

A comparison of time-based maintenance and condition-based maintenance

Bram de Jonge Ruud Teunter
Warse Klingenberg Tiedo Tinga

University of Groningen
The Netherlands

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Introduction

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- ▶ Gradual deterioration, condition monitoring is possible.
- ▶ The cost of a breakdown is 1, after which a new unit is putting into use.
- ▶ Preventive maintenance can be performed at cost $c < 1$ and makes the unit as good as new.

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- ▶ Jump process with infinitely many jumps in any time interval.

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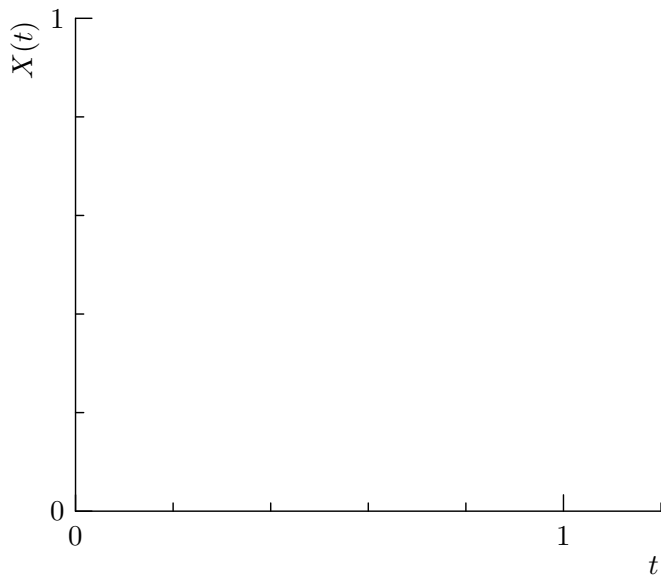
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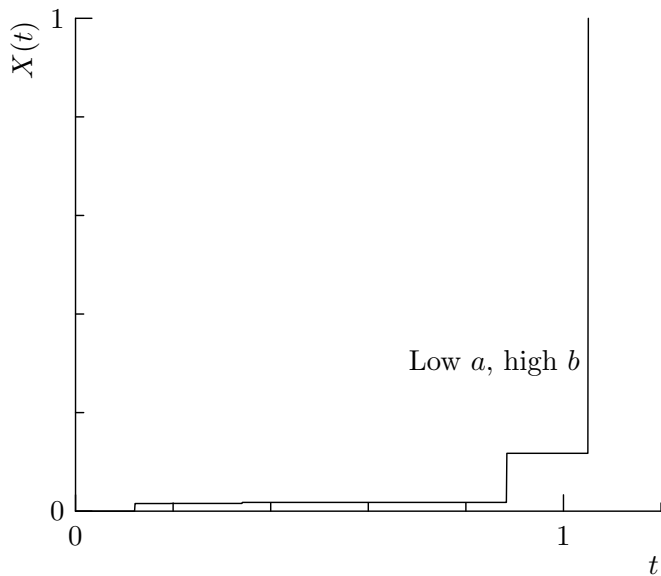
A breakdown is assumed to occur if the level of deterioration exceeds 1.

We choose a and b such that the mean time to failure equals 1 (this does not imply $ab = 1$).

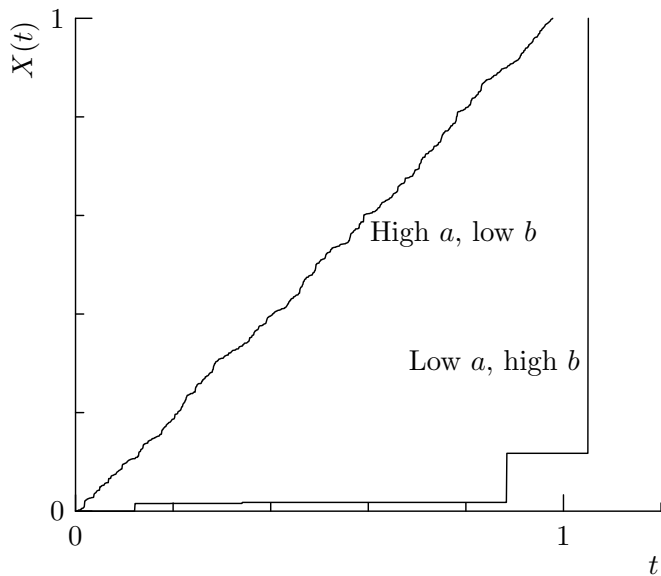
Gamma deterioration process



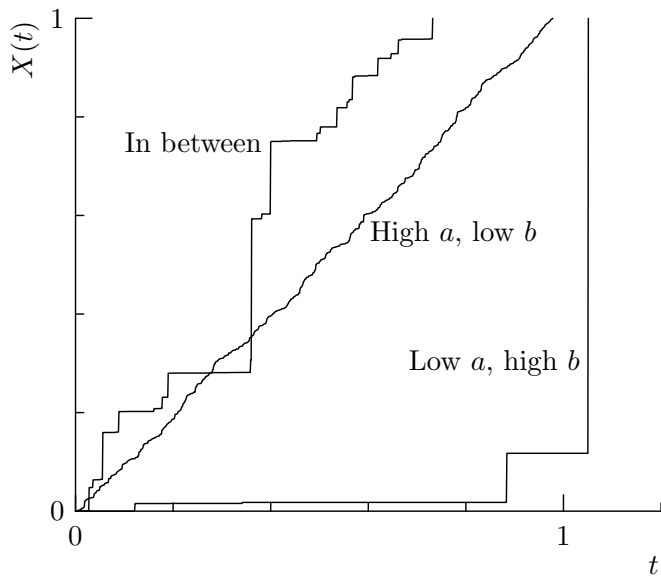
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- ▶ If the number of iterations is sufficiently high, the outcomes are very accurate.
- ▶ Simulation details:
 - ▶ Time step: $\Delta = 0.01$.
 - ▶ Number of iterations: $n = 100,000$.

