The LQI acceptance criterion and monetary optimization

A discussion note

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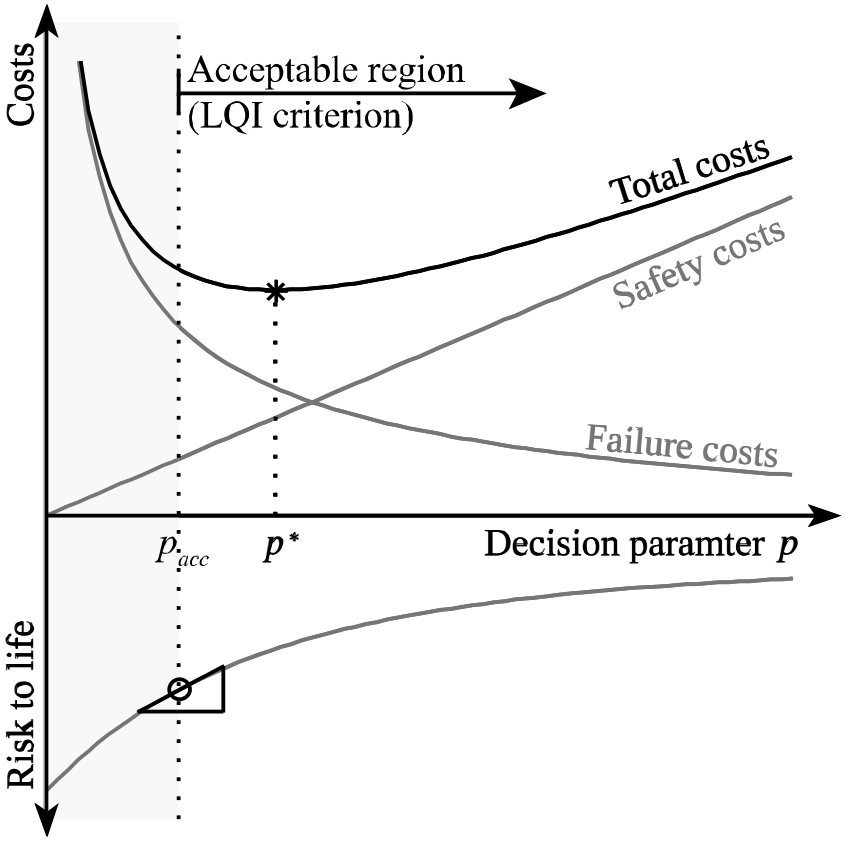
Interaction LQI and monetary optimization – Two approaches



1) *Use LQI to monetize human consequences for optimization*

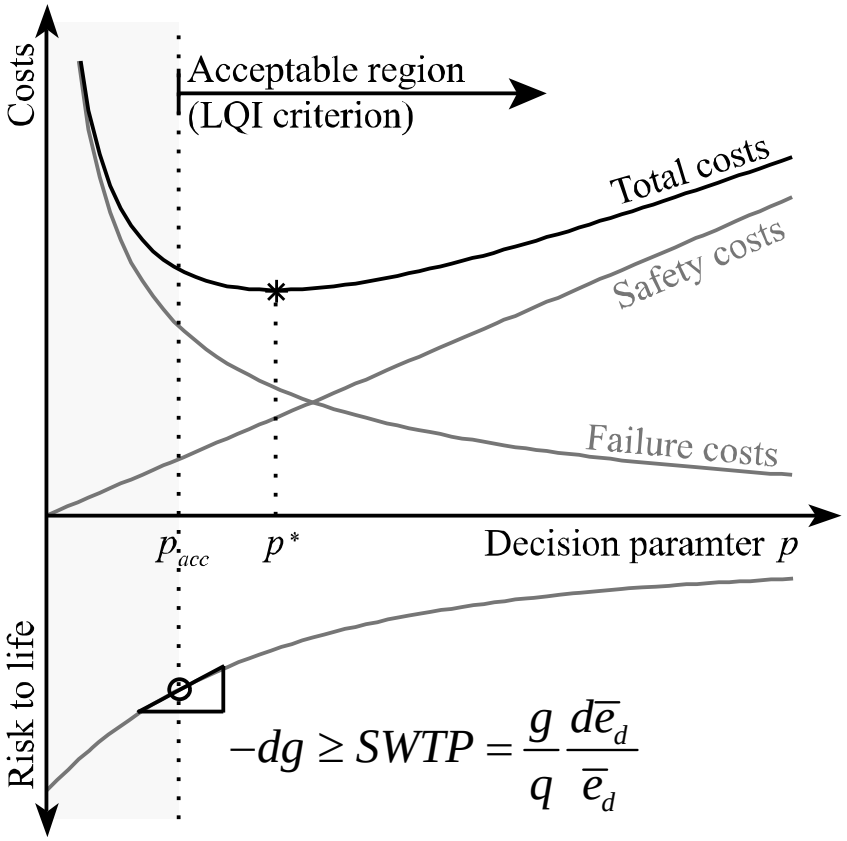
   Intuitive for monetary optimization from a societal point of view.

