

Lessons from ex-post benefit-cost analysis of road projects in Norway

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Objectives

To reveal the extent to which predictions of benefit-cost analyses delivered to the decision makers matches outturns. In particular, we ask:

1. Do the road authorities achieve their stated road program benefits?
2. What are the magnitude of deviation between forecasts and outturns
3. What causes the deviations?

Background

1. The Norwegian Public Roads administration (NPRA) carries out BCA for its trunk road schemes
2. Based on information from the BCA, decision makers may prioritize projects.
3. The BCAs are conducted *ex ante*; therefore there is little knowledge as: (i) to what degree the predictions are correct (ii) whether the project fulfil their objectives and, (iii) whether the decision makers are supplied with appropriate information *ex ante*.

We address these questions based on ex-post assessments conducted since 2006 when the Ministry of Transport sanctioned such studies. 20 projects are studied to date.

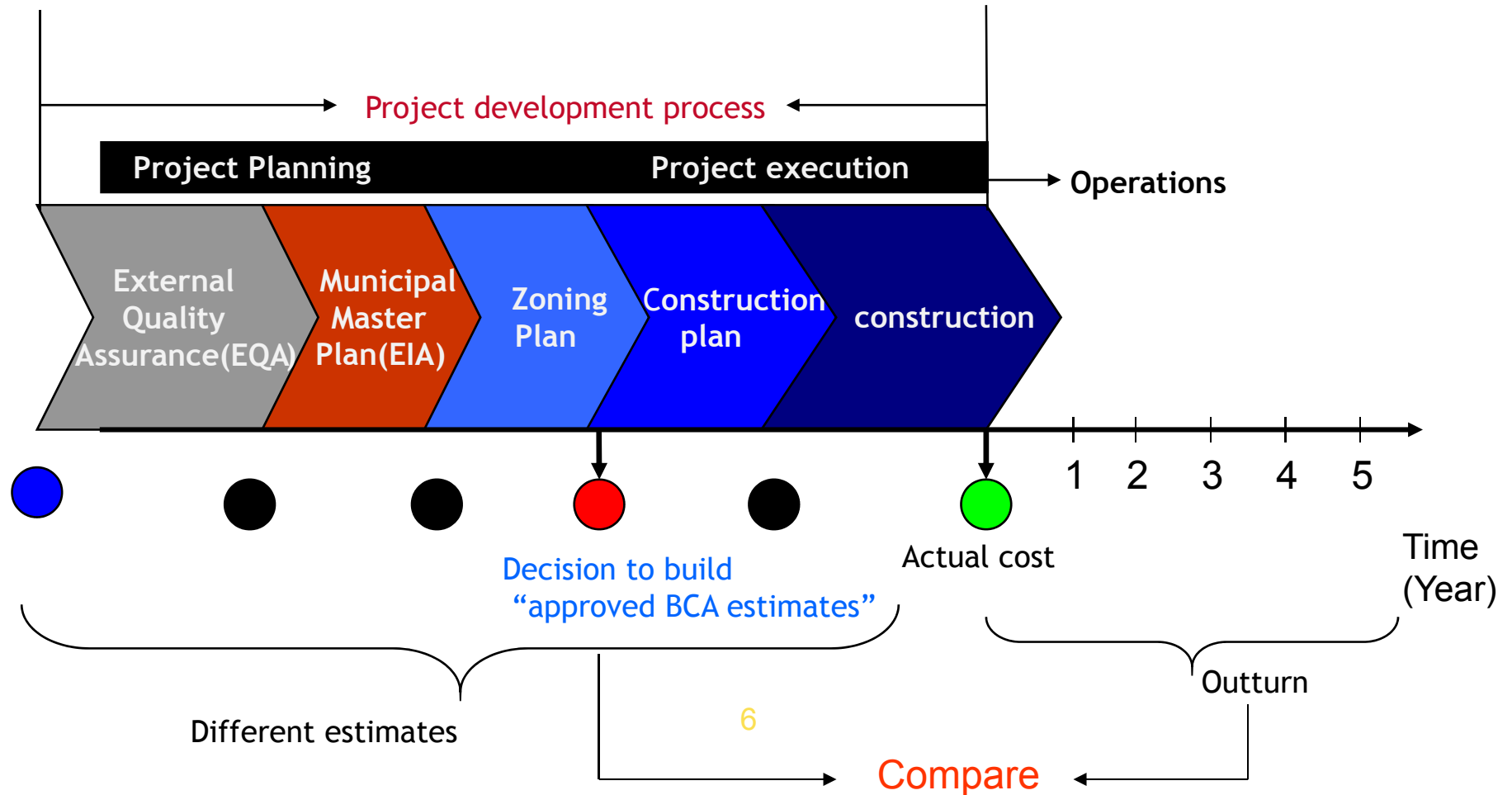
Framework for analyses

- 3 - 5 projects are ex-post evaluated every year
- Requirement:
 - Investment cost > 200 mill NOK
 - Has been open for traffic in at least 5 years
- The projects are chosen the year of the ex-post assessment
- **The baseline for ex-post assessments are the assessments presented to the decision makers when the decision to fund was made (the go-ahead decision)**
- Focus on *monetised impacts only*

To underline what we do!

We re-do the benefit- analyses to explore whether the projected outturns deviate from real outcomes

Which estimates are compared to outturns?



Impacts included in an Impact Assessment

Ex post evaluation ↑

Cost benefit analysis

Monetised impacts	Non monetised
✓ Travel time savings	Visual landscape
✓ Vehicle operating costs	Community life effects and outdoor recreation
✓ Accident costs	
✓ Induced traffic	✓ Natural environment
✓ Income loss (ferry)	✓ Cultural heritage
✓ Local air	✓ Natural resources
✓ Road maintenance costs	
Residual value of capital	
✓ Cost of public funds	
✓ Road investment costs	

Socio-economic profitability: discounted (benefits - discounted costs) > 0

Precautions taken !

- ✓ Appraisal techniques develop over time in some cases causing the tools to change from before- to the time of ex-post assessment....

We use the same software package when comparing the before and ex-post assessments

- ✓ The analysis period of the projects is 25 years, but the ex-post assessments are conducted 5 years after opening.....

The same traffic forecasts are used in the ex-post assessment as in the original analysis after year 5

