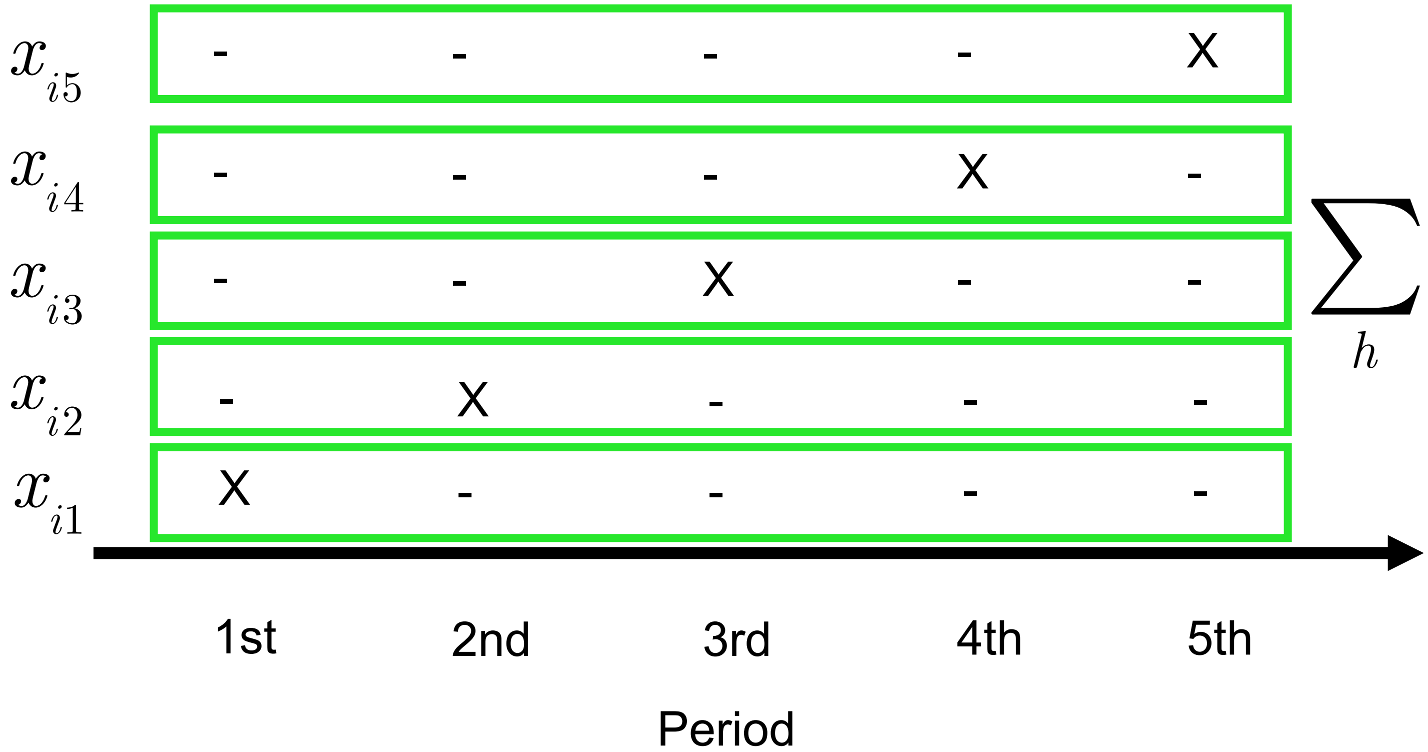
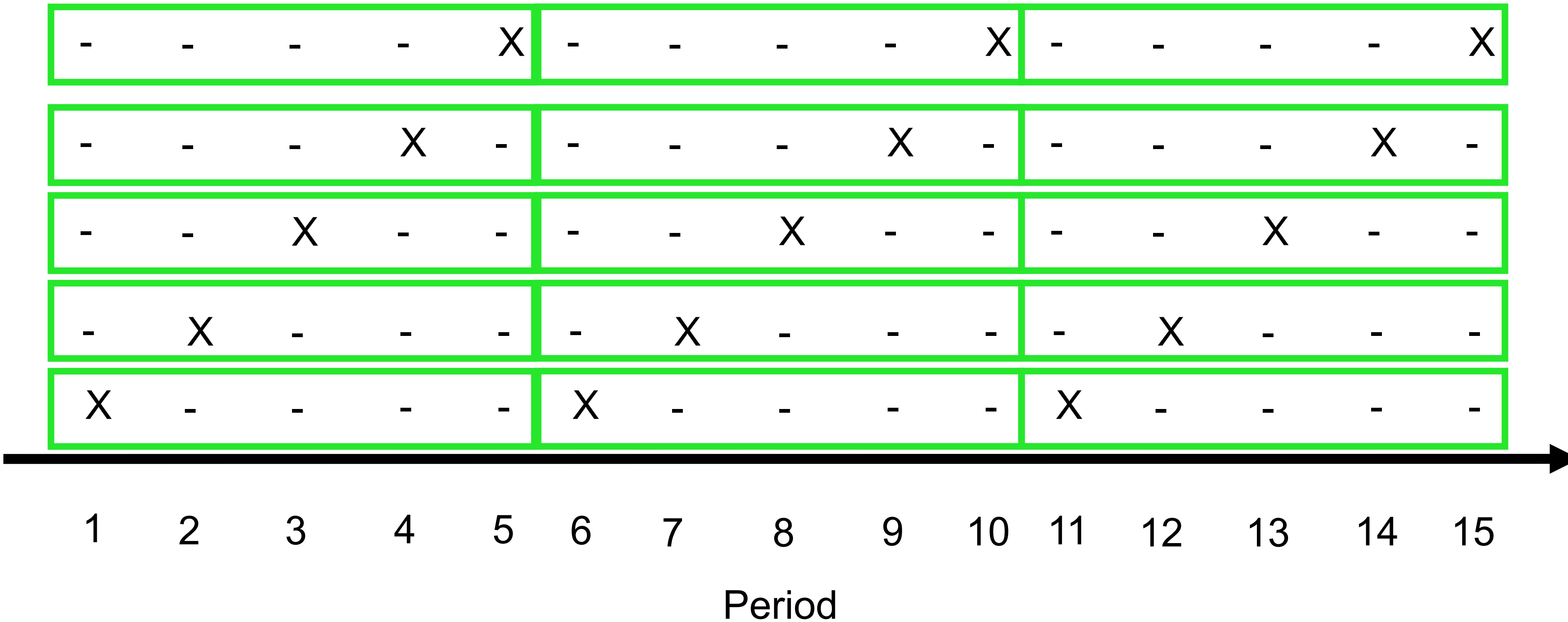
Model II Formulation