2) *Use LQI as a societal boundary condition for optimization*

   Makes sense especially for a private decision-maker performing the optimization.

Treat societal and private decision-makers differently???

Interaction LQI and monetary optimization – Two approaches



For private decision-makers:

- Own preferences for optimization
- Societal preferences for LQI criterion
- Marginal life saving costs $-dg$ are estimated only from the safety costs
- Human compensation costs H_C may be included in optimization.

⇨ *Use this approach as a starting point also for societal decision-making.*

⇨ *Discuss interaction with monetary optimization & compensation costs.*

“Societal human compensation costs”

How to define human compensation costs?

The amount of money that in case of a fatality has to be paid by a (private) decision-maker, e.g. to the relatives of the victim.

= Transfer payments from a societal point of view!!!

For societal decision-making:

- Compensation as such is not a meaningful notion in this context.
- Nevertheless a nonzero monetary value to account for loss of life seems appropriate also in optimization from a societal point of view.
- A minimum value can be derived from economic considerations (humans as production factors), larger values based on e.g. SWTP.
- The term “societal human compensation costs” is used only to make clear that the value enters monetary optimization.

“Societal human compensation costs”

References	Formula	Value [Mio. CHF]	Value / SWTP
Nathwani et al. [1], Rackwitz [3]	$SWTP\|_{d\mu=1} = \frac{g}{q}\frac{d\overline{e}_d}{\overline{e}_d}\Big\|_{d\mu=1} \approx \frac{g}{q}C_\Delta$	4.98	1.00
Faber [4], Rackwitz [2]	$SVSL = \frac{g}{q}\overline{e}_d$	5.52	1.11
Lentz [5], Rackwitz [2]	$SHC = g\overline{e}$	2.89	0.58
Skjong and Ronold [6]	$ICAF = g\frac{1-w}{w}\frac{1}{2}\cdot\frac{e_0}{2}$	10.19	2.05
Ditlevsen [7]	$ICAF = g\frac{1-c}{c}\frac{1+V_{e_0}^2}{2}e_0$	6.77	4.26
Rackwitz [2]	$SLSC \approx \Delta e\cdot g\left[1-\left(1+\Delta e/e_0\right)^{-1/q}\right]\Big\|_{\Delta e=e_0/2}$	2.46	0.49
Kübler [8]	$SLSC^{(-)} \approx -\Delta e g\left[1-\left(1-\Delta e/e_0\right)^{-1/q}\right]\Big\|_{\Delta e=e_0/2}$	103.34	20.77

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Lost future earnings

$L = g^q \overline{e}_d$

$$dL = \frac{\partial L}{\partial g}dg + \frac{\partial L}{\partial \overline{e}_d}d\overline{e}_d = 0 \quad \Rightarrow \quad -dg = \frac{g}{q}\frac{d\overline{e}_d}{\overline{e}_d} = SWTP$$

$$u(g) = g^q \quad \Rightarrow \quad \frac{L}{\partial u / \partial g} = \frac{g}{q}\overline{e}_d = SVSL$$

“Societal human compensation costs”

References	Formula	Value [Mio. CHF]	Value / SWTP
- Intertemporal aspects: Assumption that LQI gives the value of a life year saved → multiplication with life expectancy to get $ICAF$ - Different / earlier LQI definitions (i.e. no discounting & age-averaging) - Different approximations for de and de/e			
Skjong and Ronold [6]	$ICAF = g\frac{1-w}{w}\frac{1}{2}\cdot\frac{e_0}{2}$	10.19	2.05
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“Societal human compensation costs”

