Reliability in Swedish CBA – current practice and what needs to be done

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Topics of the talk

- Present current Swedish state-of-practice:
  - CBA recommendations (valuations of reliability)
  - Present modeling approaches
- Point out a few good ideas, findings and approaches
- Point out where practice should be improved

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Introduction

- Uncertain journey times creates an additional travel cost, both through experienced delays and the need for ”margins” when choosing departure time
- Hence, should be included in cost-benefit analyses
- … even more so when *regulations* (pricing etc.) and *information infrastructure* become more important tools than *physical investments*
- Several studies have studied **valuations** of journey time variability
- Can be shown that disutility is proportional to *standard deviation* of the travel time
  - Assumes free choice of departure time, not-too-long headways and given a certain travel time distribution
- For evaluation, we need ways to **forecast journey time variability**

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What's needed to include reliability in CBA

	Valuation	Modeling
Road		
Long-distance trains		
Urban public transit		

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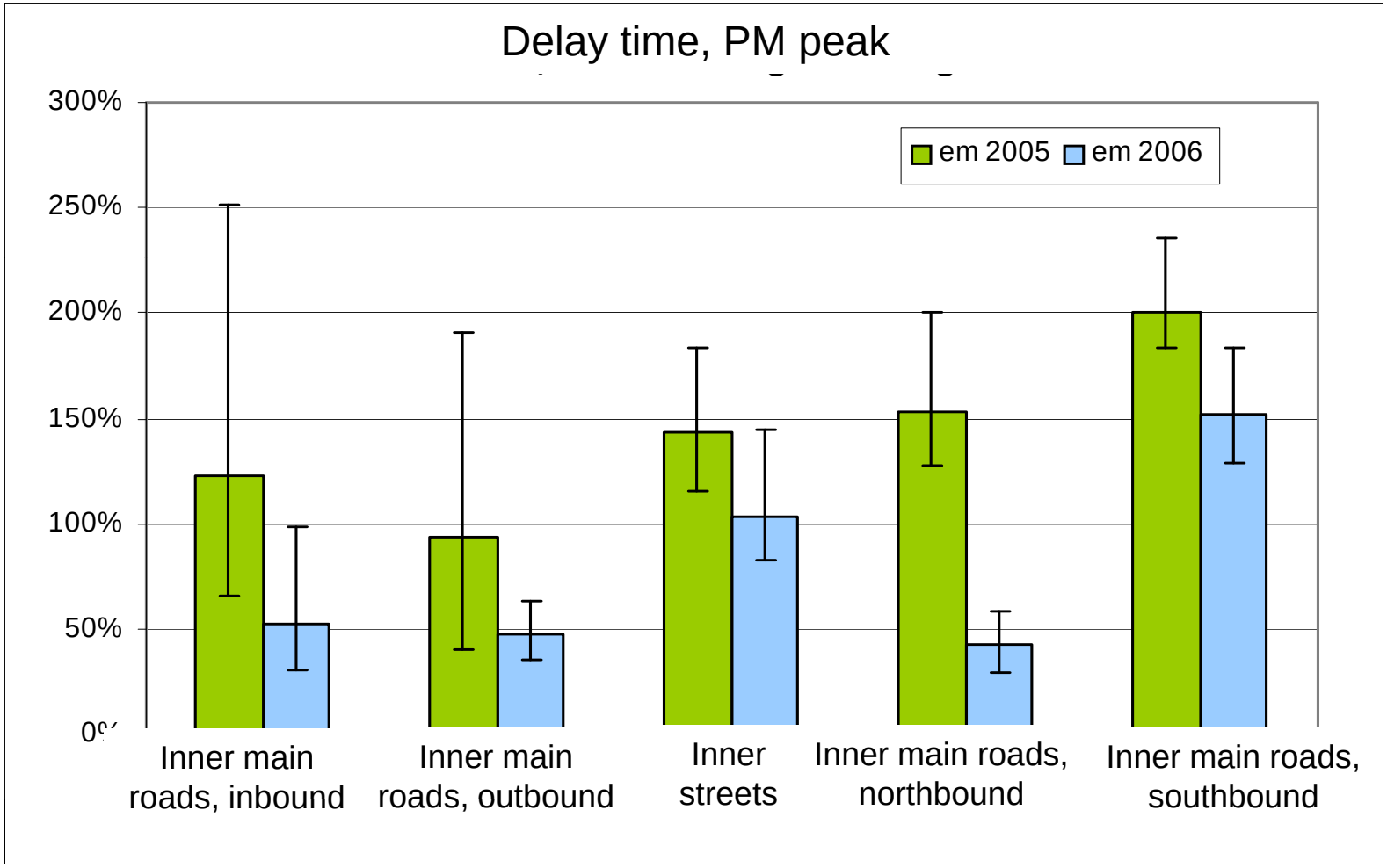
Digression:

