Programmatic appraisal – the appraisal of transport synergies

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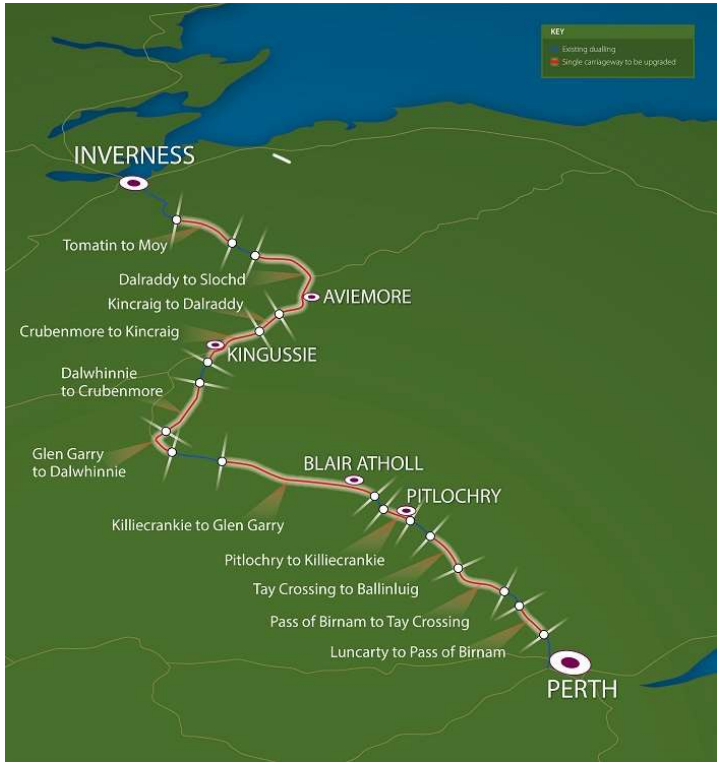
Background



