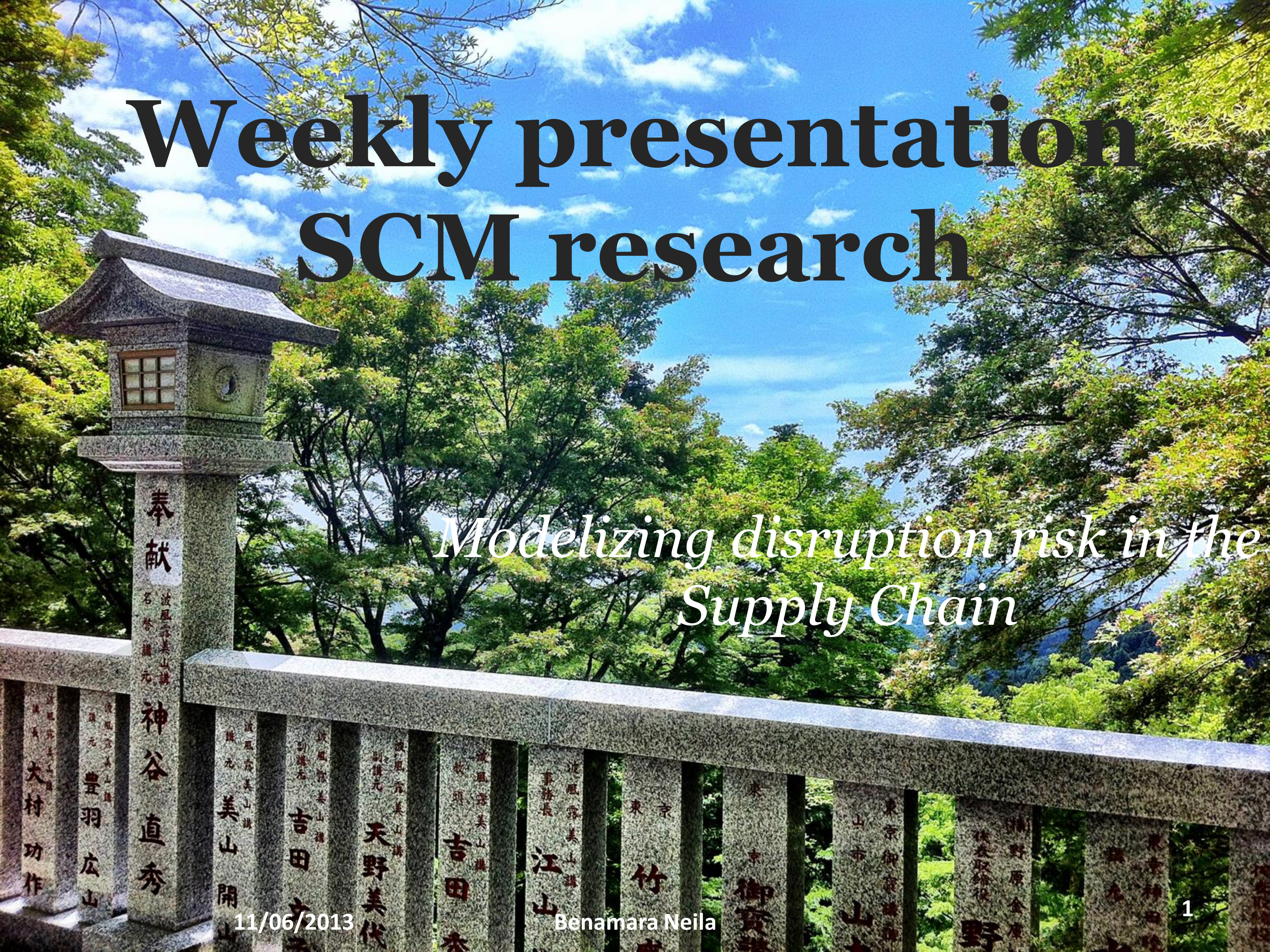


Weekly presentation SCM research

Modelizing disruption risk in the Supply Chain

Project

Build a supply chain design model risk management oriented

Consider disruption rates to select the best options as to minimize the entire Supply Chain disruption probability

Single sourcing/ Dual sourcing

Then implement it in the Graves model, with disruption rate as a supplementary option's parameter

Model

- *ON/OFF cycles*

- *Each option characterized by the parameters*

$$(\lambda, \psi)$$

disruption rate *recovery rate*

- *Expected duration of a ON cycle is 1/λ and OFF cycle 1/ ψ*

- *Duration of the cycles exponentially distributed*

Single sourcing

- *<u>Assumption</u>: at most one option can be disrupted*
- *The Supply Chain thus becomes disrupted as well (everything stops, no profit during this period)*
- *1 option j selected for each stage i*
- *Functionnal equation:*

  $$P(SC{=}OFF) = P\left(\bigcup_i Xi = OFF\right)$$
  $$= \sum_i P(Xi = OFF)$$

$$\min_{(\lambda i,\psi i)} \sum_i \frac{\lambda i}{\lambda i + \psi i}$$

Dual sourcing

- *<u>Assumption</u>: at most one option can be disrupted*
- *The Supply Chain thus NEVER becomes disrupted (as the other option of the stage will still be ON)*
- *2 options (λi,ψi) and (αi,βi) selected for each stage i*
- *Functionnal equation:*