Approach and data collection

1. Acquire project overview, project history and project development over time
2. Retrieve the database which was the basis for CBA presented to the decision makers before the go ahead-decision
3. Possibly redo the original CBA with a newer version of the CBA software (EFFEKT)
4. Substitute the outturn data into the CBA in 3
 - ✓ Traffic
 - ✓ Accidents
 - ✓ Construction costs
 - ✓ Average speed
5. Compare the before-decision analysis (3) and the ex-post assessment (4) and explain differences

Projects evaluated

No	Project	Project type	Project objective
1	Rv.23 Oslofjordforbindelsen	Strait crossing; sub sea tunnel	Reduce user costs, accidents and improve local environment
2	E18 Rannekleiv - Temse	Trunk road ; bypass	Reduce user costs, accidents and improve local environment
3	Rv.714 Hitra - Frøya	Strait crossing; sub sea tunnel	Reduce user costs, regional effects
4	E18 Teigeland - Håland	Trunk road, mainly tunnel	Reduce user costs, reduce risk of avalanche/land slide
5	Rv.62 Øksendalstunnelen	Trunk road, mainly tunnel	Reduce risk of avalanche/land slide, reduce user costs
6	E8 Nordkjosbotn - Laksvatnbukt	Trunk road	Reduce accidents, improve local environment and reduce user costs
7	E18 Gutu - Helland - Kopstad	Trunk road; bypass Sande and Holmest	Reduce accidents, reduce user costs and improve local environment
8	E39 Kleivedammen - Andenes	Trunk road	Reduce user costs, reduce accidents
9	E134 Hegstad - Damåsen	Trunk road; bypass Darbu...	Reduce user costs, reduce accidents and improve local environment
10	Rv.616 Kolset - Klubben	Strait crossing; sub sea tunnel	Reduce user costs

Projects cont.

11	Rv.580 Hop- Midttun	Trunk road within city; bypass Nestun	Reduce user costs, improve local environment
12	E6: Akershus grense - Patterød	Trunk road	Reduce user costs, accident
13	E18 Ørje - Eidsberg	Trunk road	Reduce user costs, accidents
14	Rv35 Gualia - Kneppe	Trunk road, "new link"	Improve accessability to Gardermoen airport, regional development
15	E6 Halmstad - Patterød	Trunk road	Reduce user costs and accidents
16	E18 Brokelandsheia - Vinterkjær	Trunk road; Bypass Søndeled	Reduce accidents, user costs, improve local environment
17	E39 Svegatjørn - Moberg	Trunk Road; Bypass Osøyro	Reduce user costs, accidents and improve local environment, improve situation for
18	E18 Sekkelsten- Krosby	Trunk Road; Bypass Askim	Reduce user costs, accidents, improve local environment
19	E6 Ny Svinesundforbindelse	Trunk Road	Reduce accidents, reduce user costs especially for goods transport
20	E6 Skjerdingsstad - Jaktøyen	Trunk Road; Bypass Melhus?	Reduce accidents, improve local environment, and reduce user costs