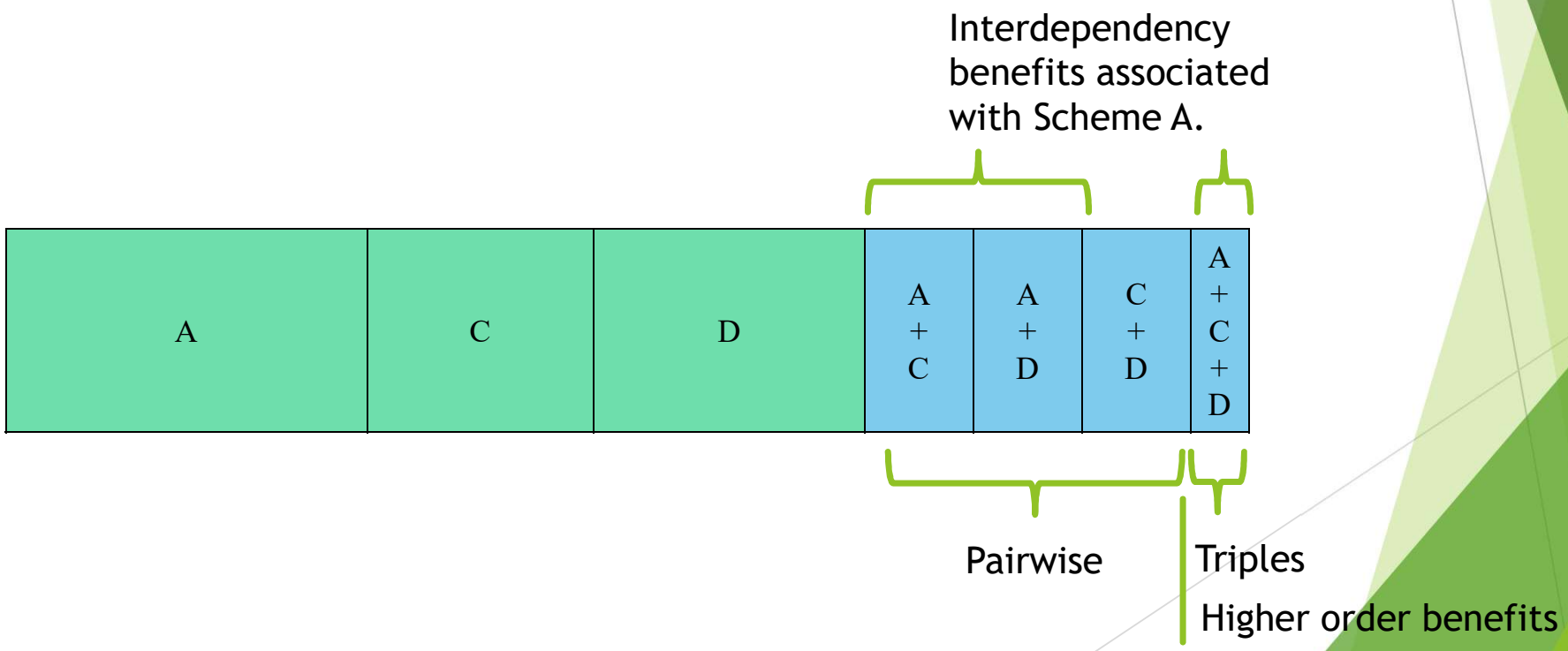
A9 route upgrade

The problem for programmatic appraisal

- Interdependence between schemes
  - The whole may be greater (or less) than the sum of the parts.
  - These can be substantial
- Uncertainty in schemes
  - Which schemes with interdependence will be constructed?
  - Will the interdependency benefits be delivered?

The problem

- Benefits from Programme of **Complementary** Schemes A, C and D



The Curse of Dimensionality

- Separately identifying all the pairwise, triples, quads, and other higher order interdependency benefits is an immense task
- With two options (Not implemented, or Full)

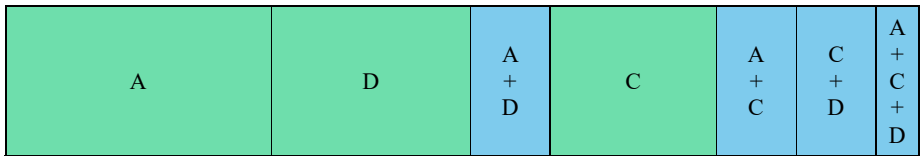
Number of Schemes	n	3	5	10	15	20
Number of combinations	2^n-1	7	31	1023	32 767	1 048 575

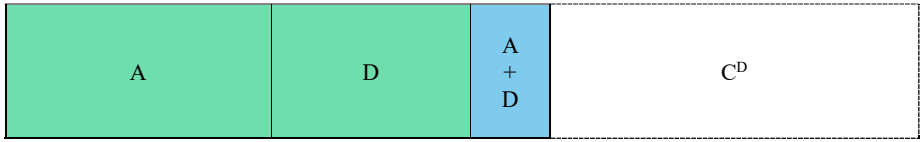
- With three options (Not implemented, Partial or Full)

Number of Schemes		n	3	5	10	15	20
Number of combinations		3^n-1	26	242	59 048	14 348 906	3 486 784 400

- Is it even possible?

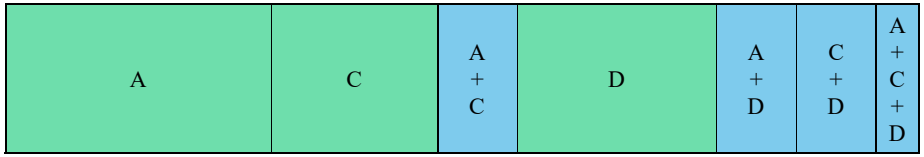
Diagnostic tests: Decremental and incremental

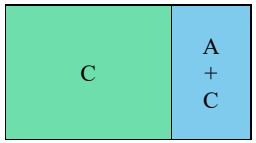




- Decremental is the missing link
  - Offers an upper bound on the interdependency benefits
  - Offers a test as to whether the strategy needs the scheme

BUT ARE THESE VALID MEASURES GIVEN UNCERTAINTY OF WHETHER SCHEMES WILL GO AHEAD?





