBIR^+$ large	0.784	*1.2*	-0.961	*-0.8*	0.000	*0.0*	**1.417**	***2.6***
$NBIR^-$ small	-0.967	*-1.3*	0.539	*0.5*	**3.200**	***2.3***	0.377	*0.8*
$NBIR^-$ large	1.110	*0.9*	1.163	*0.9*	1.153	*1.4*	1.173	*1.5*
log(cost)	-0.275	*-1.1*	-0.131	*-0.4*	**1.124**	***4.9***	-0.015	*-0.1*
Safety/acc.	-0.059	*-0.5*	-0.010	*-0.1*	**-0.096**	***-2.2***	-0.017	*-0.8*
Const small	0.458	*0.3*	1.388	*0.7*	6.422	*6.2*	0.758	*0.8*
Const large	-0.118	*-0.1*	0.453	*0.2*	7.614	*5.5*	0.390	*0.3*
Rho-sq. (0)	*0.399*		*0.541*		*0.471*		*0.140*	
Rho-sq. (c)	*0.059*		*0.018*		*0.163*		*0.106*	
No. obs.	*216*		*181*		*416*		*350*	

The Swedish Transport Administration's selection clearly takes the NBIR into account: selection probability increases significantly with the NBIR. This effect is stronger for larger projects. There is a threshold effect at NBIR=0: for negative NBIR values, the NBIR does not affect project selection significantly. Once NBIR>0, the selection starts increasing rapidly with the NBIR. Interestingly, the Adminstration's selection reveals no particular preference for safety versus accessibility benefits. Further tests show an even stronger result: based on the Administration's project selection, implicit relative

weights of five different benefit types can be estimated – person accessibility, freight accessibility, safety, emissions and maintenance. These weights turn out to be so close to each other that the hypothesis that they are equal cannot be rejected. In other words: in their project selection, the Administration actually uses implicit weights on the different types of benefits that are consistent with the valuations in the CBA guidelines. (See McFadden (1975,1976) for a similar study of decision-makers' implicit preferences for transport investment characteristics.)

The Swedish government's selection is only weakly affected by the NBIR. The only discernible effect is that small projects with a positive NBIR are more likely to be selected than other small projects, but once NBIR>0, there is further effects on increasing NBIR. The government primarily selects expensive projects, indicated by the positive parameter for log(cost). This makes intuitive sense: the larger the project is the greater is usually the political interest. The government shows a tendency to put more weight on accessibility benefits compared to safety benefits than the relative weights in the CBA. We find no preference for person relative to freight benefits.

For the Norwegian project selection, none of the hypotheses tested are supported by our data, neither for the government's selection, nor the Administration's. Since the models displayed in Table 5 do not confirm any of our pre-formulated hypotheses for the Norwegian decision makers, we have explored many other model specifications. However, we have failed to find any variable or combination of variables that correlate with the Norwegian decision-makers' selections. For example, neither the ratio of investment cost to traffic (i.e. spending per traveller), nor the ratio of benefits to traffic volume (the absolute improvement per traveller) were significantly correlated with project selection. Neither were any of the different kinds of benefits, nor the ratio of different benefit types to each other, nor project cost alone, nor total benefits, nor total net benefits. Hence, we can only conclude that project selection in Norway is apparently decided by processes and considerations unrelated to any documented investment characteristics we have access to.

3.3 Impact of regional electoral support

Several studies have shown that voting support influences politicians' selection and design of projects (see references in the introduction). Therefore, we continue to test two other hypotheses. The first is that regional policy influences the selection probability. The second is that political parties want to benefit their own voters. We use the same model specification as used in the previous section to test these hypotheses.

In Sweden, the national government instructed the Transport Administration to prioritise growing regions and specialized labour markets, which primarily meant the major urban regions (Stockholm, Gothenburg, Malmö). In Norway, it was road projects in rural areas that were prioritized. Incidentally or not, the regions benefitting from these instructions were the regions where the respective national government enjoyed the strongest electoral support. The Swedish government at the time had its strongest support in the urban populations, while the Norwegian government had its strongest support in the rural areas.