Base case

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Gamma deterioration process:

- ▶ $a = 5$, $b \approx 0.2246$.

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Relative cost preventive maintenance:

- ▶ $c = 0.2$.

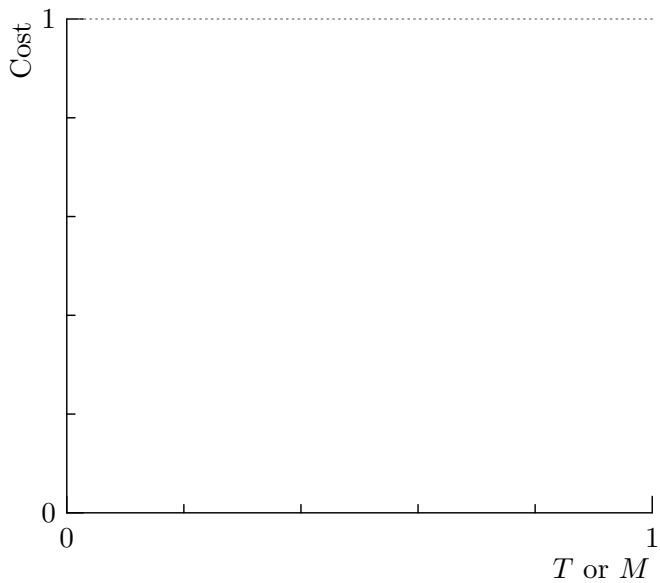
Cost analysis

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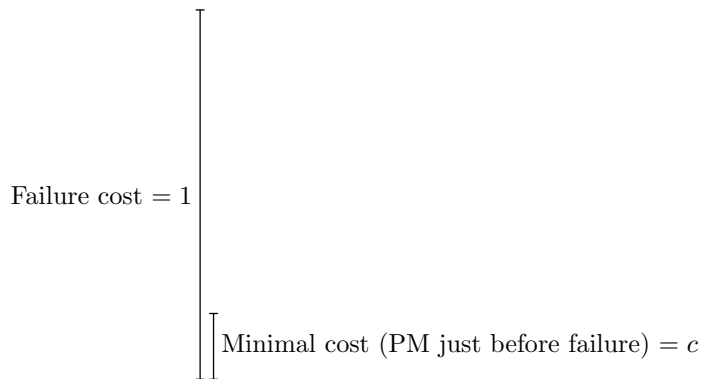
Failure cost = 1