- Incremental is the next link in the strategy
  - Offers a more conservative view to the interdependency benefits than decremental
  - Shows whether the scheme contributes to the strategy

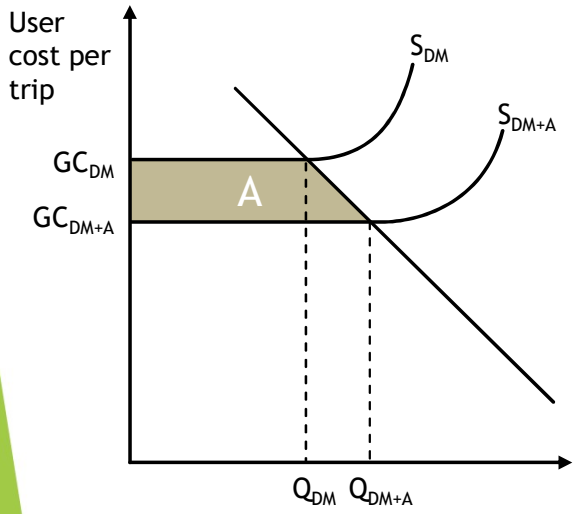
A96 route upgrade

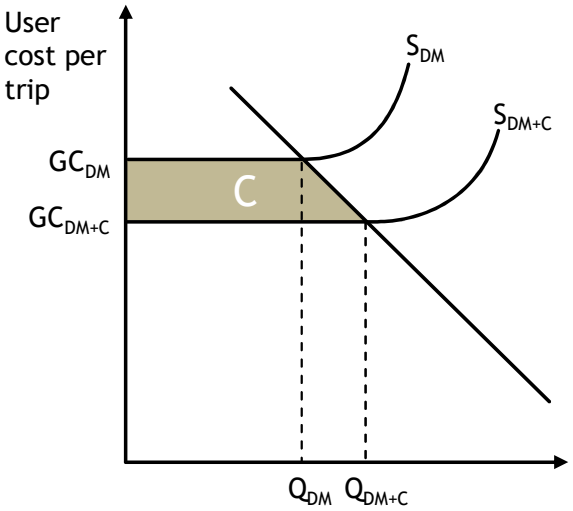
The policy challenge

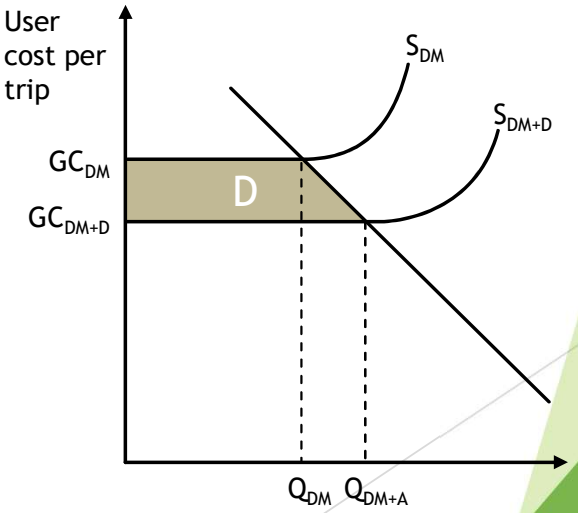
- In UK government decision making on scheme progression is made at scheme level (e.g. Scheme A)
  - How should interdependency benefits be treated?
  - We do not want to double count.
  - But can interdependency benefit A+B appear in the appraisal of Scheme A and Scheme B (if both are progressing separately)?
  - And they are uncertain too
- Overseas 5yr/10yr national transport plans are enacted. Has its associated problems.