Harvest decision is defined period by period



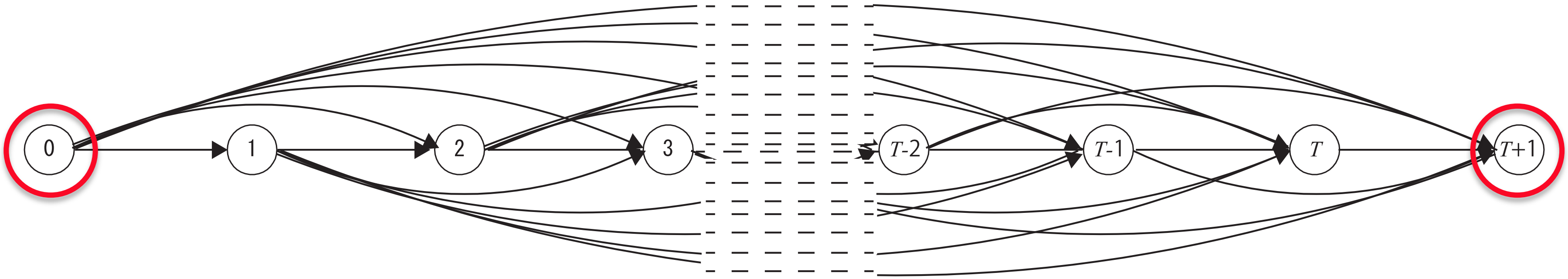
$$\sum_h x_{ih} \leq 1$$

How can we differentiate multiple harvests?



Decision Network

one-state and one-stage dynamic network



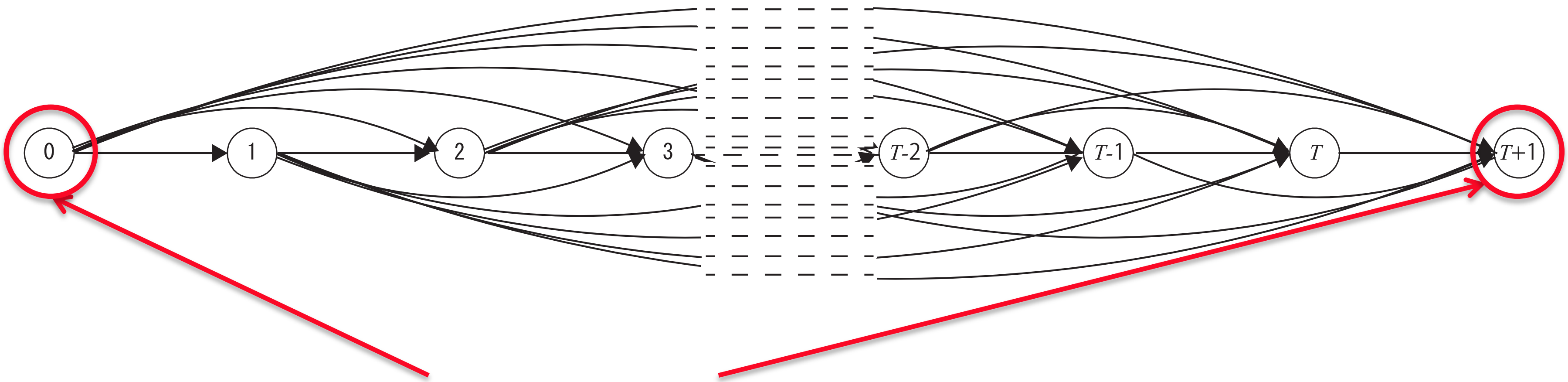
Dynamic Treatment

x^i_{ts} : portion of i-th unit planted at period t to be harvested at period s

Flow Balance Constraints

$$\sum_{t=0}^{\max(0,s-k)} x^i_{ts} = \sum_{t=\min(s+k,T+1)}^{T+1} x^i_{st}, \quad \forall i, s = 1,\ldots,T$$