The models displayed in Table 6 show that investment decisions were indeed affected by these governmental instructions. In Norway, the government's selection is skewed towards the rural regions[4]. This is shown in Model 2, where a dummy variable for

[4] Defined as the counties (*fylke*) of Telemark, Aust-Agder, Sogn og Fjordane, Nord-Trøndelag, Nordland, Troms and Finnmark.

investments in rural regions is introduced. Alternatively, Model 1 shows that government's selection can also be explained by the percentage of voters supporting the national government in the region of the project. Hence, the data shows that the national government indeed favours the rural regions, where they also have the strongest voter support. Moreover, once any of these regional variables have been controlled for, the variable "cost/traffic" also becomes significant[5]. This variable can be interpreted as a rough proxy for cost-efficiency, simply saying that one should spend money on a road in proportion to the traffic on it. The Administration's selection, on the other hand, is not correlated with voter preferences.

Table 6 shows an opposite pattern for Sweden. In Model 2, dummies are introduced for investments in major urban regions[6] and the most rural regions[7]. The results show that the Transport Administration has indeed followed the instructions from the government, and prioritized the major urban regions at the expense of the sparsely populated rural regions. Model 1 shows that this can, alternatively, be explained by the percentage of voters supporting the national government in the region of the project. Similar to Norway, the instructions from the government apparently favour those regions where they have the strongest support.

Table 6. Estimation results: binary logit models of project selection, including voter support for the national government in each region (variable explanation in text).

	Norway						Sweden					
	Govt.				Adm.		Govt.		Adm.			
	Model 1		Model 2		Model 1		Model 1		Model 1		Model 2	
Variable	Par.	*t-stat*	Par.	*t-stat*	Par.	*t-stat*	Par.	*t-stat*	Par.	*t-stat*	Par.	*t-stat*
Log(vote)	0.694	*2.2*	0.306	*0.8*	0.136	*0.4*	0.856	*0.8*	2.304	*2.5*	-0.191	*-0.2*
Rural			1.023	*2.1*							-0.941	*-2.4*
Large city			0.626	*0.5*							0.725	*2.1*
NBIR+ small									0.489	*2.5*	0.460	*2.3*
NBIR+ large									1.369	*2.5*	1.364	*2.4*
NBIR- small							2.973	*2.3*	0.395	*0.9*	0.332	*0.7*
NBIR- large									1.138	*1.4*	1.055	*1.3*
Cost/traffic	-1.861	*-1.9*	-2.115	*-2.1*	-0.051	*-0.4*						
Const small	0.043	*0.1*	1.226	*1.4*	1.909	*2.8*	5.692	*4.2*	-0.979	*-1.3*	0.856	*0.9*
Const large							7.005	*4.3*	-1.239	*-1.6*	0.700	*0.7*
Rho-sq. (0)	*0.401*		*0.418*		*0.536*		*0.468*		*0.152*		*0.172*	
Rho-sq. (c)	*0.063*		*0.089*		*0.006*		*0.157*		*0.119*		*0.139*	
No. obs.	*216*		*216*		*181*		*416*		*350*		*350*	

The regions benefiting from these respective investment principles are thus those where the respective national governments have strong local support. This may be a coincidence, but there could also be a causal relation. Local politicians obviously lobby the national government for investments in their region, and local politicians from regions where the national government enjoys strong support may have more clout with the national government. Alternatively, national governments may seek to reward regions where they have strong support. In Norway, one contributing factor may be that rural communities are overrepresented in the Norwegian electoral system (Knowles, 1981), and the Transport Committee has traditionally been dominated by politicians from rural and coastal districts. On the other hand, Norway has a long history of strong rural development support, and the decision to prioritize rural areas

[5] When introducing the term αlog(traffic) - βlog(cost), α and β become jointly significant and not significantly different from each other. The variable (traffic/cost) has a little better explanatory power than the variable log(traffic/cost), though.