  P(SC=OFF) =0

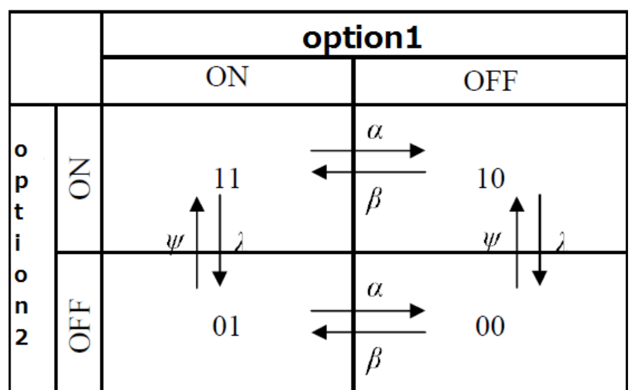
  P(1 option = OFF) $= P(\bigcup_i Xi = \text{"}OFF\text{"})$

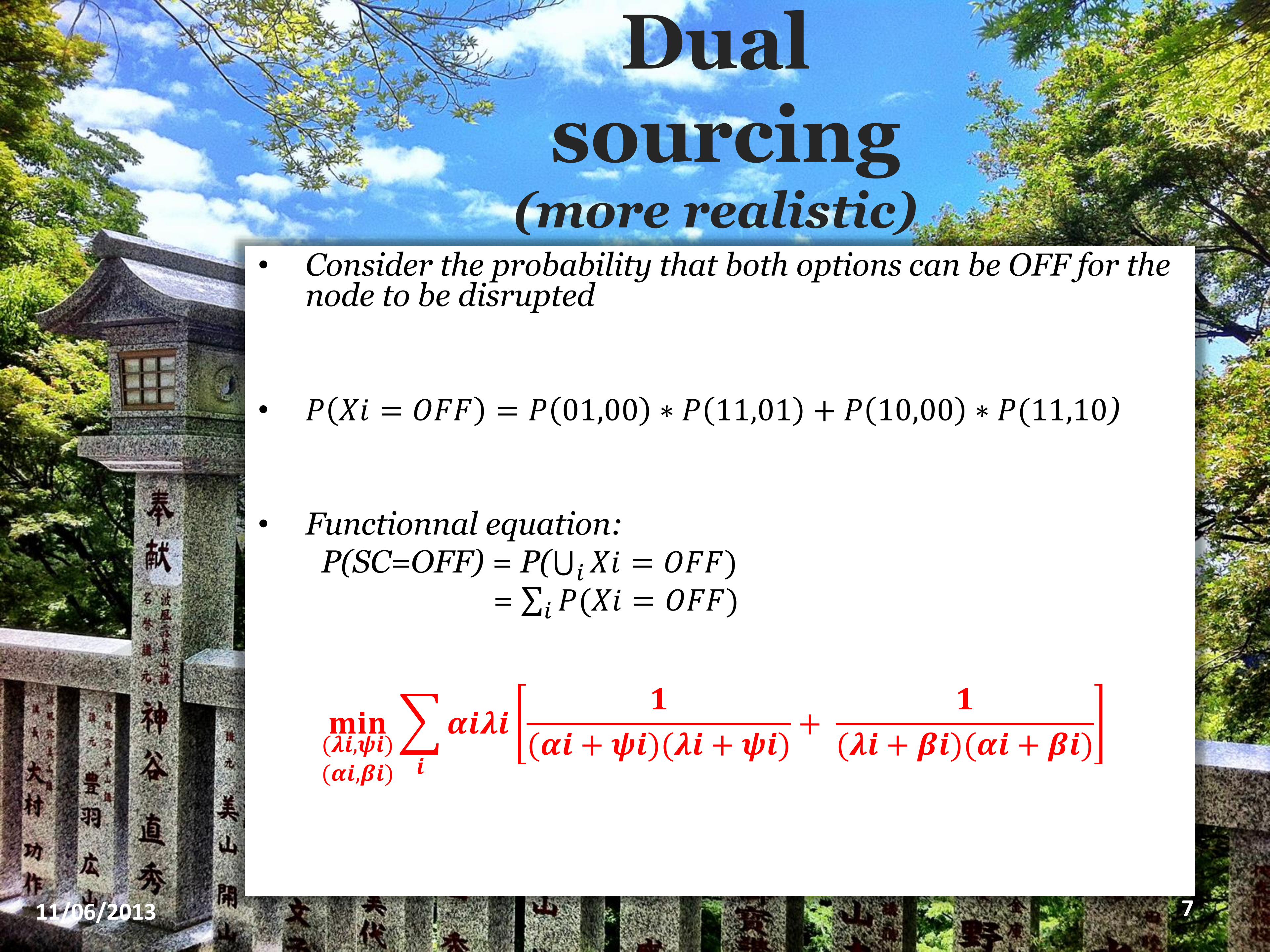
  $= \sum_i P(Xi = \text{"}OFF\text{"})$