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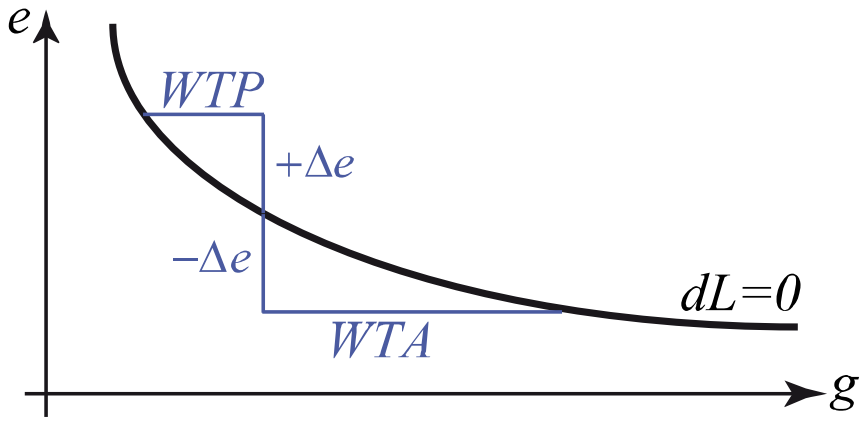
- Intertemporal aspects - No discounting & age-averaging - Non-marginal value for $de = \Delta e$ 			
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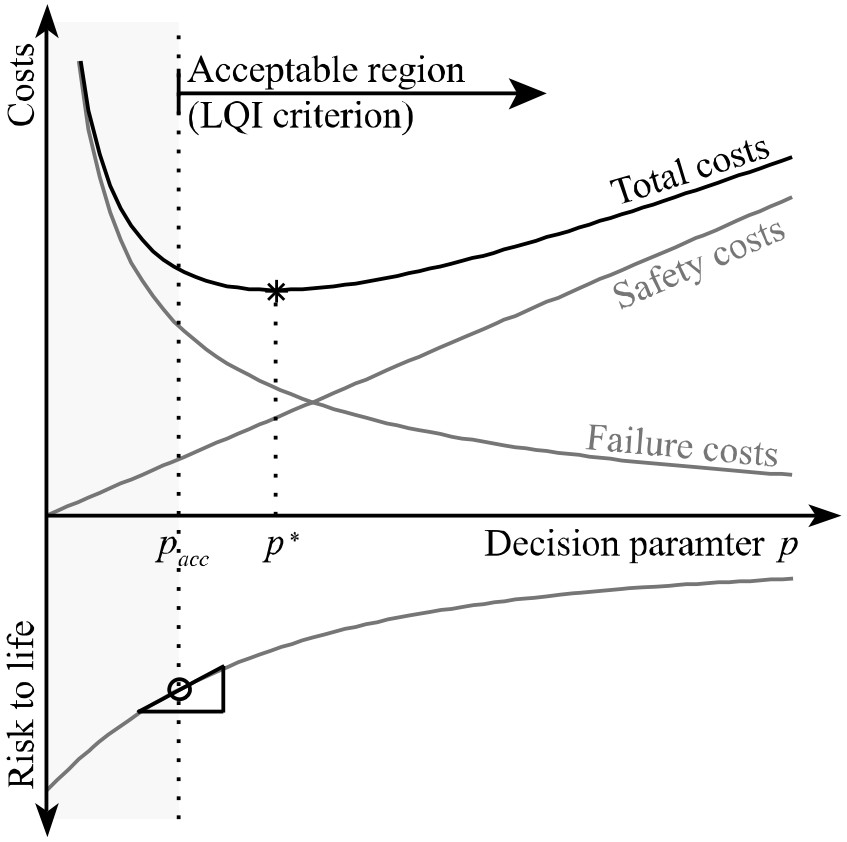
- ⇨ The $SWTP$, $SVSL$ and SHC values can be regarded to be consistent with the LQI formulation $L = g^q\overline{e}_d$.
- ⇨ The $ICAF$ and $SLSC$ values would have to be adapted to account for discounting, age-averaging and intertemporal consistency with L .
- ⇨ Influence of different H_C values for interaction between monetary optimization and the acceptance criterion $-dg \geq SWTP = \frac{g}{q}\frac{d\overline{e}_d}{\overline{e}_d}$???

Interaction LQI and optimization (societal decision-maker)



Monetary optimization:

$$\min_p \left\{ C(p) + R_M(p) + R_M(p) \cdot H_C \right\}$$

$$\Rightarrow \quad \frac{dC}{N_P} + \frac{dR_M}{N_P} + d\mu \cdot H_C = 0$$

LQI acceptance criterion:

$$-dg = \frac{dC}{N_P} \geq -d\mu \cdot SWTP\big|_{-d\mu=1} = SWTP$$

Optimal solution acceptable:

$$-\frac{dR_M}{N_P} - d\mu \cdot H_C \geq -d\mu \cdot SWTP\big|_{-d\mu=1}$$

Interaction LQI and optimization (societal decision-maker)

The LQI criterion is most likely to become active if there is no monetary benefit of increasing safety (i.e. $dR_M = 0$)

$$\Rightarrow \boxed{H_C \geq SWTP\big|_{-d\mu=1}}$$

The LQI criterion will never be active if the compensation costs are equal to or larger than the $SWTP$ to save one life!

Monetary optimization:

$$\min_p \left\{ C(p) + R_M(p) + R_M(p) \cdot H_C \right\}$$

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Conclusions

Starting point:

- LQI criterion / $SWTP$ with discounting and age-averaging
- For private decision-makers: LQI criterion as boundary condition.

Two possible approaches for societal decision-makers:

1) *Use $SWTP$ to monetize loss of life in the context of optimization*

   Defining the marginal life saving costs in the LQI criterion as "net marginal costs" leads to the same results.

2) *Use LQI as a societal boundary condition for optimization*

   LQI becomes active only if "societal human compensation costs" (e.g. SHC) are smaller than $SWTP$.