Using multi-criteria decision analysis to support reimbursement decision making in health care

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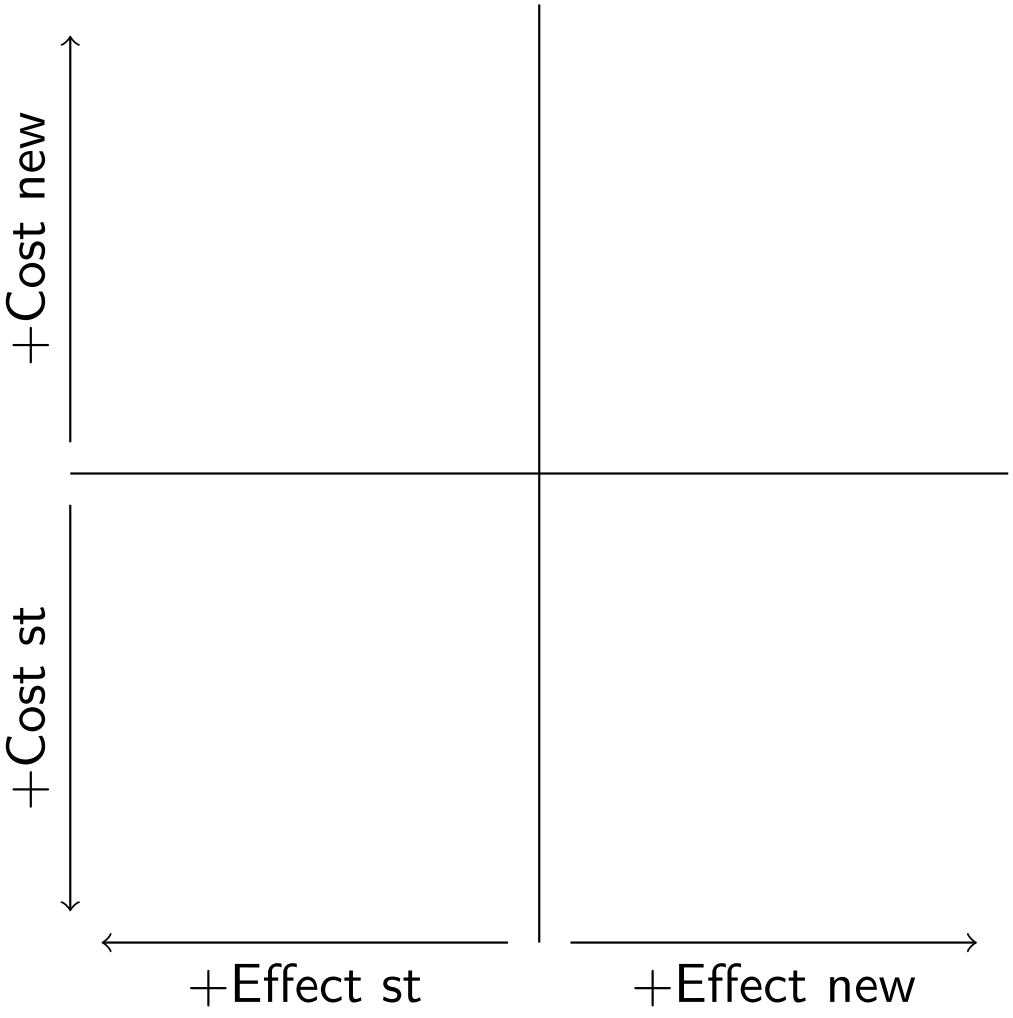
Health economic evaluation

- In health economic evaluation, two or more alternatives are compared in terms of their costs and effects
- Costs may include
  - Direct costs within the health sector
  - Patient and family resources
  - Productivity losses
- Effectiveness is generally measured in terms of a single outcome measure
  - Quality-adjusted survival time

Current routine in the field

- When two alternatives are considered, reimbursement decision making is based on an incremental analysis of the differences in costs and effects
- It is straightforward to make an appropriate decision when one alternative clearly dominates the other
- In practice, a new intervention is often both more effective and more costly than the current standard treatment
  - The treatment selection decision is based on the value of the incremental cost-effectiveness ratio: $\mathrm{ICER} = \frac{c_{\mathrm{new}} - c_{\mathrm{st}}}{e_{\mathrm{new}} - e_{\mathrm{st}}}$
  - Does the ICER exceed the willingness-to-pay threshold λ?