$$\min_{\substack{(\lambda i,\psi i)\\(\alpha i,\beta i)}} \sum_i \frac{\lambda i}{\lambda i + \psi i} + \frac{\alpha i}{\alpha i + \beta i}$$

Dual sourcing *(more realistic)*

- *<u>Assumption</u>: at most one node can be disrupted,which happens only when both options are disrupted*
- *The Supply Chain thus can be disrupted in this case (minimize this probability)*
- *2 options (λi,ψi) and (αi,βi) selected for each stage i*
- *4 state Markov Chain, {00,01,10,11}*





Dual sourcing *(more realistic)*

- *Consider the probability that both options can be OFF for the node to be disrupted*

- $P(Xi = OFF) = P(01,00) * P(11,01) + P(10,00) * P(11,10)$

- *Functionnal equation:*

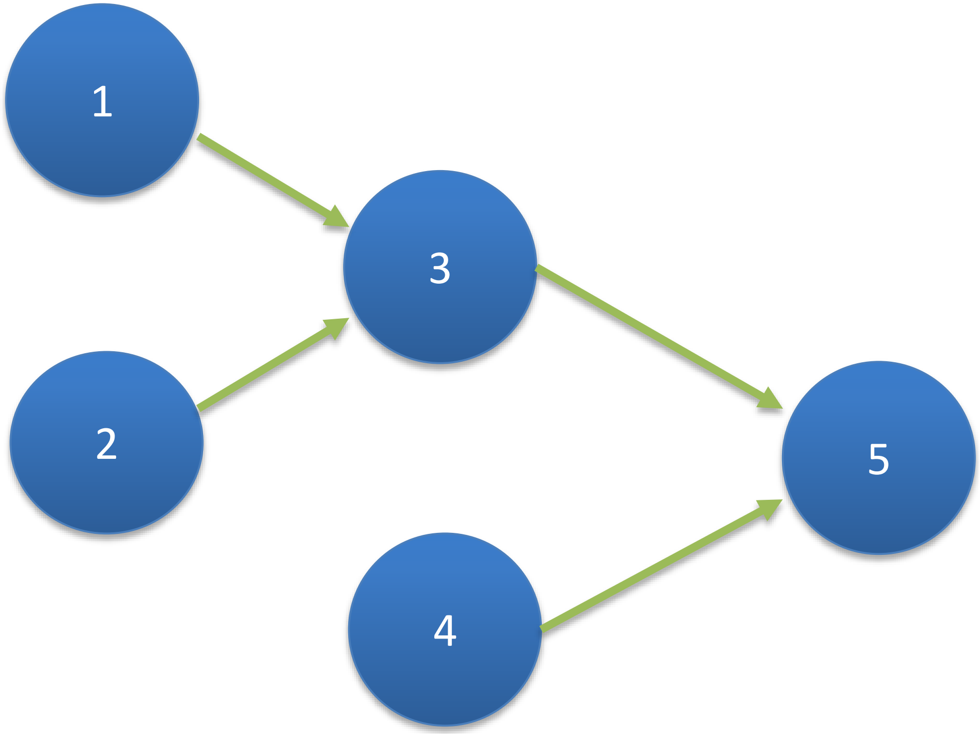
  $P(SC{=}OFF) = P(\cup_i Xi = OFF)$

  $= \sum_i P(Xi = OFF)$

$$\min_{\substack{(\lambda i, \psi i)\\(\alpha i, \beta i)}} \sum_i \alpha i \lambda i \left[\frac{1}{(\alpha i + \psi i)(\lambda i + \psi i)} + \frac{1}{(\lambda i + \beta i)(\alpha i + \beta i)}\right]$$

Simple Simulations

- *Supply Chain network (5 nodes, 4 options at each)*



Simple Simulations

- ***Results***

  - *Single sourcing*
    $P(SC = OFF) = 0.465557$

  - *Dual sourcing*
    $P(SC = OFF) = 0$
    $P(1 \text{ option is } OFF) = 1.633458$

  - *Dual sourcing (more realistic)*
    $P(SC = OFF) = 0.032104$

Next Steps

- *Consider disruption at supply chain design phase in Grave's model*

  Integrate disruption parameter in the options' choice

- *Compare with Seiji's results (consider disruptions effect on the operational phase only)*

Thank you for your attention