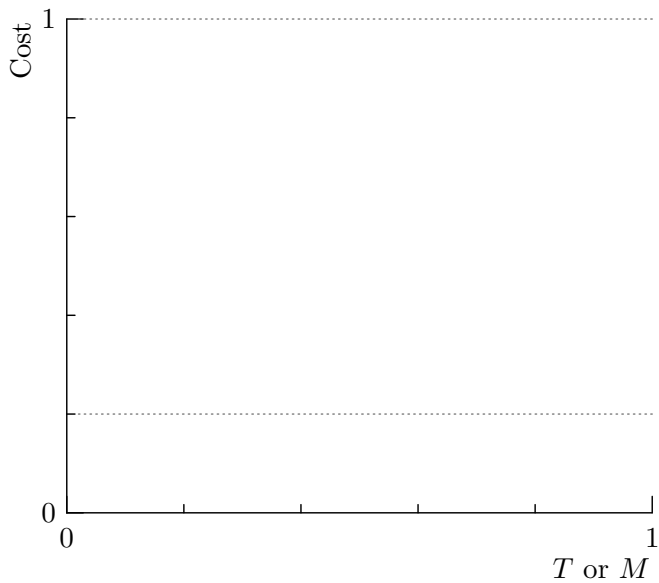
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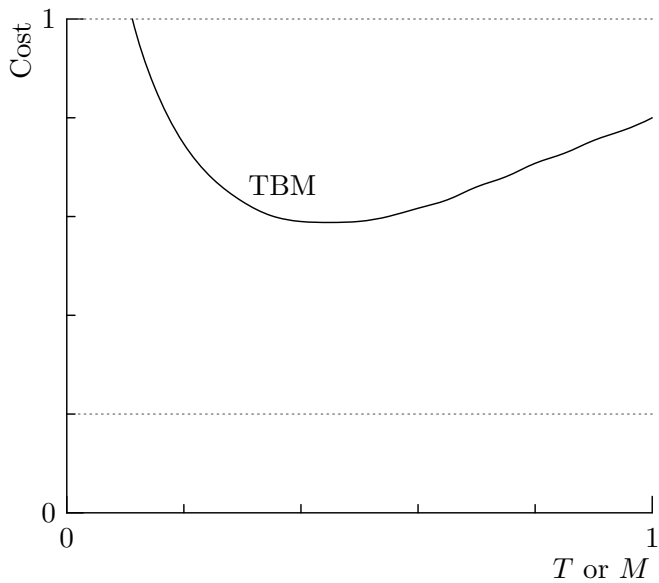
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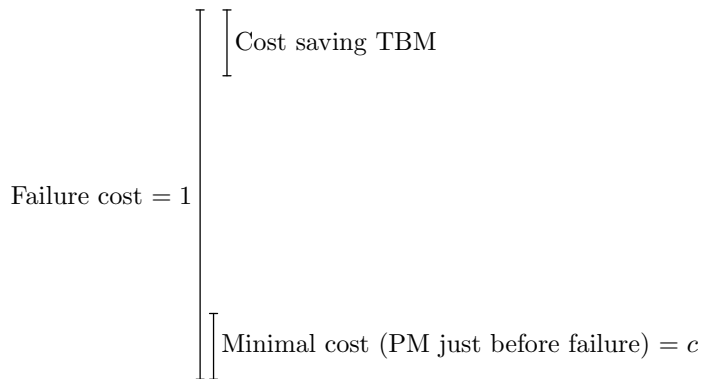
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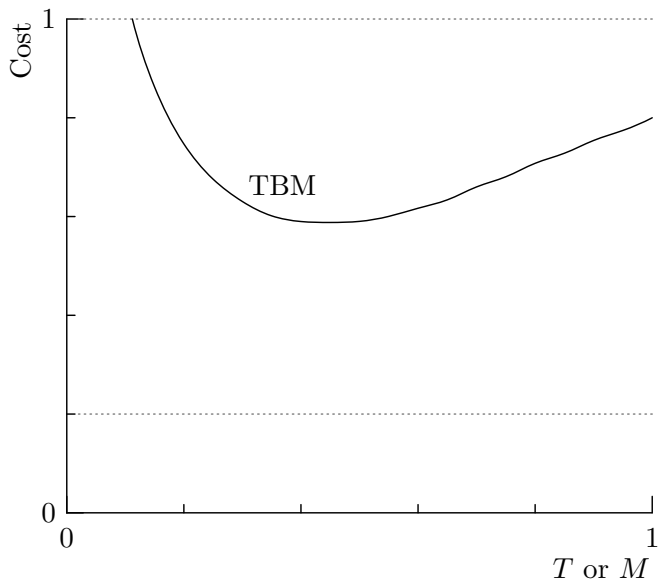
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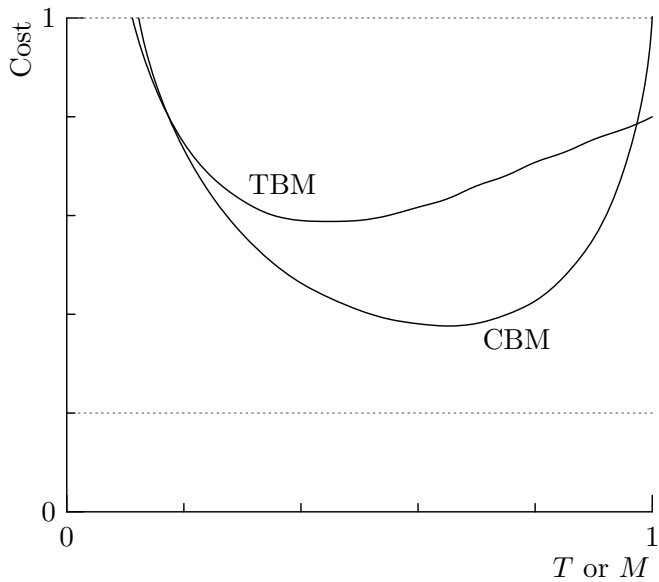
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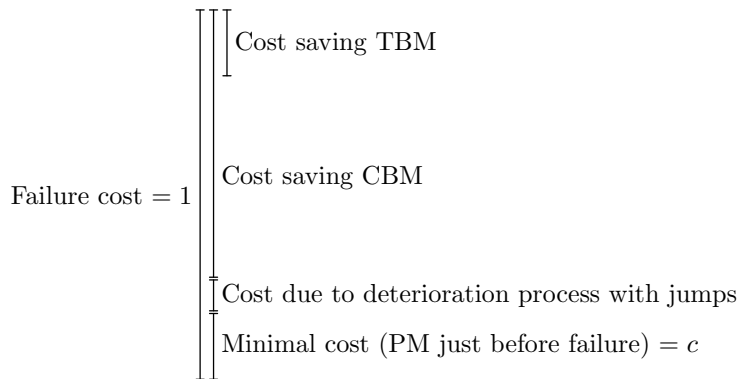
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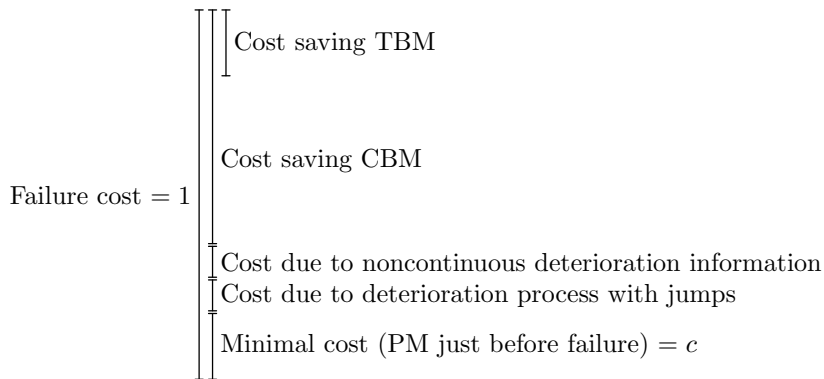
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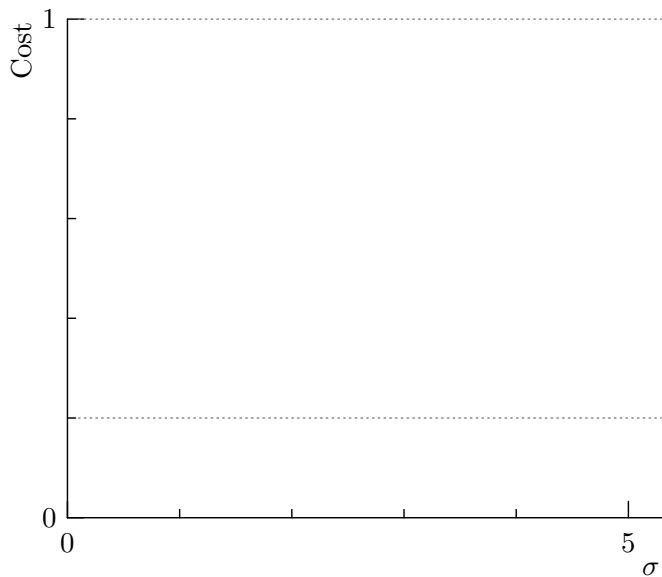
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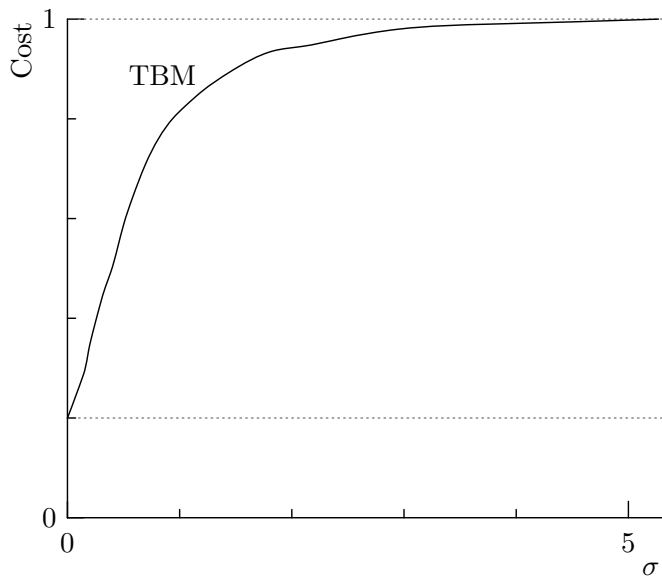
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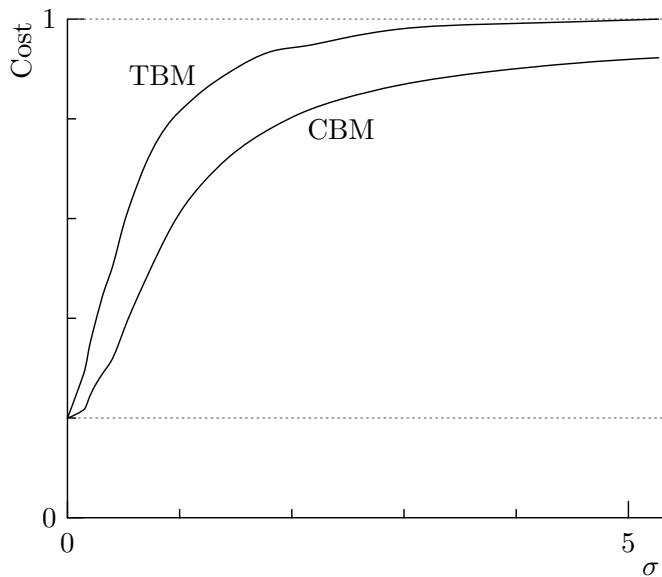
Effect of deterioration process