Reimbursement decision making based on ICERs



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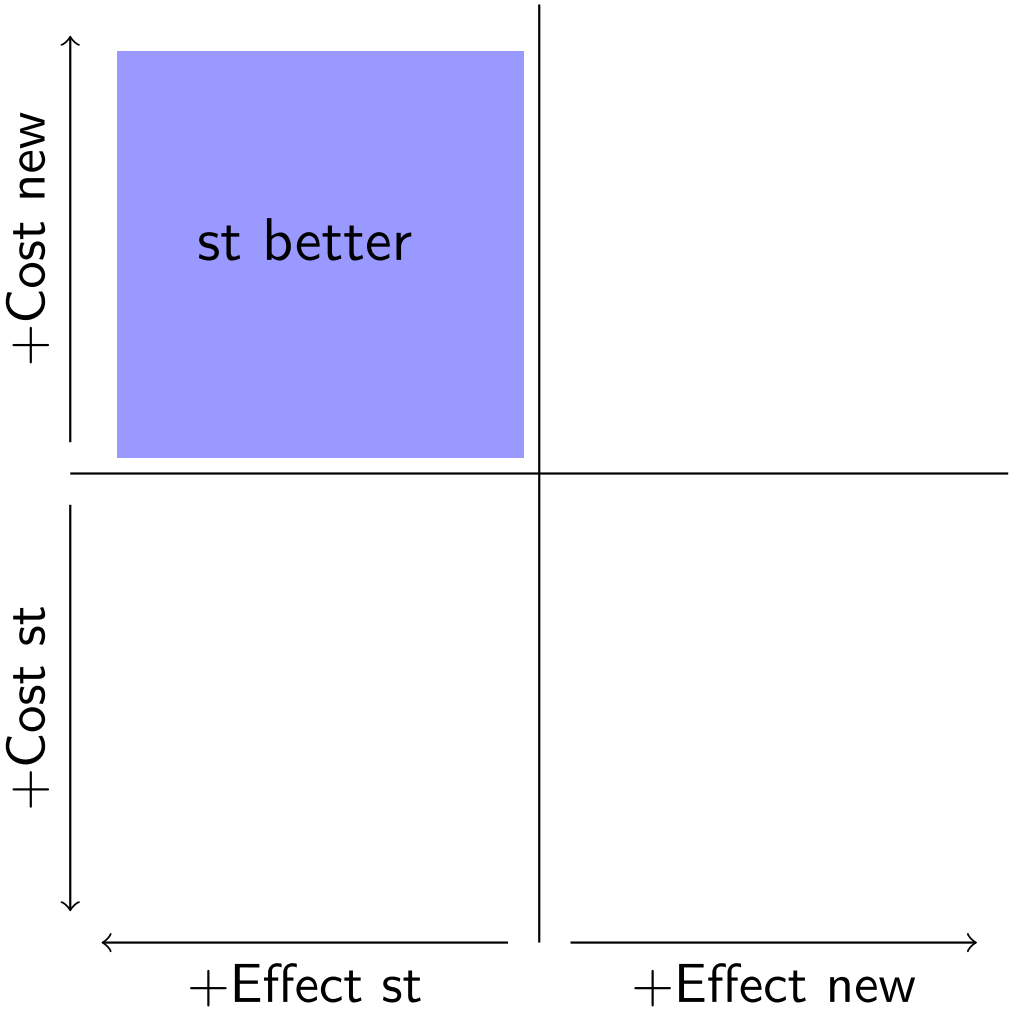