Effects of the Stockholm congestion charges: 30-50% less time in queues & less variability



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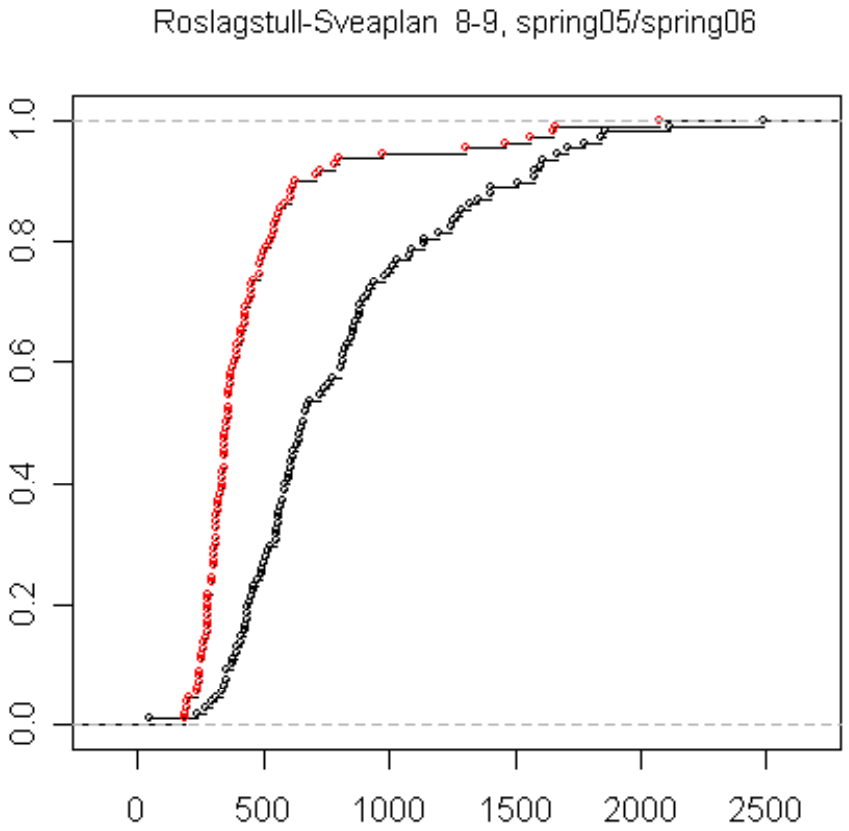
Congestion charges: More days became ”good days” in terms of travel time

- Black: april 2005, no charges
- Red: april 2006, congestion charges
- Both **mean** and **standard deviation** of travel times decreased

- The distributions got more skewed in 2006
  - High congestion => less skewed distributions



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Road: valuation

- Valuation based on the *standard deviation* of travel time
  - **After** controlling for ”anticipated” travel time variation due to time-of-day, season etc.
  - Std.dev. increases in congested conditions
- u = α*average_time + β*cost + γ*stddev
  - interpreting the interval as a 95% confidence interval
- γ/α = relative value of variability – “reliability ratio”
  - typically 0.7 – 1.3
- γ should depend on the shape of the travel time distribution (the “H factor”) (Bates, Fosgerau later)