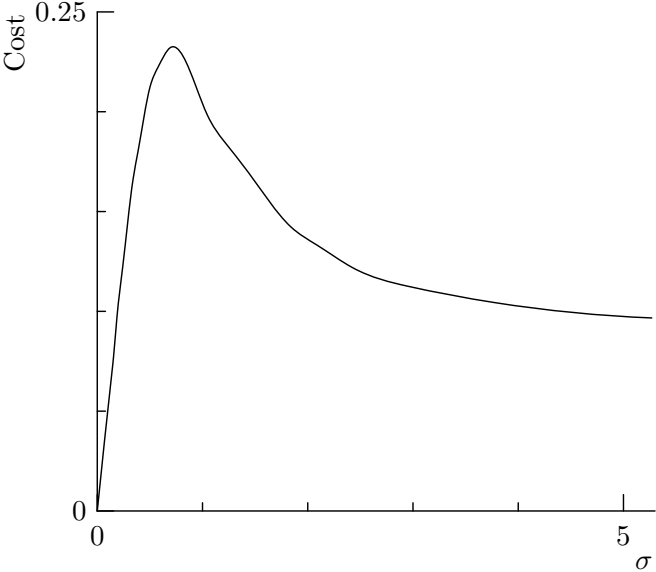
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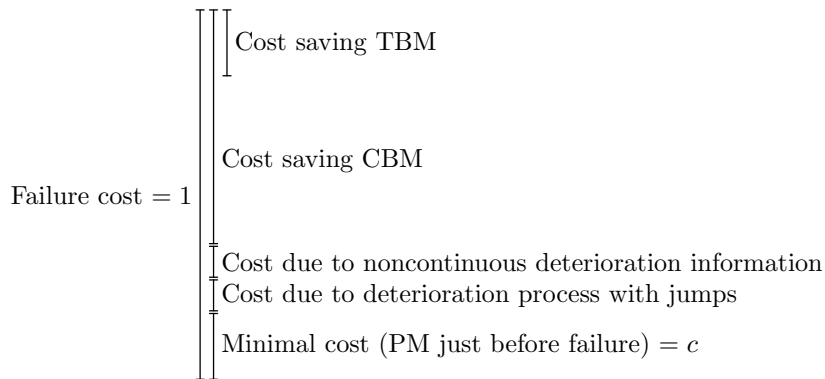
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Cost benefit CBM compared with TBM