Economics of interdependencies

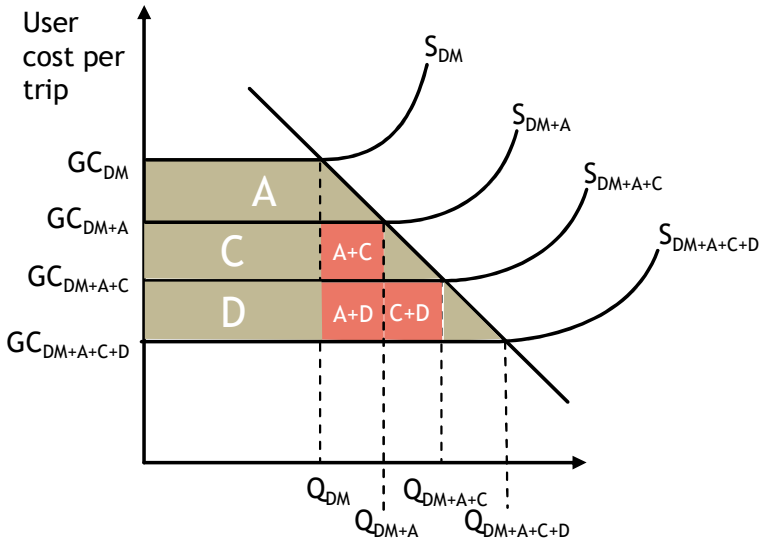
Brief review of user benefits







Complementary schemes, uncongested



Note: In this example Area A+C+D equals zero. This is a function of the shape of the cost curve and the additive properties of the cost reductions.

- Interdependency benefits are positive
- Pairwise interdependency benefits are a good indicator of total benefits
- No need to model all scenarios

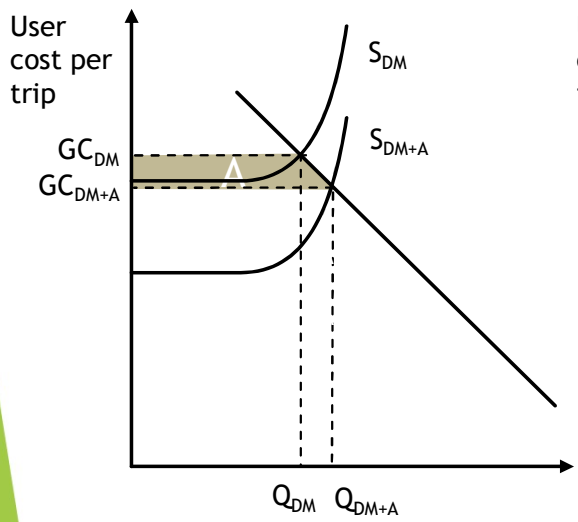
Complementary schemes, congested

Y — Z

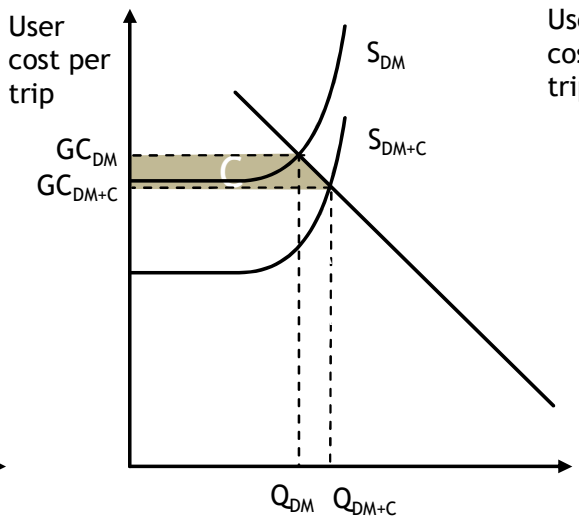
Scheme A
Speed increase only
Slow driving here