	VoT (€/h)	VoStdDev (€/h)	Rel. ratio
Morning	7.6	3.7	0.95
Business	13.3	*2.2*	*0.32*
Afternoon	6.4	1.6	0.59

- (Eliasson, 2003)

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Road: Valuation (in practice)

- Recommendation: VoR = 0.9*std.dev.*VoT
  - Based on Eliasson (2003); similar to several other studies
  - Similar to e.g. UK, Netherlands…
- No adjustment for the distribution of the travel time (the ”H factor”/”mean lateness factor”)
  - The ”0.9” part should really depend on the shape of the travel time distribution
- This is applied not only for private trips, but also for freight transport and business trips
  - No justification for this, really
- Occasionally, replaced by ”queue driving 1.5 as onerous as free-flow driving”
  - But this is actually *something else* and *additional* to travel time variability

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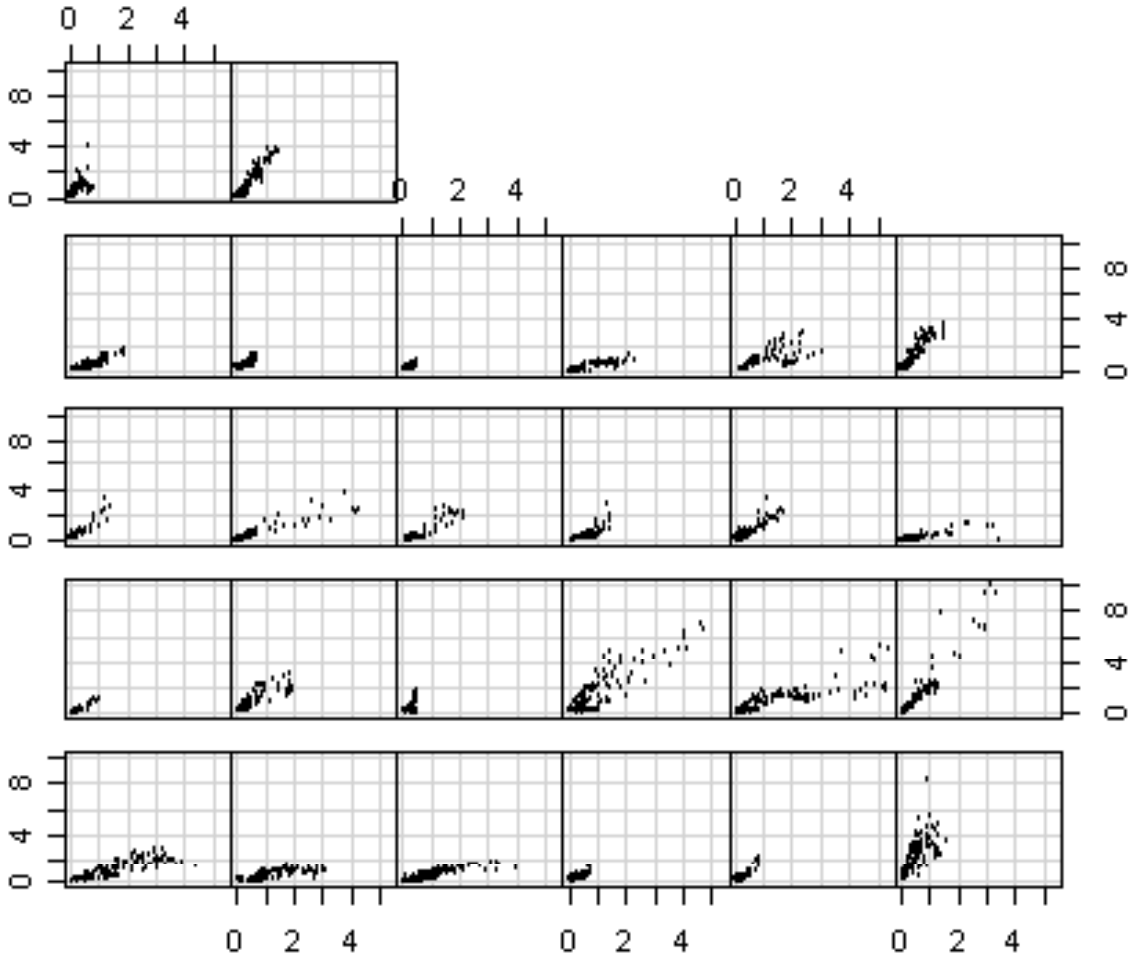
Road: Modeling the congestion/std.dev. relationship