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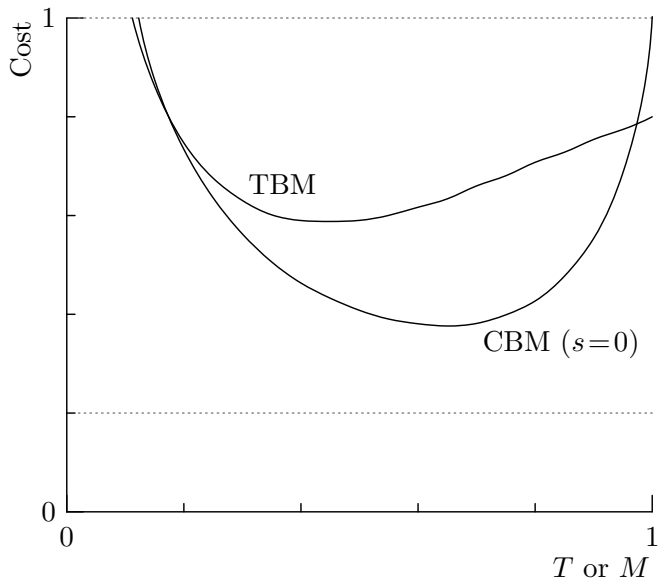
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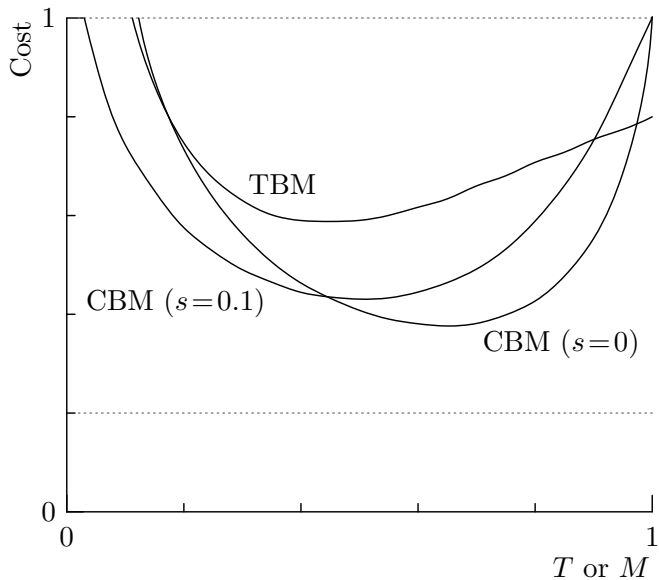
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- ▶ Under the CBM policy, maintenance is performed at time $t(M) + s$, with $t(M)$ the time at which deterioration level M is reached.
- ▶ The planning time s has no influence on the TBM policy.

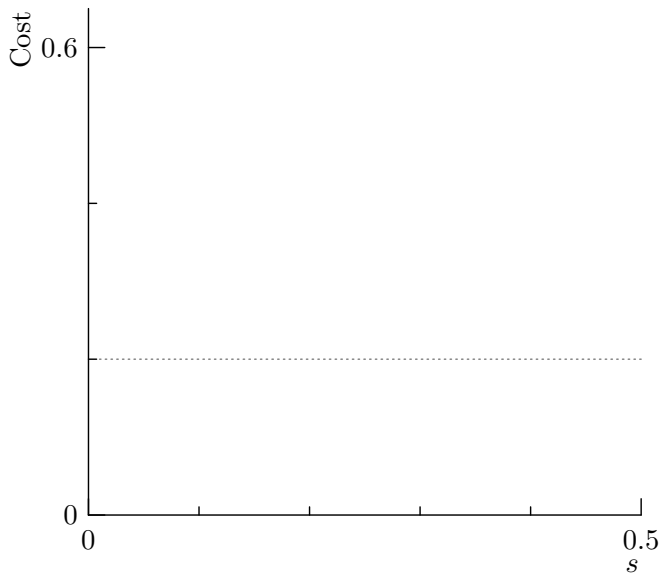
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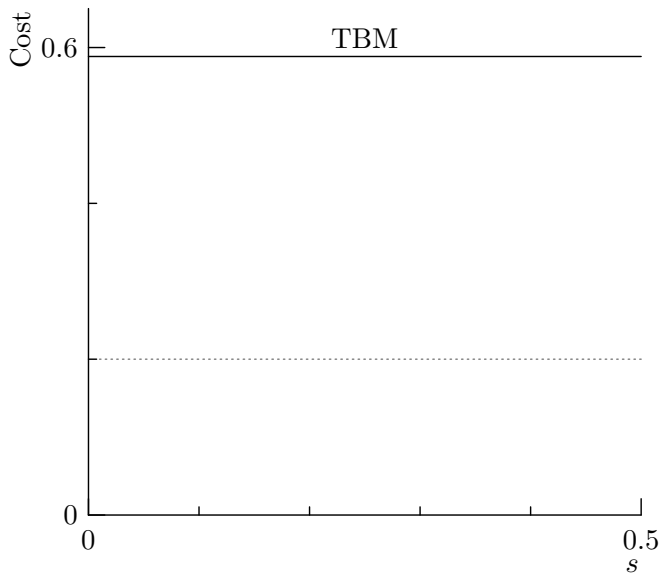
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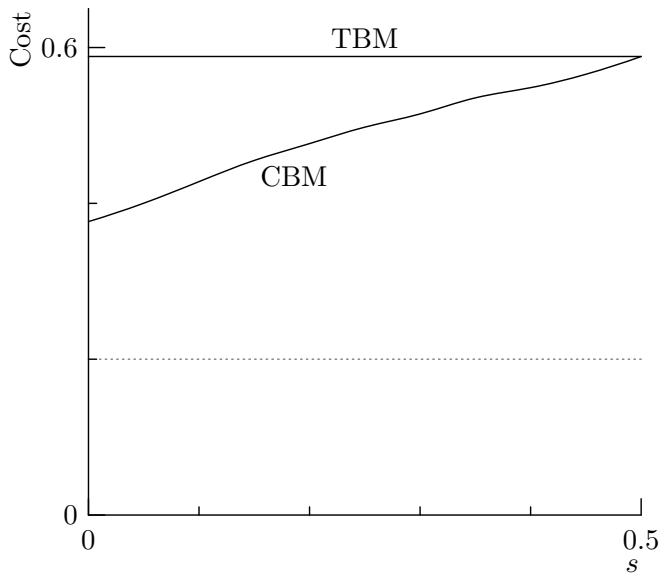
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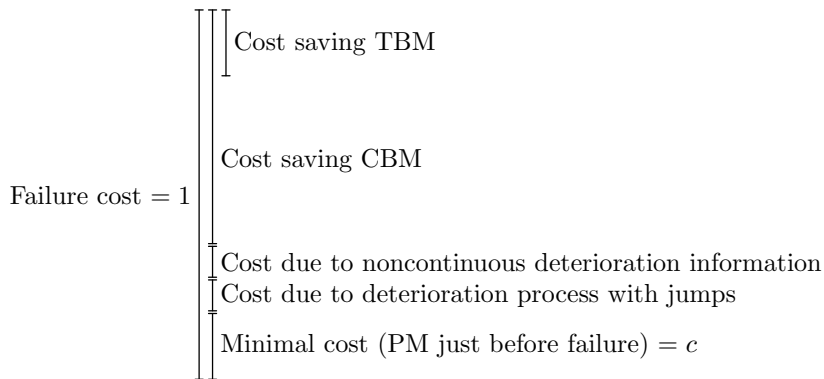
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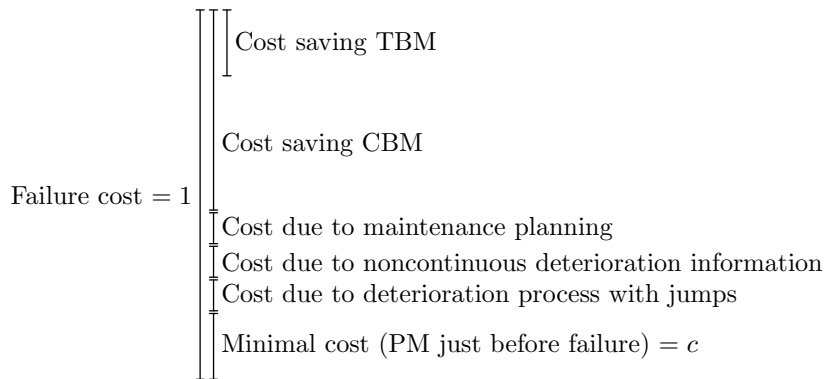
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Imperfect condition monitoring