[6] Stockholm, Göteborg, Malmö.

[7] The counties (*län*) of Dalarna, Västernorrland, Jämtland, Västerbotten, Norrbotten.

might be due to an intention to contribute to growth in these areas. In the Swedish case, it often makes economic sense to prioritize investments in growing, highly specialized regions. It is not possible to conclusively ascertain which of these explanations is the most important, although it is conspicuous that the governments in the two countries have happened to choose policies that benefit their own voters most.

3.4 CBA as a screening mechanism

Early on in the planning process, CBA is supposed to serve as a screening mechanism, discarding projects (or variants of projects) that yield low value for money. Eliasson and Lundberg (2012) found by interviewing planners that CBA was only used in this way if planners thought that benefit/cost efficiency would matter for the eventual decision. If planners thought that appraisal results would not matter for decisions anyway, they saw little point in discarding projects with poor benefit-cost ratios. This means that one might expect that CBA is used less a filter in Norway than in Sweden, given the negligible impact of CBA on eventual Norwegian decisions.

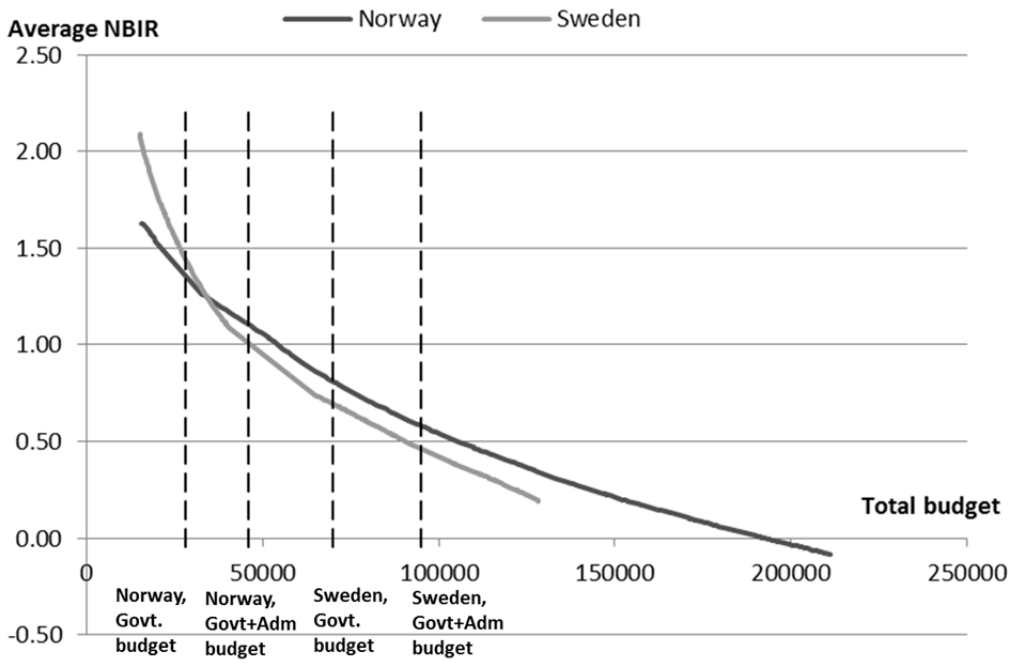

Figure 2 illustrates maximal total benefits as a function of available budget. The *y*-axis shows the maximal attainable NBIR given a certain budget (on the *x*-axis), provided that the projects with the highest NBIRs are chosen from the candidate list up to the given budget constraint.