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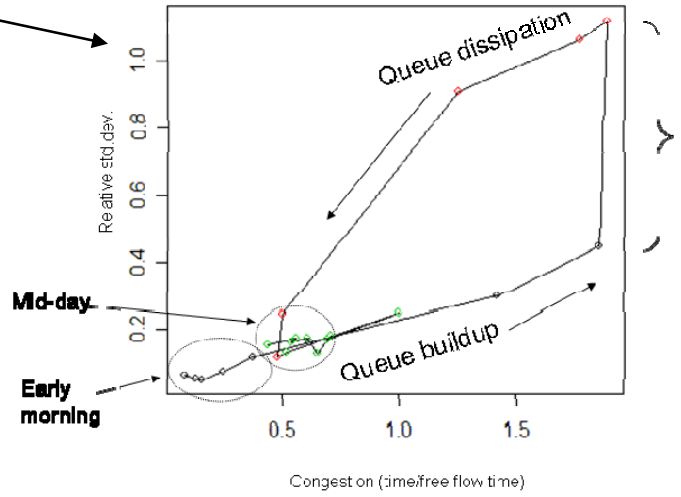
Road: Modeling

- Estimated relationship between congestion and std.dev. of travel time:

$$\sigma = c_{ToD} t^{\alpha} L^{\beta} \left(\frac{t}{t_0} - 1 \right)^{\gamma} \qquad \alpha = 1.1, \beta = -0.3, \gamma = 0.5$$

- c_{ToD} is a time-of-day constant, different for the period before peaks (queue build-up phase) and after peak (queue dissipation phase)
- Estimated in Eliasson (2006), using automatic travel time measurements for 41 urban links
- No modeling of the *distribution* (the ”H factor”) yet (see Joel Franklin tomorrow)



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Road: Modeling (in practice)

- The formula is implemented in Emme/2
- Emme/2 travel times underestimated in high congestion, though… so std.dev. is underestimated

- Not used during assignment, only as an evaluation measure in the CBA once the traffic forecast is made
- Link travel times assumed to be uncorrelated (necessary for skimming)

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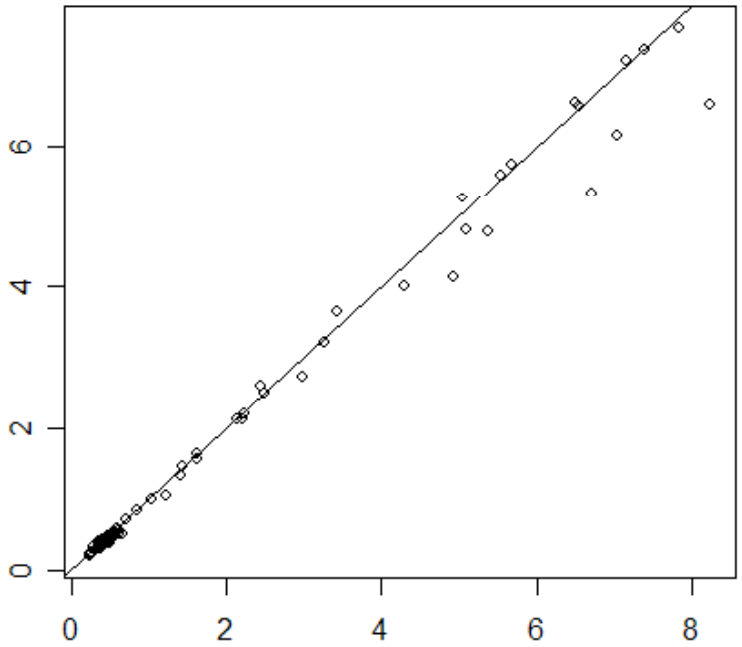
Can we assume that link travel times are uncorrelated?