Scheme C
Speed increase only
Slow driving here

Scheme D
Capacity increase only
Bottleneck here



Volume of trips from Y to Z



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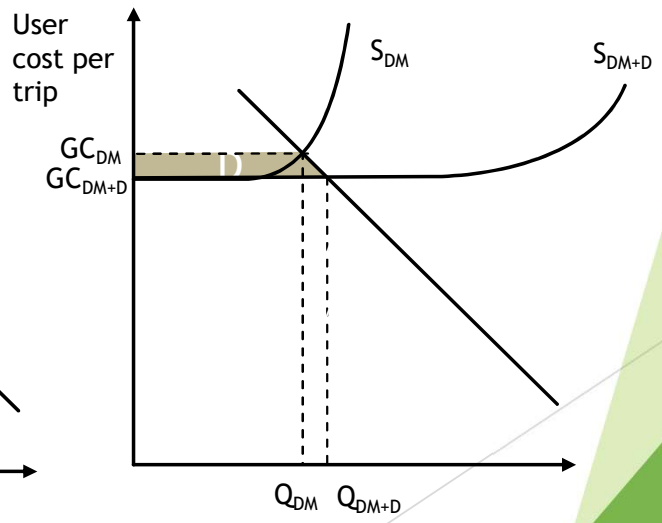

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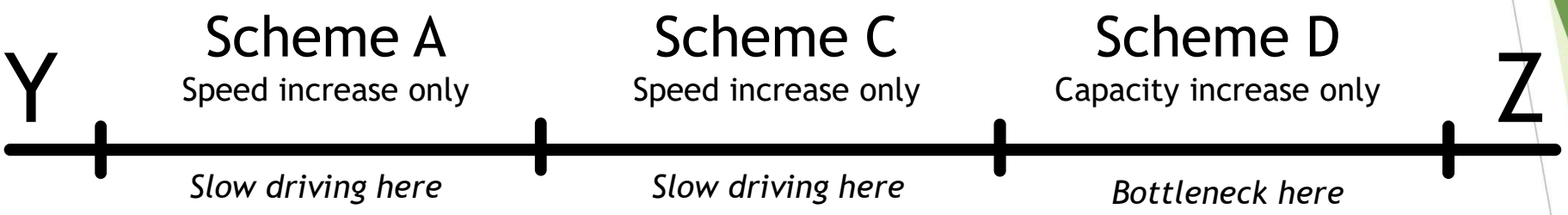
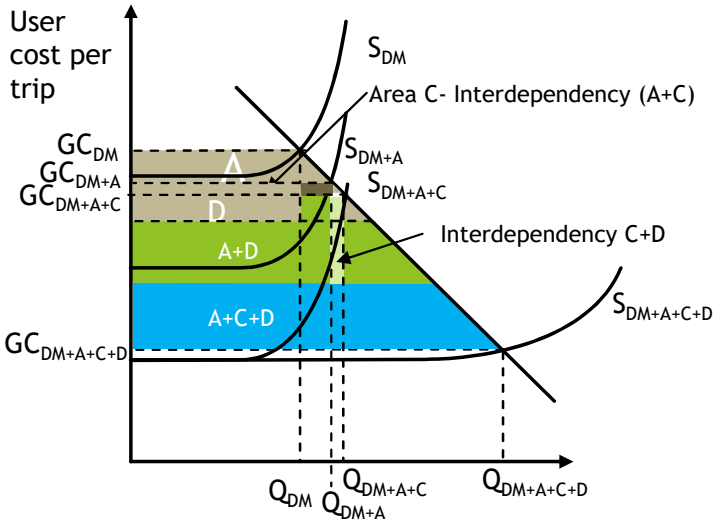
Complementary schemes, congested





- Interdependency benefits when congestion is:
  - worsened are negative (similar to Braess' paradox*)
  - eased are positive
- Pairwise interdependency benefits are NOT a good indicator of total benefits
- There is a need to model more scenarios.

* Braess paradox: Total user benefits are negative. Happens when a road improvement benefits short journeys which share a congested road with long journeys.