Inflow = Outflow with *k* as minimum rotation period



$$\sum_{t=1}^{T+1} x^{i}_{0t} = \sum_{t=0}^{T} x^{i}_{t(T+1)} = 1, \qquad \forall i$$

Start and Ending Constraints like Land Accounting

Model II

Max NPV

$$Z = \max \sum_{i=1}^{m} \sum_{t=1}^{T+1} \sum_{s=0}^{\max(0,t-k)} c_{st}^{i} \cdot x_{st}^{i}$$

$st.$

$$\sum_{\tau=0}^{\max(0,s-k)} x_{\tau s}^{i} = \sum_{t=s+k}^{T+1} x_{st}^{i}, \qquad \forall i, \forall s = 1, \dots, T-k$$

Flow Balance Constraints

$$\sum_{t=1}^{T+1} x_{0t}^{i} = \sum_{s=0}^{T} x_{s(T+1)}^{i} = 1, \qquad \forall i$$

$$\sum_{i=1}^{m} \sum_{s=0}^{\max(0,t-k)} v_{st}^{i} \cdot x_{st}^{i} = \sum_{i=1}^{m} \sum_{s=0}^{\max(0,t-k)} v_{s(t+1)}^{i} \cdot x_{s(t+1)}^{i}, \; t = 1, \dots, T-1$$

Harvest Flow Constraints

c_{ts}^{i} : NPV of i-th unit planted at period t to be harvested at period s

v_{ts}^{i} : volume of i-th unit planted at period t to be harvested at period s

Spatial Constrained Model II Formulation

Model II

Max NPV

$$Z = \max \sum_{i=1}^{m} \sum_{t=1}^{T+1} \sum_{s=0}^{\max(0,t-k)} c_{st}^{i} \cdot x_{st}^{i}$$

$st.$

$$\sum_{t=0}^{\max(0,s-k)} x_{ts}^{i} = \sum_{t=s+k}^{T+1} x_{st}^{i}, \qquad \forall i, \forall s = 1, \ldots, T-k$$

Flow Balance Constraints

$$\sum_{t=1}^{T+1} x_{0t}^{i} = \sum_{s=0}^{T} x_{s(T+1)}^{i} = 1, \qquad \forall i$$

$$(1-\alpha) \cdot v_0 \le \sum_{i=1}^{m} \sum_{s=0}^{\max(0,t-k)} v_{st}^{i} \cdot x_{st}^{i} \le (1+\alpha) \cdot v_0, t = 1, \ldots, T$$

Harvest Flow Constraints

$$x_{ts}^{i} = \begin{cases} 1 & \text{if } i\text{-th unit planted at period } t \text{ to be harvested at period } s \\ 0 & \text{otherwise} \end{cases}$$

Comparison of Model I & II

Model I

$$Z = \max_{\{x_{ih}\}} \sum_{i=1}^{m} \sum_{h=1}^{H} c_{ih} \cdot x_{ih}$$

$st.$

$$\sum_{h=1}^{H} x_{ih} \leq 1, \qquad \forall i$$

$$(1-\alpha)v_0 \leq \sum_{i=1}^{m} \sum_{h=1}^{H} v_{ij}^{p} \cdot x_{ij} \leq (1+\alpha)v_0$$

$$(p = 1, \cdots, T)$$

Model II

$$Z = \max \sum_{i=1}^{m} \sum_{t=1}^{T+1} \sum_{s=0}^{\max(0,t-k)} c_{st}^{i} \cdot x_{st}^{i}$$

$st.$

$$\sum_{t=0}^{\max(0,s-k)} x_{ts}^{i} = \sum_{t=s+k}^{T+1} x_{st}^{i}, \qquad \forall i, \forall s = 1, \ldots, T-k$$

$$\sum_{t=1}^{T+1} x_{0t}^{i} = \sum_{s=0}^{T} x_{s(T+1)}^{i} = 1, \qquad \forall i$$

$$(1-\alpha) \cdot v_0 \leq \sum_{i=1}^{m} \sum_{s=0}^{\max(0,t-k)} v_{st}^{i} \cdot x_{st}^{i} \leq (1+\alpha) \cdot v_0$$

$$(t = 1, \ldots, T)$$

End of Harvest Scheduling 101

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