- Uncorrelated travel times on links along a route necessary for ”skimming” the stddev for an entire O-D route
- Not really true, though… but the error seems not too large

Total std.dev. assuming uncorrelated travel times on pair of adjacent links



Correct total std.dev. for pair of adjacent links

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Road reliability in CBA: towards fairly OK

	Valuation	Modeling
Road	Valuation of σ No correction for different distr. (”different H:s”) No justification for freight/bsn. valuation	Relationship σ/congestion Used in Emme/2, but not validated (yet) No correlation btw. links
Long-distance trains		
Urban public transit		

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Long-distance trains: Valuation

- ”Delays” are defined as the positive difference between actual and scheduled arrival time
- Practice: Average delay (risk*length) valued as 2*(travel time)
- … unfortunately
- We know that delay valuation is *not* proportional to delay risk
  - increases **slower than linearly** in the risk
  - See Maria Börjesson tomorrow
- … but this is not yet reflected in official recommendations
- The factor 2 should be *much* higher – 5-10 (depending on risk level)
  - Practice: 2 is changed into 3 or 4

- Theory for reliability valuation with **long headways** not as well developed
- Freight treated as person travel (delays = 2*VoT) – no good base for this

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Long-distance trains: Modeling

- No ”official” modeling method for forecasting impacts of investments/measures/timetables on delays
- Practice: use statistics and subjective judgments

- Ongoing work: simulating how primary delays ”propagates” into secondary delays
  - Averaging over possible ”classes” of timetables, given infrastructure and primary delays
- No good estimates of how infrastructure/maintenance affects *primary* delays

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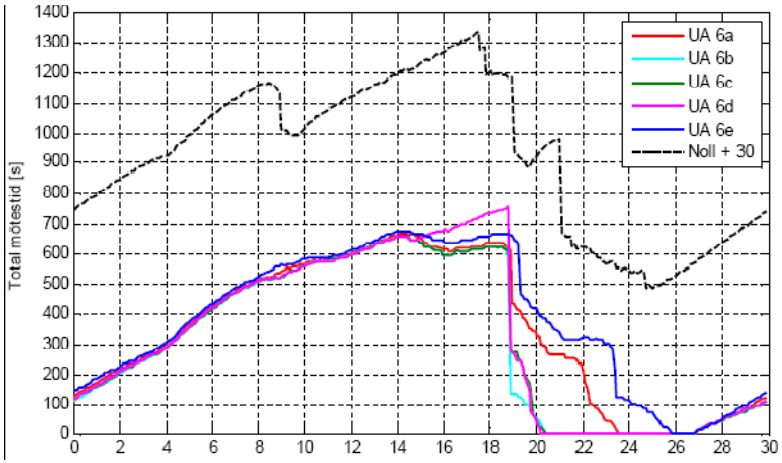
Evaluating how infrastructure improvements affect *secondary* delays

- The infrastructure determines which timetables are possible
  - Where trains can meet etc.
- Idea: specify a *class of possible future timetables*
  - …that are possible given the infrastructure
- Given distribution of *primary* delays, simulate distribution of *secondary* delays (for all trains) – averaged over the class of timetables
  - The distribution of *primary* delays is assumed to be unaffected – given by historical statistics



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Rail reliability in CBA: Much to do, and recommendations not up-to-date

	Valuation	Modeling
Road	Valuation of σ No correction for different distr. (”different H:s”) No justification for freight/bsn. valuation	Relationship σ/congestion Used in Emme/2, but not validated (yet) No correlation btw. links
Long-distance trains	Average delay = 2-3*VoT Should be higher and non-linear in the risk level (possibly prop. to stddev)	Only statistics and judgments Ongoing work on primary delay propagation Nothing on maintenance => primary delays
Urban public transit		

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Urban transit: Valuation

- No official recommendation yet
- Tentative result: VoR = 1.1*stddev*VoT
- Should depend on distribution (”H factor”) and headway – but currently doesn’t

- Ongoing valuation study

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Urban transit: Modeling

- Essentially nothing: statistics and subjective judgment – in the best case

- Additional complication: Importance of interconnections?