This analysis can be repeated for competing schemes

Implications for interdependency benefits

- This gives the following summary:

Scheme types	Sign of interdependency benefits if network is:	
	Uncongested	Congested
Complementary	**Positive**	Positive if congestion is ameliorated Negative if congestion is worsened
Competing	**Negative**	Positive if congestion remains in the Do Something and both routes using either scheme are viable. Negative if sufficient capacity on one route is created such that that route dominates route choice

Categorised by change in travel demand

Counter-intuitive

- Size of interdependency benefits depend on:
  - Slope of demand curve: steeper it is the less the interdependency benefits are for complementary (or more positive for competing)
  - Slope of supply curve (i.e. congestion): the more congestion there is the more likely interdependency benefits to be crowded out for complementary (or be positive for competing)

Implications for appraisal

- If network is uncongested:
  - Use decremental (missing link), and incremental tests as upper and ‘mid’ish’ bounds
  - Use pairwise interdependency benefits if network is relatively uncongested to identify individual components of interdependency benefits ;
- If network is congested:
  - The above, plus
  - Need to explore use of higher order interactions (triples, quads, etc.)

Economics of Uncertainty

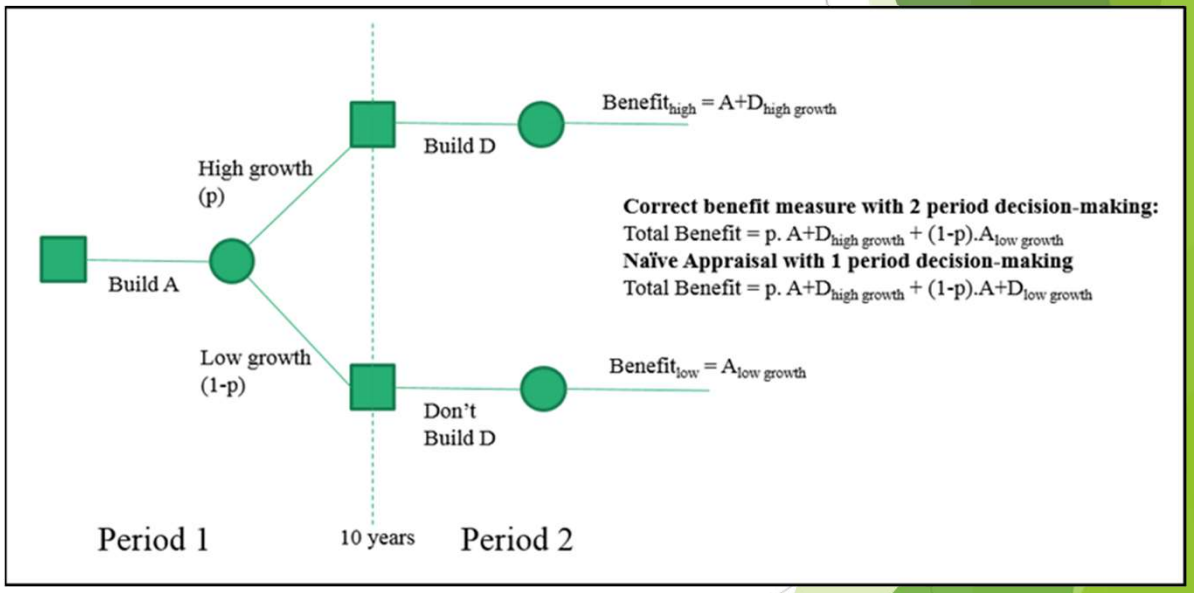
Risk

- Sources of risk for the construction of other schemes
  - Policy risk
  - Risk on delivering the asset
  - Risk on operating the asset
  - Risks on demand and revenue

Other schemes may not go ahead. If so interdependency benefits may be ZERO in the future!!!