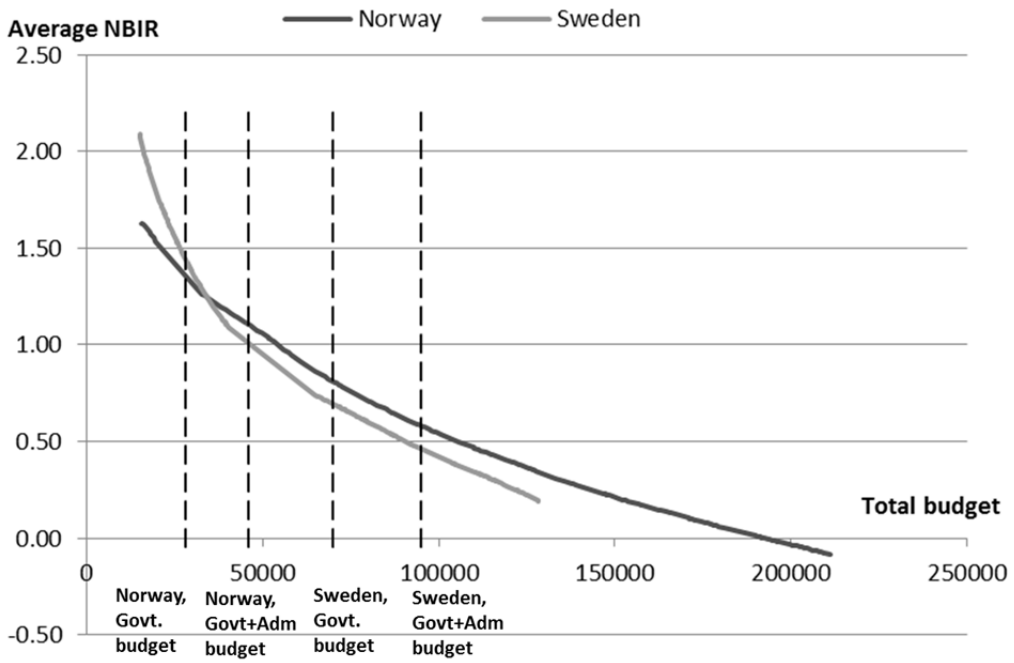

Figure 2. Distribution of NBIRs: maxinal total NBIR within a given budget. The budgets are given in NOK and SEK, respectively (1 NOK = 1.14 SEK).

The dotted lines show the maximal attainable average NBIRs given the budgets of the Governments and Administrations. For example, had the Norwegian government chosen to spend its budget (28 MNOK) on the highest-NBIR projects, it had attained an average NBIR of 1.32. Similarly, had the Swedish government and Administration spent their combined budget (95 MSEK) on the highest-NBIR project, the average NBIR of their plan would have been 0.48. Actual attained NBIRs are much lower, as demonstrated by Table 2.

The figure explains the low average NBIR for the Norwegian projects: the Norwegian candidate list contains many more inefficient projects than the Swedish list. The high ends of the two lists (the most cost-efficient projects) exhibit a similar NBIR distribution in both countries. Hence, the reason for the difference in average NBIR is not that Norwegian projects generally have lower NBIRs, but that lot of low-NBIR projects are included in the Norwegian candidate list of candidates. The cost of all projects with NBIR>0 is similar – 73 billion SEK in Sweden and 72 billion NOK in Norway. But while the Swedish candidate list contains suggested investments with a total cost of 128 billion SEK, the Norwegian list contains investments with a total cost of 211 billion NOK; in other words, there are many more inefficient projects on the list.

In passing, we can note that the total Swedish budget is considerably larger than the total cost of profitable projects – 95 billion SEK compared to 73 billion SEK. The opposite is true in Norway: the total budget is 46 billion NOK while the cost of all profitable projects would be 72 billion NOK. Moreover, we find no evidence for the common conjecture that less expensive projects tend to have higher average NBIRs than more expensive projects.