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Transit reliability in CBA: Most things remain to be done

	Valuation	Modeling
Road	Valuation of σ No correction for different distr. (”different H:s”) No justification for freight/bsn. valuation	Relationship σ/congestion Used in Emme/2, but not validated (yet) No correlation btw. links
Long-distance trains	Average delay = 2-3*VoT Should be higher and non-linear in the risk level (possibly prop. to stddev)	Only statistics and judgments Ongoing work on primary delay propagation Nothing on maintenance => primary delays
Urban public transit	Tentative valuation of σ No correction for different distr. (”different H:s”)	Only statistics and judgments Add. compl.: Interconnections

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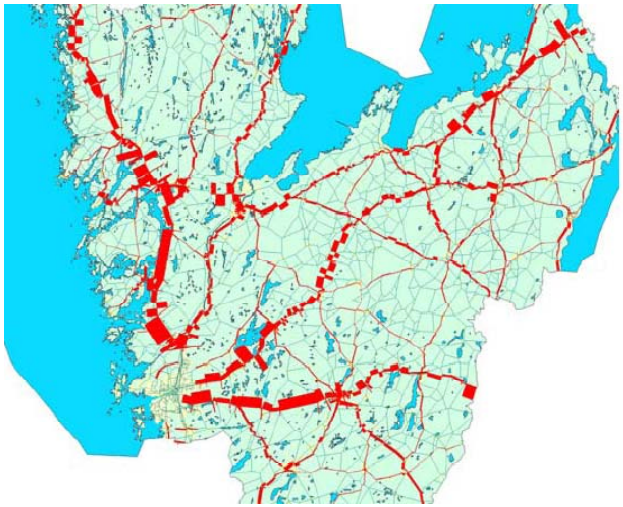
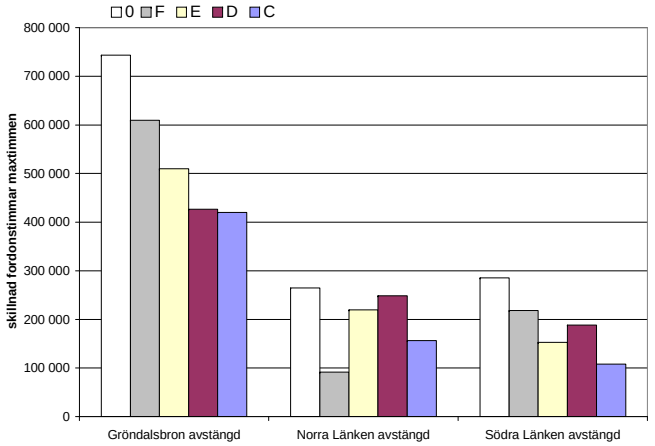
A complement: The vulnerability approach

”Vulnerability” approach:

- Identify critical links (through e.g. vulnerability maps)



- Analyse how the consequences of a breakdown of given critical links are affected by e.g. an added link



Results from the ongoing National Transport Investment Plan

- National Transport Investment Plan 2010-2021
- Reliability included in CBA for the first time

- Road: Travel time reliability benefits around 10% of time benefits
- Rail: 20% of time benefits

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Conclusions

- Travel time reliability important factor in CBA
  - 10-20% extra benefits on average; higher for some projects
- … even more so when *regulations* (pricing etc.) and *information infrastructure* become more important tools than *physical investments*
- Road traffic: beginning to look OK, more work under way
- Rail traffic: valuations soon OK, modeling efforts under way
  - Main deficit: sources of primary delays
- Urban transit: valuations soon OK, almost no modeling

- To a certain extent, other approaches such as ”vulnerability studies” can help out

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