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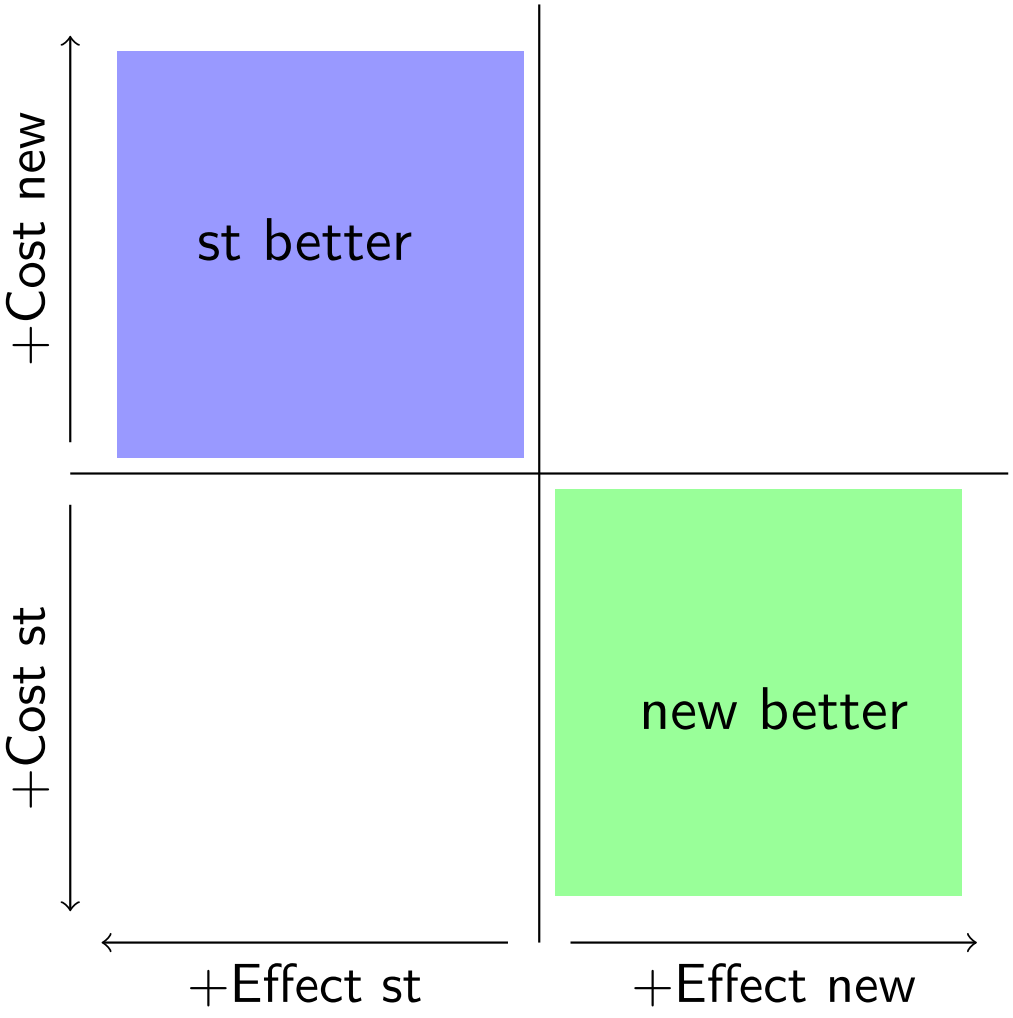

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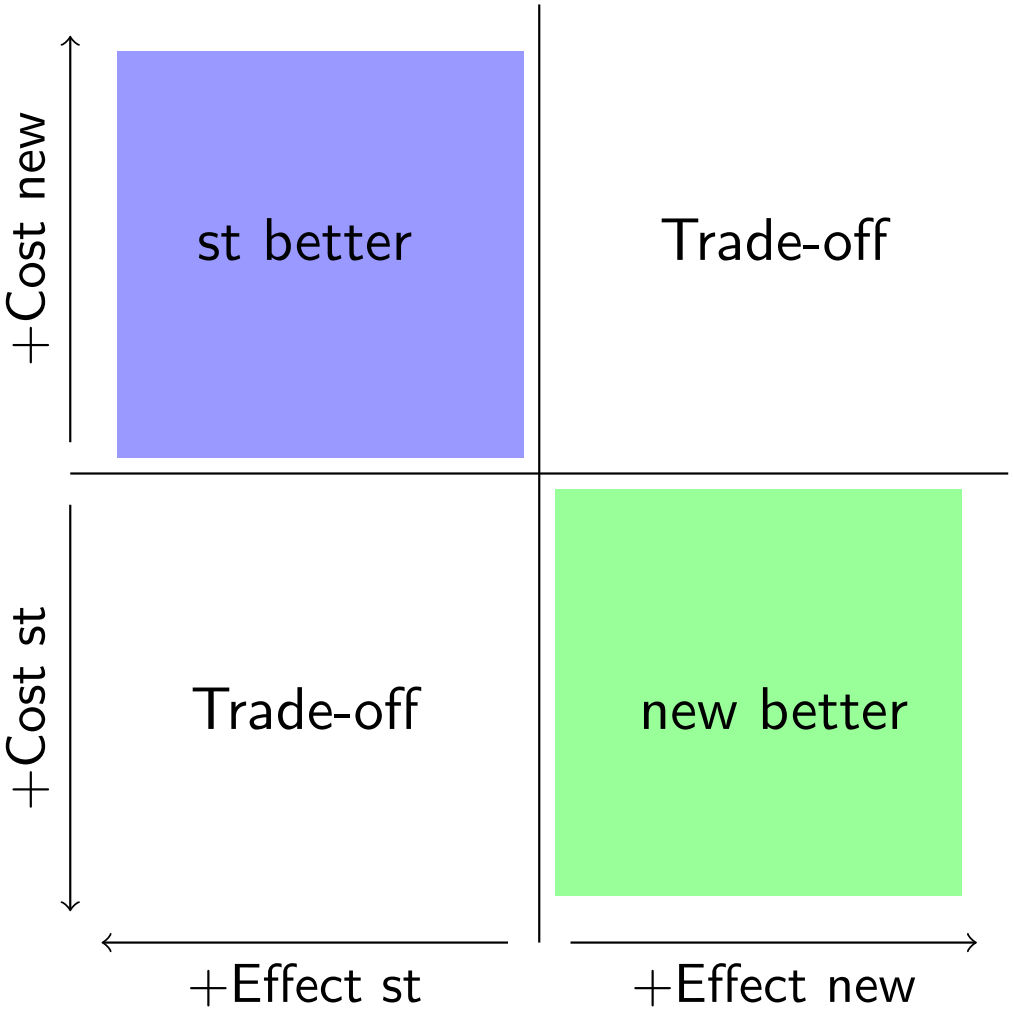