3.5 Selection efficiency

We define the *selection efficiency* of a decision-maker as how much value she adds compared to random selection from a list of projects. Let B_0 be the net benefit attained

if projects are selected randomly from a list of candidates (without replacement[8]) given a certain budget, and B_{max} the maximal attainable benefits given a list of projects and the same budget. Given a selection that produces total benefits B, we define the selection efficiency μ as

$$\mu = \frac{B - B_0}{B_{max} - B_0}.$$

A value of μ=1 means that the decision-maker has selected the optimal set of projects, while μ=0 means that the decision-maker has not added any value above what randomly selecting projects from the list would have given. μ will be negative if the selected projects have lower average benefit-cost ratio than the average of the candidate projects.

Table 7 shows the selection efficiency of the Norwegian and Swedish governments and administrations. The selection efficiencies are calculated assuming that the governments first select projects from the list of candidates, and then the Administrations do likewise from the remaining candidates, each up to their respective budget constraint.

Table 7. Selection efficiency: attained benefits compared to optimal and random selection (billions of SEK and NOK, respectively).

	Norway			Sweden		
	Govt.	**Adm.**	**Govt.+Adm.**	**Govt.**	**Adm.**	**Govt.+Adm.**
Budget	28	18	47	70	25	95
Maximal benefits	66	42	109	119	55	173
Attained benefits	31	13	44	77	45	122
Attained NBIR	0.08	-0.27	-0.05	0.10	0.80	0.28
Benefits given random selection	27	18	43	83	28	113
Selection efficiency	**0.10**	**-0.20**	**0.02**	**-0.17**	**0.62**	**0.15**

The table shows that the Norwegian government could have attained a maximum of 66 billion NOK, given its budget of 28 billion NOK. Their actual selection only produces 31 billion NOK of benefits, slightly higher than the 27 billion NOK a random selection of projects would have given on average. This implies a selection efficiency of 10%. The Norwegian Administration has a selection efficiency of only -20%. The negative number means that a random selection of projects would have produced more benefits, on average.

The selection efficiency of the Swedish government is also negative[9], on par with that of the Norwegian Administration. This is mainly due to the inclusion of a small number of very expensive projects where costs substantially exceed benefits. The Swedish Administration, on the other hand, exhibits an impressive selection efficiency of 61%: its selection of projects results in 45 billion SEK of benefits, compared to a maximum of

[8] Note that this means that B_0 will depend on the available budget if the budget is a significant fraction of the total cost of the list of candidate projects.

[9] This might be an exaggeration of the selection inefficiency if the government is not selecting from the entire list of candidates, but only from the pool of relatively large projects. However, it turns out that restricting the analysis only to large projects does not change the result. In fact, the selection efficiency is even worse when looking only at the pool of large projects. This is because the small projects selected by the government have comparatively high benefit-cost ratios.

55 billion SEK and the 28 billion SEK which a random selection would have given. This is illustrated in Figure 3.