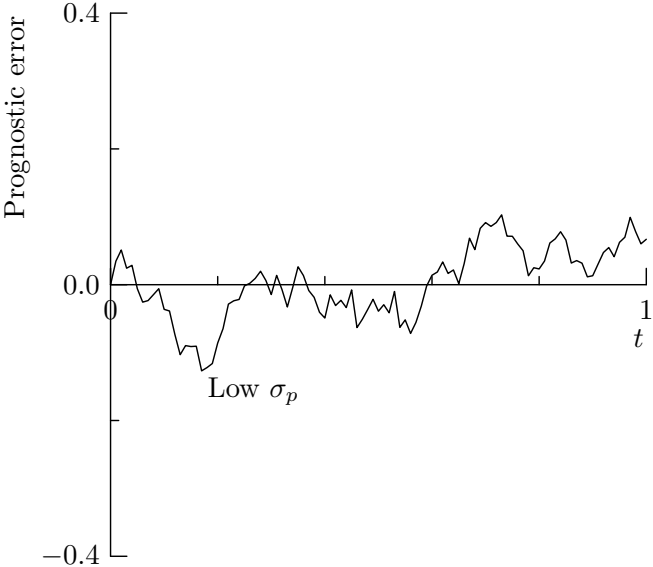
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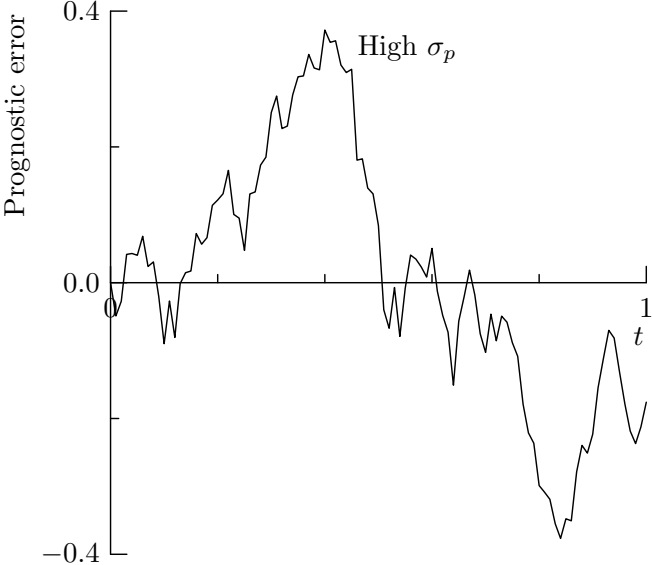
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- ▶ The difference between the true level of deterioration and the observed level of deterioration is modelled by $\sigma_p W(t)$.
- ▶ $W(t)$ is a standard Brownian motion.