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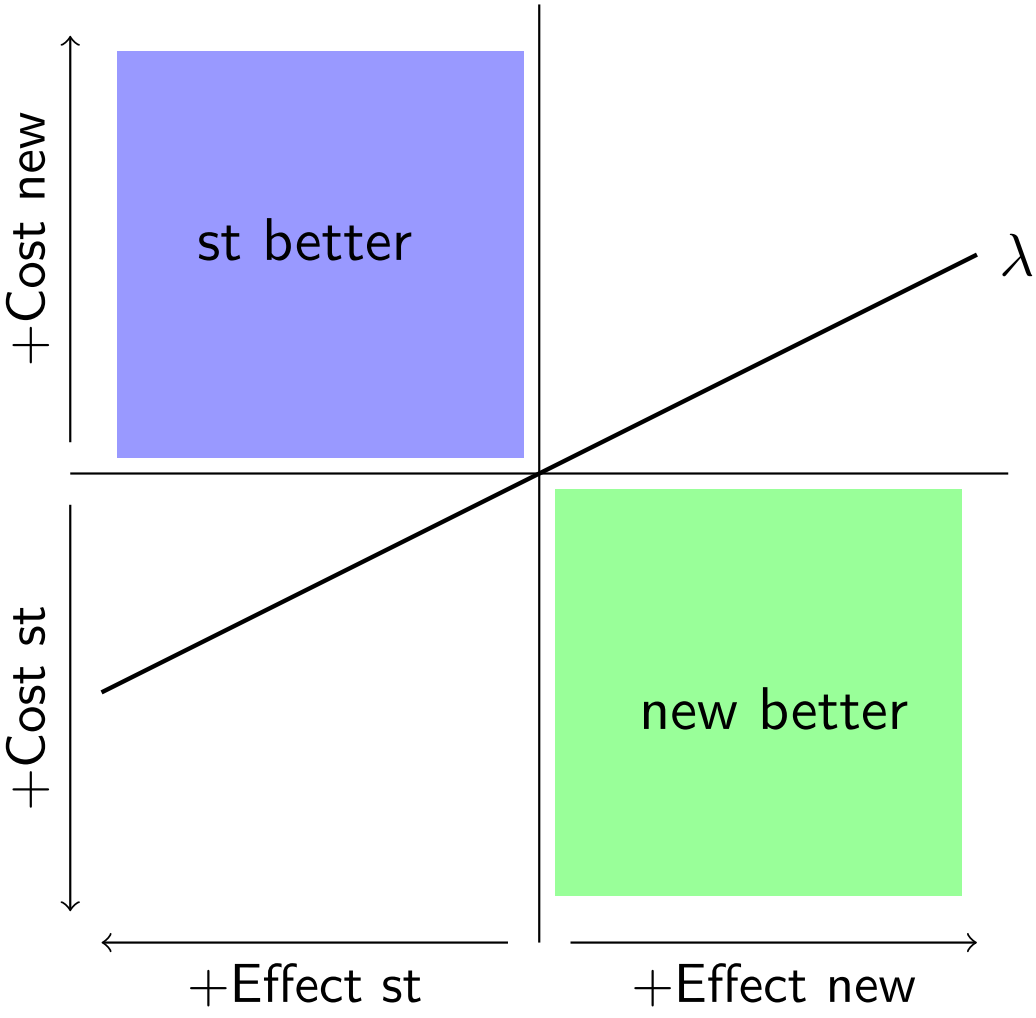
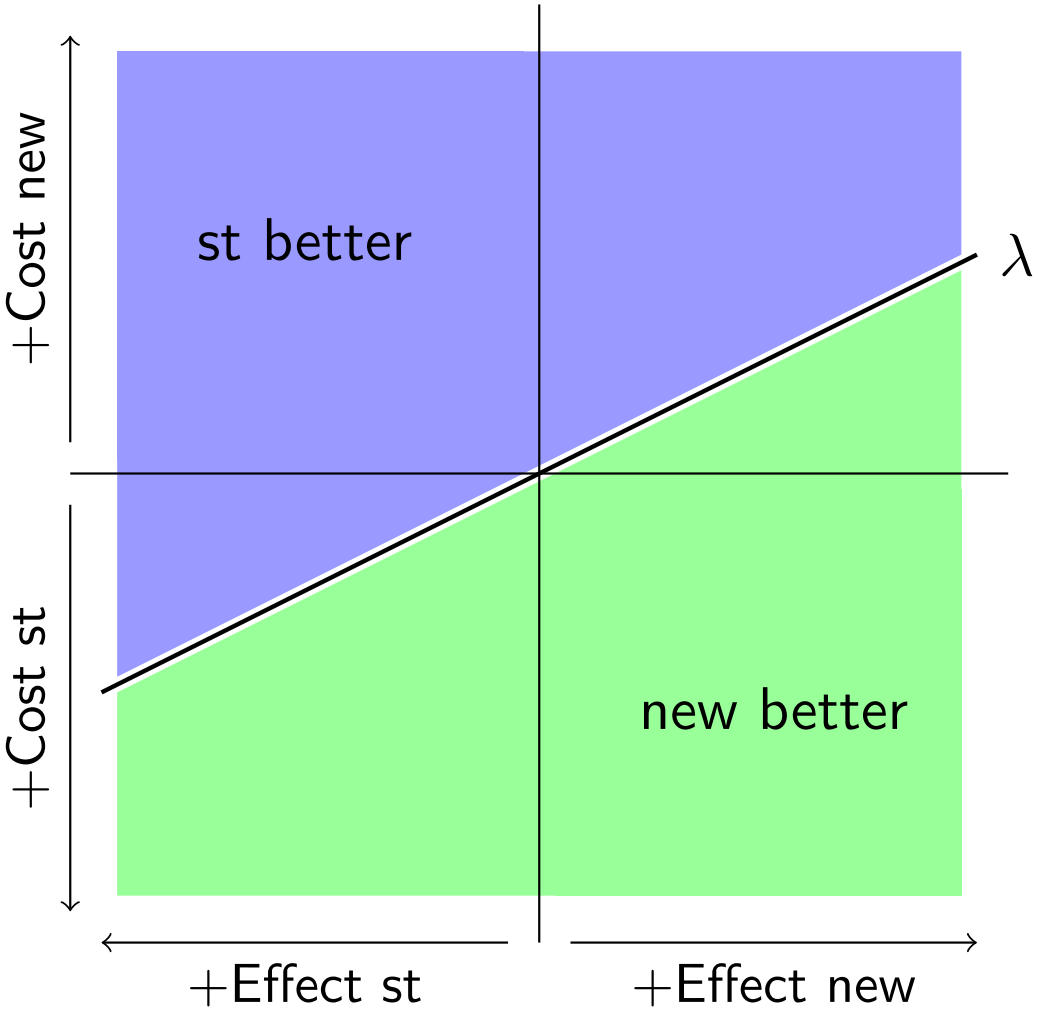