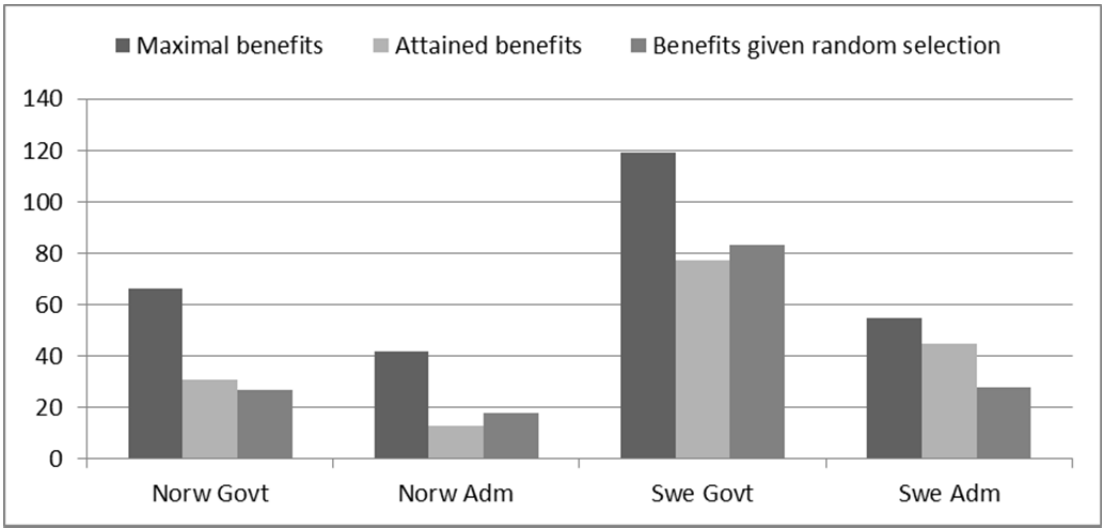

Figure 3. Maximal and attained benefits, compared to benefits attained by random selection, given the available budget.

4 DISCUSSION

Although both Norway and Sweden claim that cost-benefit analyses should play an important role in the selection of transport investments, there is in general only little evidence that this in fact is the case. Several earlier studies have concluded that costs and benefits carry little or no weight in actual project selection. Our results confirm this for Norway, where CBA results do not seem to affect project selection at all. In Sweden, the government's selection is only slightly affected, and only for small projects. The exception is the Swedish Transport Administration's selection in the construction of the Investment Plan 2010-2021, which seems to be strongly affected by CBA results (although earlier Swedish data suggests the opposite).

Awareness among planners that CBA results will affect project selection seems to have the added benefit of screening out the least cost-efficient projects at an early stage, before they enter the list of candidates. This is supported both by interviews with Swedish planners (Eliasson & Lundberg, 2012) and by the observation that the Norwegian list of candidates has a much longer tail of very cost-inefficient projects. This counteracts to some extent the problem that the government does not take cost-efficiency into account when selecting projects. In Norway, the combination of letting cost-inefficient projects on to the candidate list and low or negative selection efficiency results in very low benefits of the resulting project portfolio.

This also underscores the common recommendation that it is important to undertake a CBA early in the decision process, to avoid that planning resources are spent and prestige is attached to inefficient projects. Once an investment suggestion has made it onto a formal or informal list of candidates, then even inefficient projects acquire a momentum of their own.

Obviously, decision-makers may and should take other things than cost-efficiency into account. But this makes it all the more important that the planning administrations present to them a list of reasonably cost-efficient candidates. In fact, it should perhaps be the most important role of transport planners, supposedly experts in their field, to

present decision-makers with different alternative strategies or actions that are both viable and efficient. The decision-makers can then choose the alternative that is in line with their political vision, for example. But decision-makers should be able to trust the experts that inefficient or non-viable have been filtered out at an earlier stage. If this has not been done, then experts have not done their job properly.

But why, then, do not benefit-cost ratios affect project selection? It is uncontroversial that the CBA does not capture all relevant effects, and that there are other relevant considerations than those included in a CBA. But even given this, one would expect at least *some* correlation between selection probability and benefits and costs, or maybe indicators such as cost/traffic or benefits/traffic.

Ideally, decision-makers should motivate their project selection by openly stated criteria and decision rules. Now, we have the paradoxical and slightly frustrating result that decision-makers claim to use cost-benefit results, and spend considerable resources on producing them, but apparently do not use them at all for project selection – without stating what other decision criteria they use.

One possible explanation is that projects are selected to reach certain norms or standards, rather than to produce benefits in a traditional sense. For example, if it is decided that all roads should have a given standard e.g. in terms of pavement, width or curvature, then this may very well result in a number of projects that produce very little tangible user benefits, just to comply with such general regulations or planning guidelines.

A second possible explanation is that investments may be symbolic actions against perceived problems. With symbolic we mean that the investment may not solve the problem, or produce any benefits; its purpose is merely to show that the authorities take the problem seriously. A typical example may be a region with a negative employment or population trend, which the national government tries to revive with investments in infrastructure. Such investments are often unlikely to have any effects on either employment or population trends, but shows that the government cares. In some cases, there is anecdotal evidence that it may in fact affect a region's self-image – but whether this translates into any objective effects is usually uncertain at best.