Handling risk in economic appraisal (theory)

- Expected value
  - Benefit under each scenario and associated probability
- Quasi-option value /real options
  - Correction term when moving from a 1 period decision to a 2 period decision
- Problem:
  - WHAT ARE THE PROBABILITIES:
    - Of a scheme being constructed?
    - Of low/high growth?
  - Most governments do not put firm probabilities on these



Possible: Solution is a risk register and risk management framework (e.g. WebTAG)

Highway case study

Case study: Interdependency benefits

Our case study:

- 5 schemes A, B, C, D & E
  - These represent amalgamations of smaller schemes
  - C is proposed to be constructed after A & B, but before D & E.
- C is are scheme of interest – decision to be made on it
- A & B are complementary to C and are on the same route (in traffic terms)
- D is complementary to all schemes (in traffic terms)
- E is complementary to D, but competes with A, B & C (in traffic terms)
- Long route corridor
- Modelling
  - HA regional traffic model (strategic)
  - Variable demand
  - Multiple time periods
  - Multiple years

Case study - uncertainty

- Schemes classified as per WebTAG (other 2 categories form part of Do Minimum)

Scheme	Description	Uncertainty
A	Road widening	Reasonably foreseeable
B	Roundabout upgrade and road widening	Reasonably foreseeable
D	Road widening	Hypothetical
E	Road widening and junction upgrade	Hypothetical

- Possibly rather blunt, not very informative

Case study: interdependency benefits

- In our case study CONGESTION had a BIG effect
  - ‘A’ & ‘B’ negative pairwise interdependency benefits with all schemes (the bottleneck affect) [A is positive with C too]
  - ‘D’ is negative with A & B (bottleneck affect), positive with ‘C’ and ‘D’
  - ‘E’ negative with all schemes [only a priori expectation]
- We only get significant and positive interdependency benefits if 3 schemes are implemented.
  - Need to reduce congestion sufficiently.
- Here the triples give the best indicators of total scheme benefits
  - This will be a function as to level of congestion in network,
  - Unlikely to be a general finding

Case study: interdependency benefits

Interdependency benefits very relevant to Scheme C

- Incremental test benefits: +34% (in 2026) [A & B precede C]
- Decremental test benefits: + 21% (in 2026) [Benefit of adding C to A, B, D & E]
  - Decremental < Incremental due to competing effect of E
- Interdependency benefits for C
  - Pairwise (-12% with Scheme E, to +6% Scheme D)
  - Triples (-6% to +38%, triplea mostly positive) [*incremental test is a triple*]
- Risk register:
  - A & B classified as *Reasonably foreseeable*
    - Classify incremental benefit (& triple) +34% as "*Reasonably foreseeable*"
  - D & E are hypothetical
    - Classify their interdependency benefits as "*Hypothetical*" [includes *Decremental*]
    - Note these are negative – raises questions about what the overall route/corridor investment strategy is & cherry picking in the appraisal (?)

Case study – modelling issues

- Model runs: Finally did 28 scenarios (for the 5 schemes)
- Regional model needed (national model for Scotland)
  - Needed to model re-routeing and to include other schemes
  - Gives a different answer from the scheme specific model
  - Noise issues in the regional model required higher level of convergence than normal for an RTM
- Congestion effects mean multiple model years are needed
- With congestion need to look at diagnostics: O-D journey times, bottleneck pinchpoints, etc.
  - Increases analytical effort

Conclusions

Conclusions

- Programmatic appraisal is characterised by:
  - Interdependencies;
  - Uncertainty
- Interdependency benefits
  - They can be large
  - A simple rule is available for programmatic appraisal in uncongested conditions
  - In congested conditions it is more complex and a lot more effort is needed
  - FUTURE RESEARCH: thresholds for congestion to become relevant
- Uncertainty
  - This is problematic within current guidelines which are quite blunt
  - A more nuanced view is likely to be needed in the future.
  - FUTURE RESEARCH: further development of the uncertainty analysis and classification

Conclusions contd

- Modelling
  - The modelling effort is not trivial
  - BUT these schemes are very expensive (£Billions)
  - Modelling effort should therefore be justified
- Policy
  - Very risky to use a decremental analysis as a basis for interdependency and a decision. This is the most uncertain level of benefit.
  - There is a role for corridor/route 'strategic' appraisal to help define the problem, and avoid 'cherry picking' schemes that add benefits, but do not suppress them.

Thank you for your attention

Questions?

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