The acceptability threshold. We are willing to pay λ to get 1 unit of health gain.

Reimbursement decision making based on ICERs



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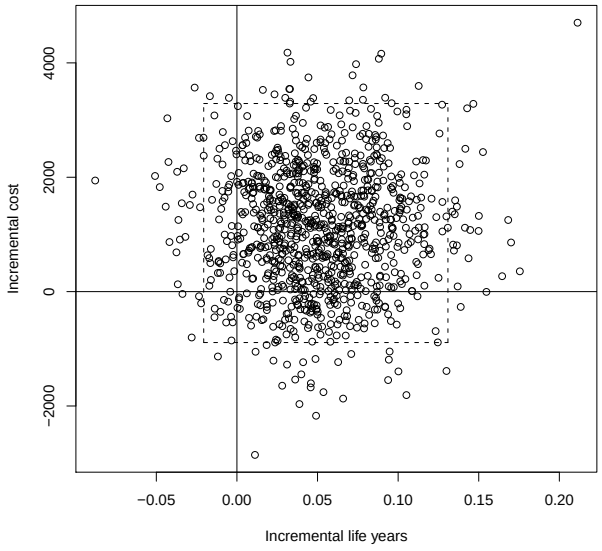
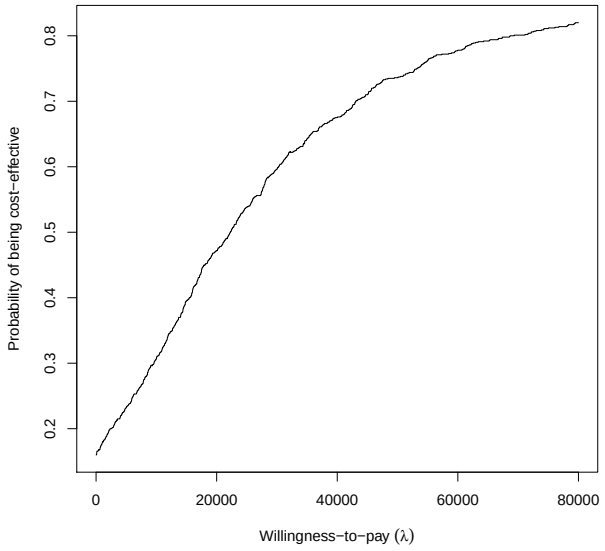
Current routine in the field cont'd

- The decision uncertainty is quantified by simulating from the joint distribution of the differences in costs and effects





- A similar analysis can be performed when more than two alternatives are considered

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Limitations of the current approach

- All relevant health effects need to be captured in terms of a single aggregated measure of effectiveness
  - Not all interventions aim at increasing (quality-adjusted) life expectancy
- Depending on the perspective of the analysis, certain cost categories are either in- or excluded
  - health sector perspective versus societal perspective
- To overcome these limitations, we propose to use a combination of MAVT and SMAA to structure the problem and make the value trade-offs explicit

Proposed solution

- MAVT to formalize the decision maker's preference structure
  - Additive value function:
    $v(x) = \sum_{i=1}^{n} w_i v_i(x_i)$
- SMAA to allow for imprecision in the weights and uncertainty in the criteria values

Towards a value function for the reimbursement decision problem

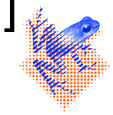
- Treatment selection based on ICERs is equivalent to maximizing the net monetary benefit function $\mathrm{NMB} = \lambda e - c$

$$\frac{c_{\mathrm{new}} - c_{\mathrm{st}}}{e_{\mathrm{new}} - e_{\mathrm{st}}} \leq \lambda \Rightarrow \lambda e_{\mathrm{new}} - c_{\mathrm{new}} \geq \lambda e_{\mathrm{st}} - c_{\mathrm{st}} \Rightarrow \mathrm{NMB}_{\mathrm{new}} > \mathrm{NMB}_{\mathrm{st}}$$

- The NMB function can easily be transformed into an additive value function by defining $v_1(c) = -c$ and $v_2(e) = \lambda e$:

$$v(c, e) = v_1(c) + v_2(e)$$

- Assuming that $v_1(c)$ and $v_2(e)$ are bounded, a strategically equivalent representation $v'(c, e) = w_1 v_1'(c) + w_2 v_2'(e)$ is obtained by rescaling of the partial value functions to $[0, 1]$



Extending the baseline value function

- The two-criteria value function can straightforwardly be extended by introducing additional effectiveness attributes

$$v(c, e_1, \ldots, e_n) = w_1 v_1(c) + w_2 v_2(e_1) + \ldots + w_{n+1} v_{n+1}(e_n)$$

- Different weights for the various cost components can be introduced by moving towards a hierarchical objectives structure

MAVT alone is not sufficient

The additive MAVT model is very useful in practice, but suffers from:

- Not being able to take into account uncertainty (e.g. costs between 30 and 50)
  - MAUT can, but is very difficult to use in practice
- Requiring exact criteria weights
  - Exact weights are hard to elicit "correctly"
  - With multiple DMs, how to find concensus?
  - Some DMs don't want to reveal their exact preferences

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Solution: stochastic multi-criteria acceptability analysis (SMAA)

SMAA-2

- SMAA-2 is an MCDA method for ranking a set of alternatives evaluated on basis of a set of criteria
- Extends MAVT by allowing:
  - Imprecise or completely missing weights
  - Uncertain criteria values
  - Inverse approach to decision aiding
- SMAA-2 doesn't consider imprecision with regard to the partial value functions

SMAA decision aiding metrics

Rank acceptability index share of weights and measurements making an alternative have ranks $1, \ldots, m$ (most preferred, second most, etc.)