A third, somewhat similar explanation is that projects may be selected on the grounds that a certain problem is perceived as severe, rather than on the grounds that the project actually solves the problem. This is particularly common when planning processes are problem-oriented – an increasingly common trend. The idea of problem-oriented planning is to first identify problems or deficits in the transport system, and then look for solutions to those problems. But in the definition of something as a problem lies an implicit notion that there *is* a viable solution. So, the process is directed towards certain solutions already at the stage when problems are identified, regardless of the costs and benefits of these solutions. Such processes, unsurprisingly, often end up in identifying a certain investment as the only solution to the identified problem, concluding that even if the cost of the investment regrettably exceeds the benefits, it should be carried out anyway – since the problem is so severe, and the investment is the only solution to it. The catch, obviously, lies in the definition of what exactly constitutes a problem. In some cases, this might be relatively uncontroversial: severe problems with air quality or road safety, for example. But more often, the identified problems rest on arbitrary definitions of what is sufficient: for example, insufficient access to nearby labour markets, population centres airports etc. Here, the definition of what constitutes a problem is completely arbitrary, and it is obvious that the definition only serves as setting up a motivation of a certain investments further on in the

planning process. Such processes often accumulate enough backing from politicians and planners that the resulting investment proposals become very difficult to reject.

A fourth explanation, supported by the main findings of the present study, is that the support the government has in the region of suggested projects matters more than cost-efficiency. This may be either because the national government use investments partly as a reward to the regions where it enjoys strong support or because local politicians from these regions have more clout with the national government. In Norway this seems to be the only factor, of those we have access to, that matters. However, when controlling for voting patterns the parameter for traffic/cost, which can be seen as a rough indication of the net benefit, becomes significant. Hence, our results suggest that in Norway prioritizing projects in rural areas is more important than cost-efficiency, but when the former is taken into account the latter also has some influence. Since road projects generating high benefits mostly are located in and around the larger cities in Norway, the cost-efficiency are bond to become very low. Clearly also the voters care more about self-interest and regional distribution than about cost-efficiency on the national level.

5 CONCLUSIONS

The purpose of this paper is to test Norwegian and Swedish decision-makers' claim that cost-benefit analysis results is an important criterion for prioritizing among transport investments. We have studied four decision-making actors: the Swedish and Norwegian governments, and the public administrations of the two countries (the Transport Administration in Sweden and the Road Administration in Norway). The study focuses on road investments only.

The Swedish government shows a slight tendency to favour projects with high benefit-cost ratios, but only for small projects. For larger projects, there is no significant impact on selection probability of the benefit-cost ratio or any other measure of efficiency that was tested. In fact, the selection efficiency of the Swedish government turns out to be negative, meaning that a random selection of projects from the list of candidate would have produced more benefits.

The Swedish Transport Administration, on the other hand, selects projects remarkably consistent with cost-benefit analysis, given the low expectations from previous studies and the other decision makers in this study. The effect is stronger for large projects. The Administration exhibits a selection efficiency of 61%, implying that it attains 61% of what a strictly benefit-maximizing decision-maker would have attained, compared to random selection. Moreover, the Administration seems to put relative weights on different types of benefits that coincide with the relative weights in the CBA. One potential problem is that there are signs of a threshold effect: selection probability jumps at the point where benefits just exceed the cost. This is a potential problem since that exact threshold is a function of comparatively uncertain global parameters, such as discount rate, project lifetime and assumed growth of traffic and valuations (for this reason the relative cost-benefit ratio between investments is much more robust to such parameters than the absolute numbers (Börjesson, Eliasson, & Lundberg, 2014)). A worrying sign is that after the completion of this study, the Transport Administration has revised its CBA guidelines in several ways that will make net benefits increase for all projects and hence lower that threshold.[10]. Future studies will reveal whether this

[10] The discount rate has been lowered, valuations are now assumed to increase with economic growth, and default project lifetimes have been increased.

will decrease the Administration's selection efficiency.