RESULTS (1a):

Traffic in the opening year (AADT)

No	Project	Estimates	Actual	Deviation
				Estimates/Actual
1	Rv. 23 Oslofjordforbindelsen	4240	3780	-11 %
2	E18 Rannekleiv - Temse	8232	10242	24 %
3	Rv. 714 Hitra - Frøya	353	512	46 %
4	E134 Teigeland - Håland	1000	1367	37 %
5	Rv. 62 Øksendalstunnelen	1386	1333	-3 %
6	E8 Norkjosbotn-Laksvatnbukt	2300	2392	4 %
7	E18 Gutu-Helland-Kopstad	12000	16700	39 %
8	E39 Kleivedammen-Andenes	700	924	32 %
9	E134 Hegstad - Damåsen	740	8050	1088 %
10	Rv.616 Kolset - Klubben	88	155	76 %
11	Rv.580 Hop- Midttun	19300	14000	-27 %
12	E18 Ørje - Eidsberg	3288	4488	36 %
13	E6 Akershus - Patterød	21750	20700	-5 %
14	Rv.35 - Lierdermoen	2354	1600	-32 %
15	E6 - Patterød	24613	26954	10 %
16	E6 - Brokelandsheia - Vinterkjær	6814	6018	-12 %
17	E39 Sveгатjørn - Moberg	2700	5000	85 %
18	E18 Sekkelsten- Krosby	5200	8000	54 %
19	E6 Ny Svinesundforbindelse	10282	11406	11 %
20	E6 Skjerdingstad - Jaktøyen	9100	9900	9 %

14 out of 20 projects demonstrates higher traffic level than estimated!

RESULTS(1b):**Average traffic growth rate, the first 5 years**

No	Project	Estimates	Actual
1	Rv. 23 Oslofjordforbindelsen	1.4 %	6.8 %
2	E18 Rannekleiv - Temse	1.2 %	3.2 %
3	Rv. 714 Hitra - Frøya	1.2 %	3.2 %
4	E134 Teigeland - Håland	1.2 %	4.5 %
5	Rv. 62 Øksendalstunnellen	1.0 %	5.5 %
6	E8 Norkjosbotn-Laksvatnbukt	1.1 %	3.7 %
7	E18 Gutu-Helland-Kopstad	1.2 %	3.0 %
8	E39 Kleivedammen-Andenes	1.0 %	3.9 %
9	E134 Hegstad - Damåsen	1.0 %	2.5 %
10	Rv.616 Kolset - Klubben	1.4 %	1,6 %
11	Rv.580 Hop- Midttun	1.7 %	3.2 %
12	E18 Ørje - Eidsberg	2.0 %	5.6 %
13	E6 Akershus - Patterød	2.0 %	5.7 %
14	Rv.35 Lier - Gardermoen	2.0 %	12.1 %
15	E6 Lier - Patterød	2.0 %	4.4 %
16	E11 Trøkelandsheia - Vinterkjær	2.2 %	2.6 %
17	E39 Sveгатjørn - Moberg	1.7 %	4.1 %
18	E18 Sekkelsten- Krosby	2.0 %	3.4 %
19	E6 Ny Svinesundforbindelse	2.0 %	3.2 %
20	E6 Skjerdingsstad - Jaktøyen	1.4 %	-0.3 %

Average traffic growth rates are higher than forecasted!

Results (2): Construction costs

Project no.	Project name	Construction costs(Mill. NOK)		Deviation (Estimate - Actual)
		Estimates	Actual	
1	Rv 23 Oslofjordforbindelsen	1560	1370	
2	Ev 18 Rannekleiv - Temse	215	263	
3	Rv 714 Hitra - Frøya	589	460	
4	Ev 134 Teigeland - Håland	437		12 %
5	Rv 62 Øksendalstunnellen	215		1 %
6	E8 Norkjosbotn-Laksvatnbukt	242		43 %
7	E18 Gutu-Helland-Kopstad			-3 %
8	E39 Kleivedammen-Andenes		183	-6 %
9	E134 Hegstad - Damåsen		249	-5 %
10	Rv.616 Kolset - Klubben		336	32 %
11	Rv.580 Hop- Midttun		372	16 %
12	E18 Ørje- Eidsb	252	246	-2 %
13	E6 Akersb	296	302	2 %
14	Rv. 2	681	780	15 %
15		295	302	2 %
16	na - Vinterkjær	507	425	-16 %
	ørn - Moberg	248	211	-15 %
	kelsten- Krosby	506	520	3 %
	Ny Svinesundforbindelse	847	849	0 %
	E6 Skjerdingsstad - Jaktøyen	678	583	-14 %

50% of projects were completed with lower costs than forecasted
It is a fact that sometimes projects ends with underruns rather than overrunsbut wait a moment!