Central weight vector center of gravity of the favourable weight space: "Which preferences support an alternative to be the most preferred one?"

Confidence factor probability for an alternative to be preferred when preferences equal its central weight vector: "Are the measurements sufficiently precise?"

Case study in IVF treatment selection

- We consider a previously published cost-effectiveness decision problem relating to infertility treatment (Fiddelers et al., 2009)
- The objective of the original study was to compare the cost-effectiveness of seven IVF strategies
- Effects were quantified in terms of the mean live birth probability for a couple starting IVF treatment
- Costs were analyzed from a societal perspective
- Multiple pregnancies are considered one of the most important complications of infertility treatment, but this side effect was not taken into account in the original analysis

A. Fiddelers et al., Cost-effectiveness of seven IVF strategies: results of a Markov decision-analytic model, Human reproduction 24 (2009) 1648-1655.

IVF treatment

- A complete IVF treatment consists of a maximum of three IVF cycles
- An IVF cycle starts with hormonal stimulation of the ovulatory process, after which multiple eggs are retrieved and fertilized
- If at least two normally fertilized embryos are available, a choice must be made between
  - elective single embryo transfer (eSET)
  - double embryo transfer (DET)
  - standard treatment policy (STP): eSET in patients $<$ 38 years of age with at least one good quality embryo and DET in the remainder of patients
- Compulsory single embryo transfer (cSET) is performed when only one embryo is available

IVF strategies

- It is possible to switch from embryo transfer policy in successive IVF cycles
- The following IVF strategies are considered:
  - Strategy 1: 3 x eSET
  - Strategy 2: eSET + 2 x STP
  - Strategy 3: eSET + STP + DET
  - Strategy 4: eSET + 2 x DET
  - Strategy 5: 3 x STP
  - Strategy 6: STP + 2 x DET
  - Strategy 7: 3 x DET

Criteria

- Probability of a life birth
- Risk of twin pregnancy
- Costs (analyzed from a societal perspective)
  - the cost of IVF treatment
  - the cost of a singleton and twin pregnancy
  - the cost of delivery
  - the cost of the period from birth until six weeks after birth