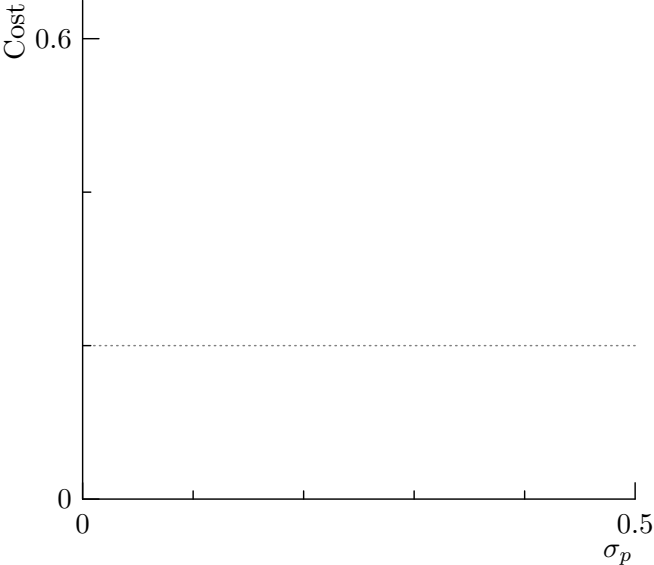
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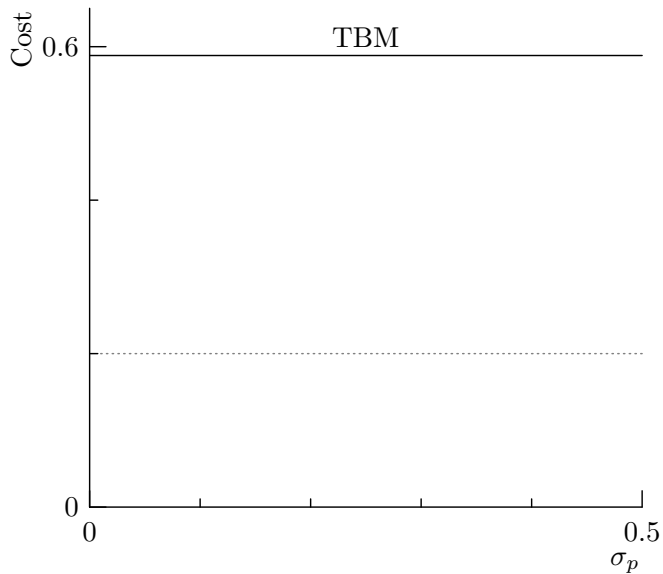
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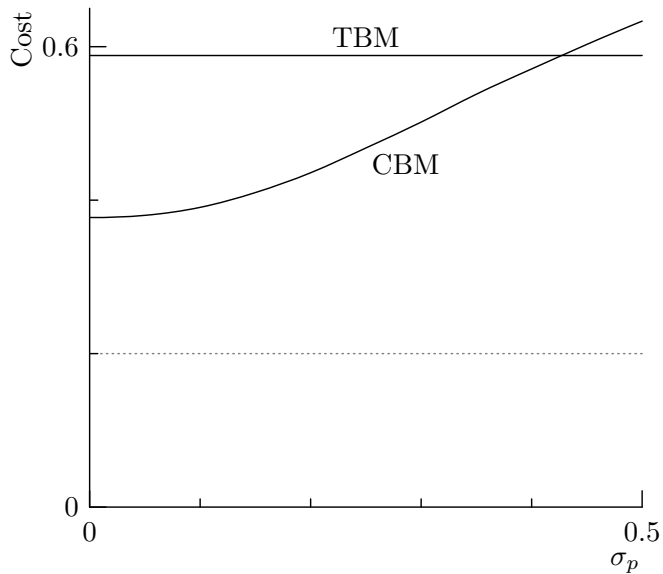
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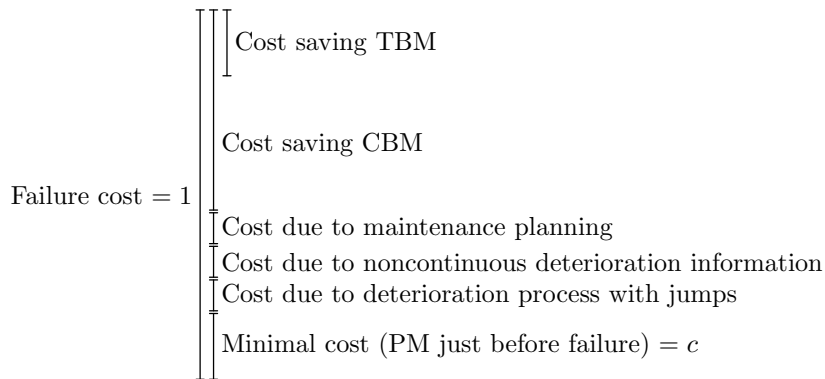
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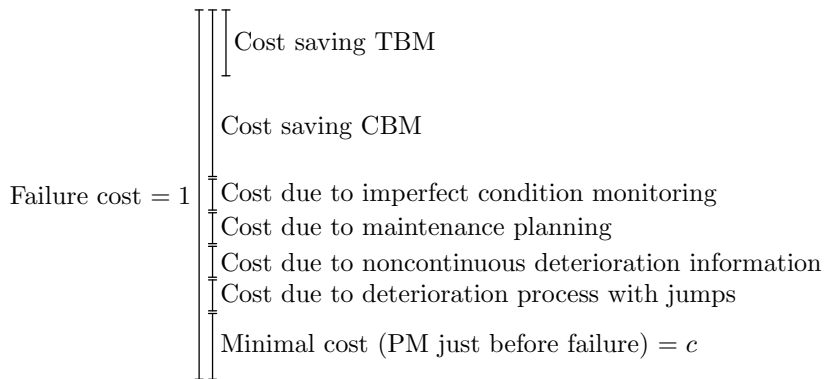
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Uncertainty deterioration level failure