Were the projects built as presented to the decision makers?

Yes	Yes/No	
All others	Oslofjord Some cost underruns/overruns can be explained by change of plans!	Hitra-Frøya: Connecting road was not built; planning difficulties Teigeland- Håland 1,75 km not built to avoid cost overrun

Results (3): Accident costs

*Reduction in accidents with
personal injury, opening year*

No	Project	Estimates	Actual	Deviation%
1	Rv. 23 Oslofjordforbinde	8.6	7.8	-9 %
2	E18 Rannekleiv - Temse	6.1	8.1	33 %
3	Rv. 714 Hitra - Frøya	-0.2	-0.2	0 %
4	E134 Teigeland - Håland	0.0	0.7	
5	Rv. 62 Øksendalstunnelle	1.8	1.9	5 %
6	E8 Norkjosbotn-Laksvatn	4.0	3.7	-6 %
7	E18 Gutu-Helland-Kopsta	4.0	14.2	252 %
8	E39 Kleivedammen-Ande	1.1	1.9	69 %
9	E134 Hegstad - Damåsen	2.1	4.3	105 %
10	Rv.616 Kolset - Klubben	-1.5	-1.9	24 %
11	Rv.580 Hop- Midttun	4.6	0.7	-85 %
12	E18 Ørje - Eidsberg gren	3.8	5.4	42 %
13	E6 Akershus grense- Patt	3.1	2.4	-23 %
14	Rv.35 Lunner- Gardermo	3.7	4.0	10 %
15	E6 Halmstad - Patterød	4.3	0.8	-82 %
16	E18 Brokelandsheia - Vin	7.4	7.6	3 %
17	E39 Sveгатjørn - Moberg	0.7	1.4	100 %
18	E18 Sekkelsten- Krosby	2.8	6.0	114 %
19	E6 Ny Svinesundforbinde	6.3	6.4	2 %
20	E6 Skjerdingsstad - Jaktø	2.7	5.1	89 %

Results 4: Cost Benefit Analysis (NPV; mill NOK)

Project name	Estimates	NPV		Ratio
		Actual	Deviation	
Rv 23 Oslofjordforbindelsen	4563	4565	0 %	5.4
Ev 18 Rannekleiv - Temse	409	498	22 %	1.1
Rv 714 Hitra - Frøya	-242	156	-0.9	0.9
Ev 134 Teigeland - Håland	-445	-418	-0.8	-0.7
Rv 62 Øksendalstunnellen	57	6	0.2	0.2
E8 Norkjosbotn-Laksvatnbukt	-81	0	-0.2	-0.4
E18 Gutu-Helland-Kopstad	-406	0	-50 %	-1.0
E39 Kleivedammen-Andenes	0	0	-47 %	-0.5
E134 Hegstad - Damåsen	0	473	56 %	0.9
Rv.616 Kolset - Klubben	0	-428	21 %	-0.9
Rv.580 Hop- Midttun	0	203	-40 %	1.0
E18 Ørje- Eidsberg	0	311	419 %	0.4
E6 Akershus og Akershus lufthavn	27	72	163 %	0.2
Rv. 35 Lunner	395	285	-28 %	0.5
E6 Halden	95	768	708 %	0.4
E18 Interkjæ	184	450	145 %	0.3
E6 Østfold	-90	62	-169 %	-0.3
E18 Krosby	165	502	204 %	0.3
E6 Ny	811	1011	25 %	0.8
E6 Skjerdingsstad - Jaktøyen	-418	-186	-56 %	-0.5

A majority of projects (15 out of 20) have higher NPVs than was forecasted; Negative NPV improves in some cases

Conclusions/lessons learnt/challenges

1. *Is NPRA achieving its stated road program benefits?*

15 of 20 projects showed an improvement in NPVs than forecasted and

The projects are therefore more profitable to the society than forecasted and the NPRA seems to be achieving the stated objectives

Note, however that 40% of the projects have negative NPVs !