Criteria values

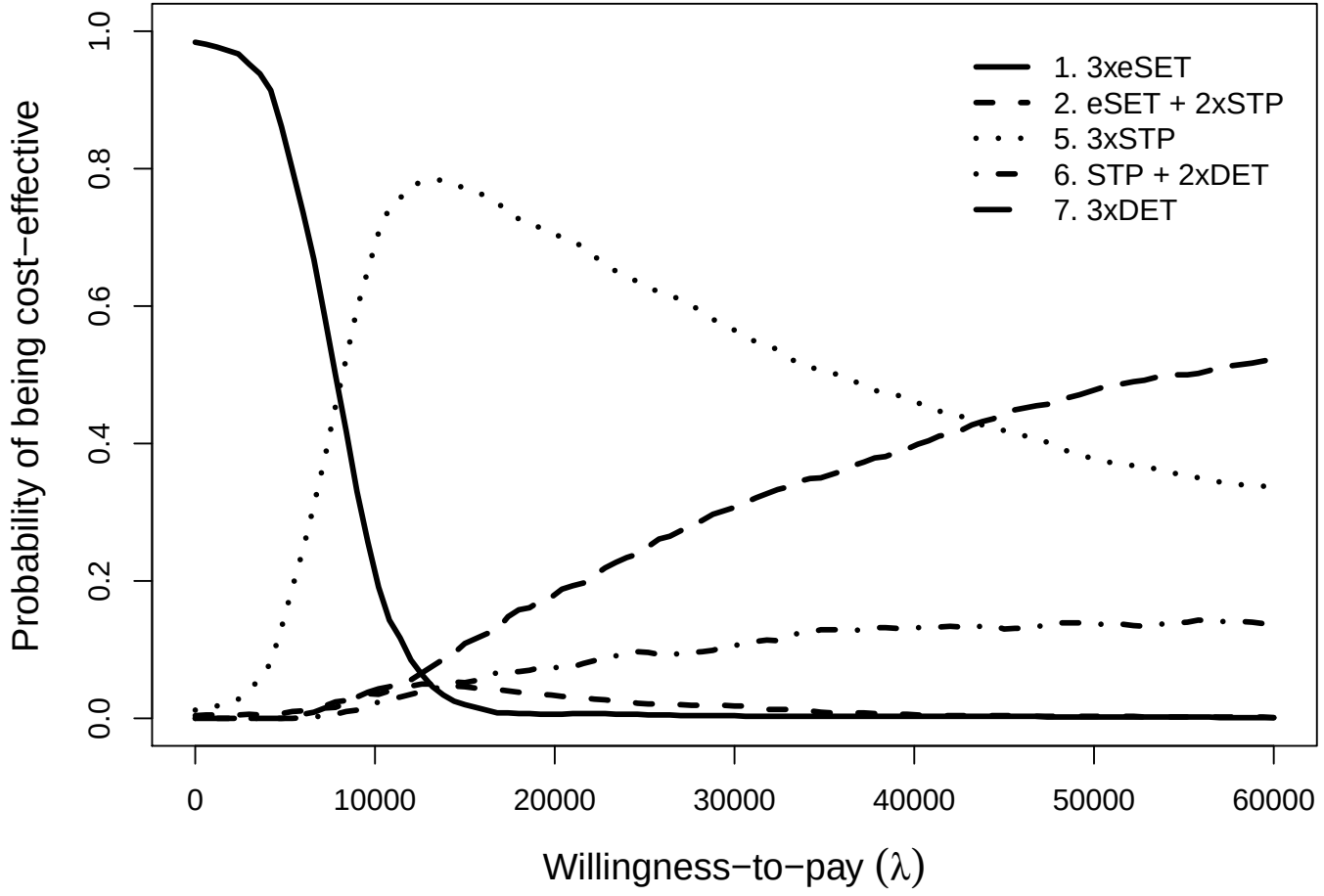
- To generate the criteria values, the simulation model as presented in the original study was reimplemented
- Uncertainty was accounted for by specifying probability distributions for the model parameters

Strategy	Life birth	Twin pregnancy	Costs
3 x eSET	0.374	0.008	14,207
eSET + 2 x STP	0.457	0.010	15,161
eSET + STP + DET	0.470	0.030	15,658
eSET + 2 x DET	0.492	0.063	16,464
3 x STP	0.520	0.020	15,481
STP + 2 x DET	0.550	0.064	16,649
3 x DET	0.577	0.115	17,704

Table: Estimated mean values

Results of the classical analysis

Results of the cost-effectiveness analysis when the risk of twin pregnancy is ignored



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Results of the SMAA analysis

Criterion	preference direction	Worst value	Best value
Life birth	↑	0.225	0.696
Twin pregnancy	↓	0.249	0.001
Costs	↓	30,601	8,980

Table: Scale ranges for the partial value functions

Strategy	rank 1	rank 2	rank 3	rank 4	rank 5	rank 6	rank 7
3 x eSET	0.191	0.101	0.202	0.068	0.082	0.049	0.307
eSET + 2 x STP	0.048	0.434	0.206	0.099	0.075	0.120	0.018
eSET + STP + DET	0.002	0.031	0.185	0.534	0.169	0.064	0.015
eSET + 2 x DET	0.001	0.004	0.034	0.112	0.284	0.542	0.023
3 x STP	0.610	0.108	0.159	0.019	0.018	0.047	0.039
STP + 2 x DET	0.051	0.274	0.106	0.124	0.318	0.086	0.041
3 x DET	0.097	0.048	0.108	0.044	0.054	0.092	0.557

Table: Rank acceptability indices from the analysis without preference information

Strategy	confidence	life birth	twin pregnancy	costs
3 x eSET	0.784	0.07357992	0.3733216	0.5530984
3 x STP	0.887	0.33655314	0.3495487	0.3138981
3 x DET	0.515	0.68922068	0.0964687	0.2143106

Table: Central weights and corresponding confidence factors

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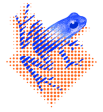
Conclusions

- In the original study, the authors concluded that combining several embryo transfer policies was not cost-effective
- This conclusion still holds when the risk of a twin pregnancy is included in the analysis
- Compared to the classical analysis, the SMAA analysis resulted in increased discrimination among the three remaining strategies

Thank you for your attention!



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