In Norway, neither the selection of the government, nor that of the Road Administration shows any correlation with costs or benefits, nor with any measure of cost-efficiency that was tested, in fact not with any other project characteristic that we had access to. The selection efficiency of the Norwegian government is slightly positive at 10%, while the Administration's selection efficiency is negative. There seems to be an implicit awareness in the Administration that cost-efficiency is in fact unimportant. The presence of a large number of inefficient projects in the list of candidates is hard to explain in any other way. Obviously, having projects with very low benefit-cost ratios among the candidates exacerbates the problems of random project selection. The random selection of the Norwegian government and Administration had been less of a problem if the least efficient candidate projects had been filtered out, leaving only reasonably cost-efficient candidates on the list.

Comparing the Swedish and Norwegian distributions of benefit-cost ratios shows that the high end of the distribution – the most cost-efficient projects – is similar between the two countries. The tail of the distribution at the low end, however, differs: the Norwegian list contains a much longer tail of projects with low or very low benefit-cost ratio. The most plausible explanation is that the inefficient Swedish projects are filtered out at an earlier stage. This is also supported by interviews with planners. This filtering of inefficient projects may either occur because planners at the Administration (who prepare the list of candidates) are aware that projects with low benefit-cost ratio will not be selected anyway, or because they view it as their responsibility to filter out the least efficient projects – maybe through redesigning them – before they reach the eventual decision-makers' table.

In both countries, investment decisions seem to be influenced by the electoral support for the national government. This is consistent with the hypothesis that local politicians get more clout with the national government if they belong to the same party and have a strong local voter base. On the other hand, we cannot rule out that this result is a side effect of the different regional policies in the two countries. In Sweden, growing regions and specialized labour markets were prioritized, while rural regions were prioritized in Norway, and this coincides with the voting patterns of the two countries, and the Norwegian electoral system over-represents rural districts compared to the cities. But whether there is a causal relationship is impossible to tell from our data. However, the tendency of supporting projects in district where the government enjoys voter support could be one reason for the low weight of cost-efficiency in the Norwegian project selection process, because most cost-efficient Norwegian road projects are located in and around the larger cities.

It may seem strange that both countries spend considerable resources calculating cost-benefit analyses of projects, when they apparently have so little bearing on eventual decisions (in particular in Norway). An optimistic hypothesis is that politicians want inefficient projects weeded out at an early stage, so that only reasonably efficient projects enter the list of candidates. Once politicians are given a list of projects to choose from, other considerations than cost-efficiency are apparently more important. Some of these considerations may be relevant, such as regional development, macroeconomic stimulus or distributive concerns. Other considerations may be more dubious, such as vote-buying by directing spending to certain regions, travel modes or projects. But in any case, these other considerations would be less fatal if the government had been presented with a list of reasonably cost-efficient projects. Constructing a list of efficient candidates from a larger pool of ideas would be a worthwhile purpose of CBA. If that is the intention of decision-makers when they stress

the importance of cost-efficiency, there seems to be some degree of success in Sweden, but reasons for disappointment in Norway.

Presenting a list of options where a large share is a waste of taxpayers' money to decision-makers who do not take cost-efficiency into account is a recipe for wasting public resources. It is reasonable to argue that project ideas should be filtered at an earlier stage, so that decision makers can apply any other considerations they may have to a list of reasonably efficient options. This role rests on the assumption that the experts and civil servants at the public administrations do their part of the job: analysing and evaluating various ideas to come up with alternative projects that would all create value for taxpayers' money. The fact that political decision-makers are not governed by cost-efficiency should not allow the administrations to shy away from the task of preparing efficient alternatives. Letting wasteful and inefficient projects reach decision-makers' table is letting decision-makers down.

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