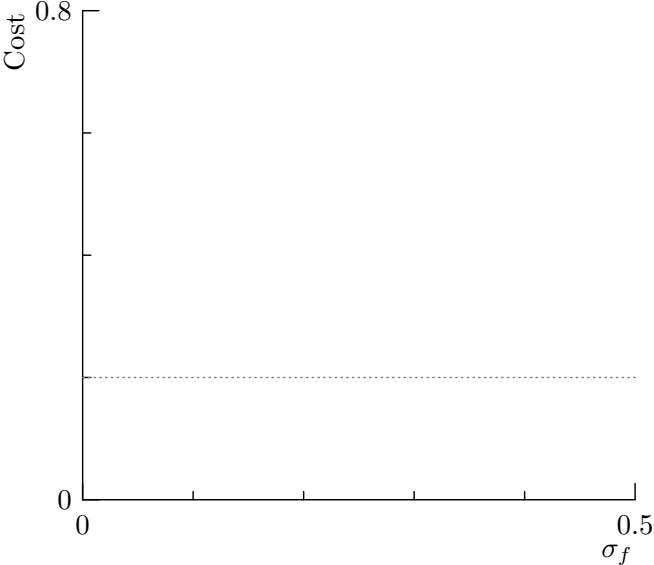
Uncertainty deterioration level failure

- ▶ The deterioration level at which failure occurs is normally distributed with mean 1 and standard deviation σ_f .

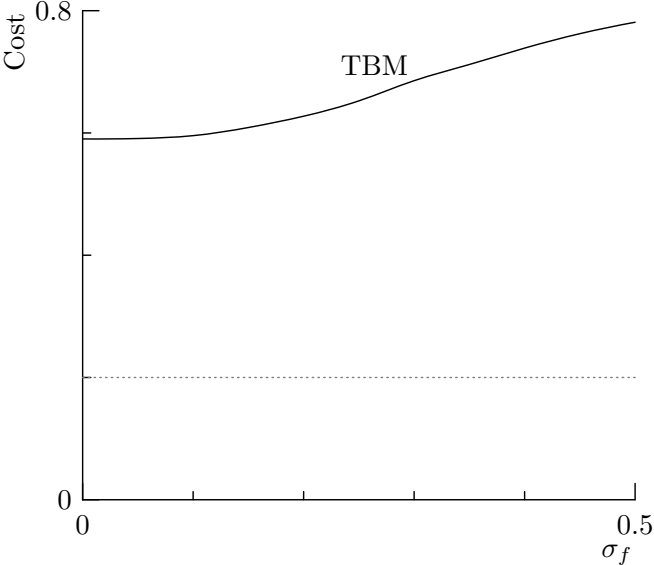
Uncertainty deterioration level failure

- ▶ The deterioration level at which failure occurs is normally distributed with mean 1 and standard deviation σ_f .
- ▶ The normal distribution is left truncated at 0 and right truncated at 2.

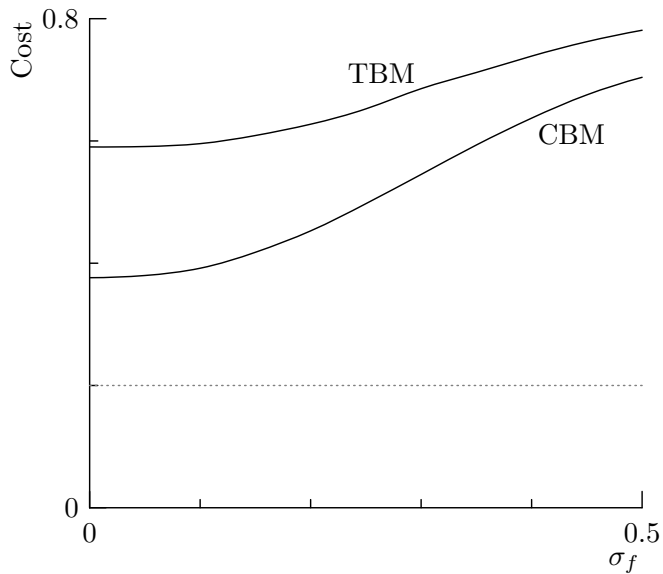
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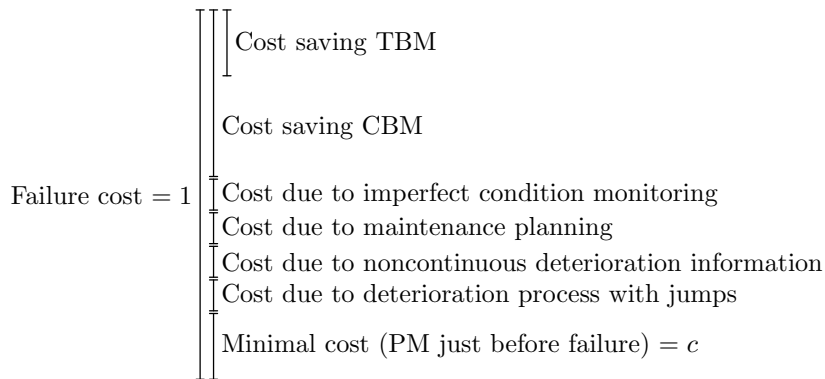
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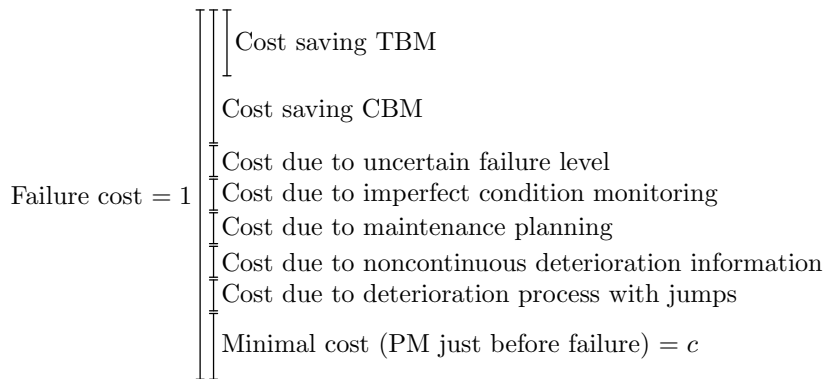
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Questions?

B.de.Jonge@rug.nl