2. What causes the deviations between the predicted and measured impacts?

1. The traffic growth has been higher than forecasted for all projects and the cost estimates deviates from estimates
2. 3 of the projects have been built differently than assumed. This means that:
 - ✓ It is important to update the BCAs to the time for decision so that decision is based on best available knowledge

Challenges

- Non-monetised impacts are sometimes the reason for going ahead with a project. A methodology for ex-post assessments of non- monetised impacts is needed
- Ex post assessments of complex projects (urban projects) is needed



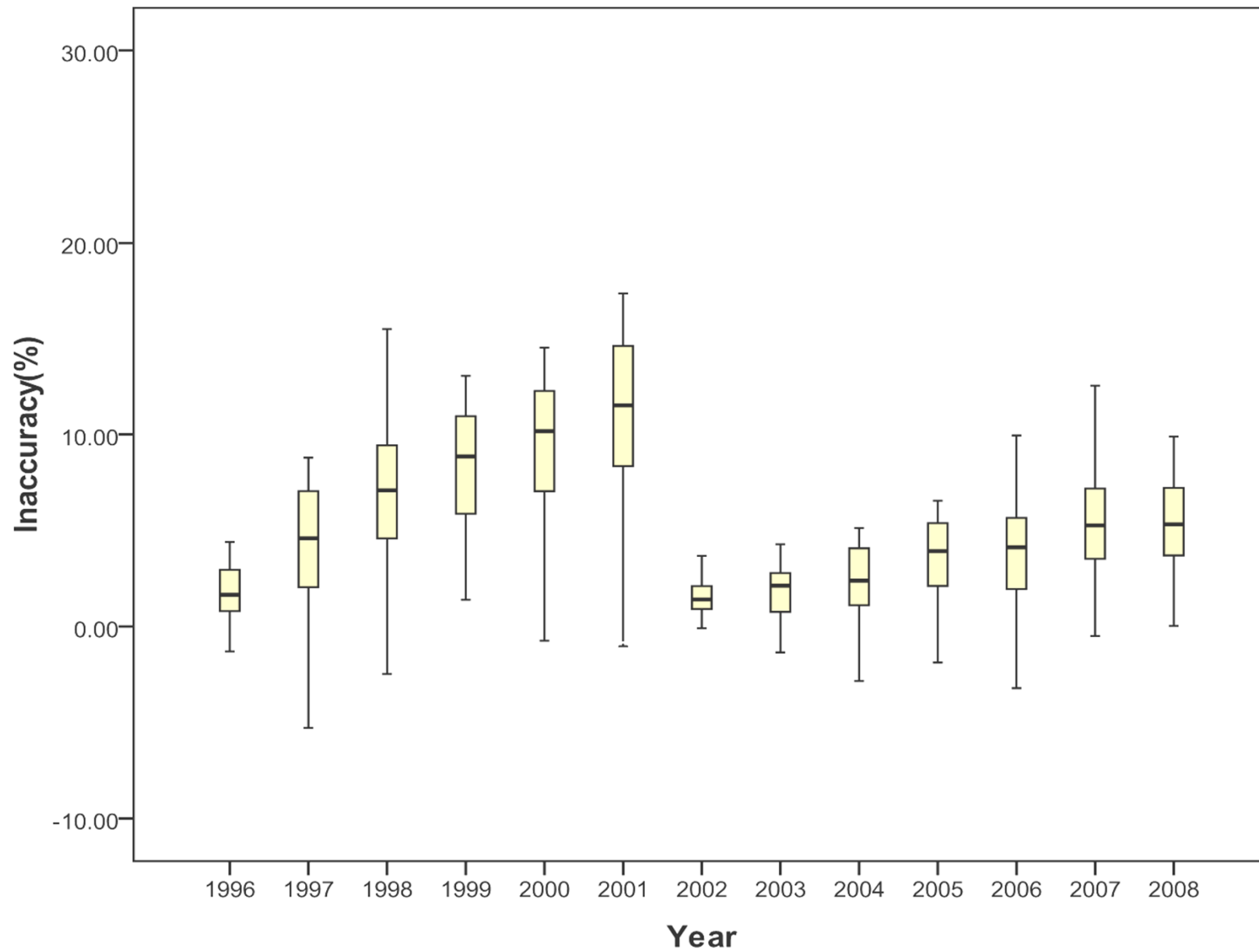
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Thanks for listening!

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Foto: Colourbox

The accuracy of traffic forecasts



The accuracy of cost estimates

