Dynamic Efficiency for Stock Pollutants

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Motivation and key results (1)

- Usual view in the sparse "text book" like literature: static efficiency through time
  - teaching implications
- Stock pollutants complicate matters

  :: what not abated today carries over to future time periods
  - … "carry overs" to our understanding of efficiency in a general context?
  - … very visible for cost effectiveness (least cost way of reducing emissions): only cost considerations – trade-offs over time (trivial)
  - … more intriguing for efficiency/optimality

… motivation and key results (2)

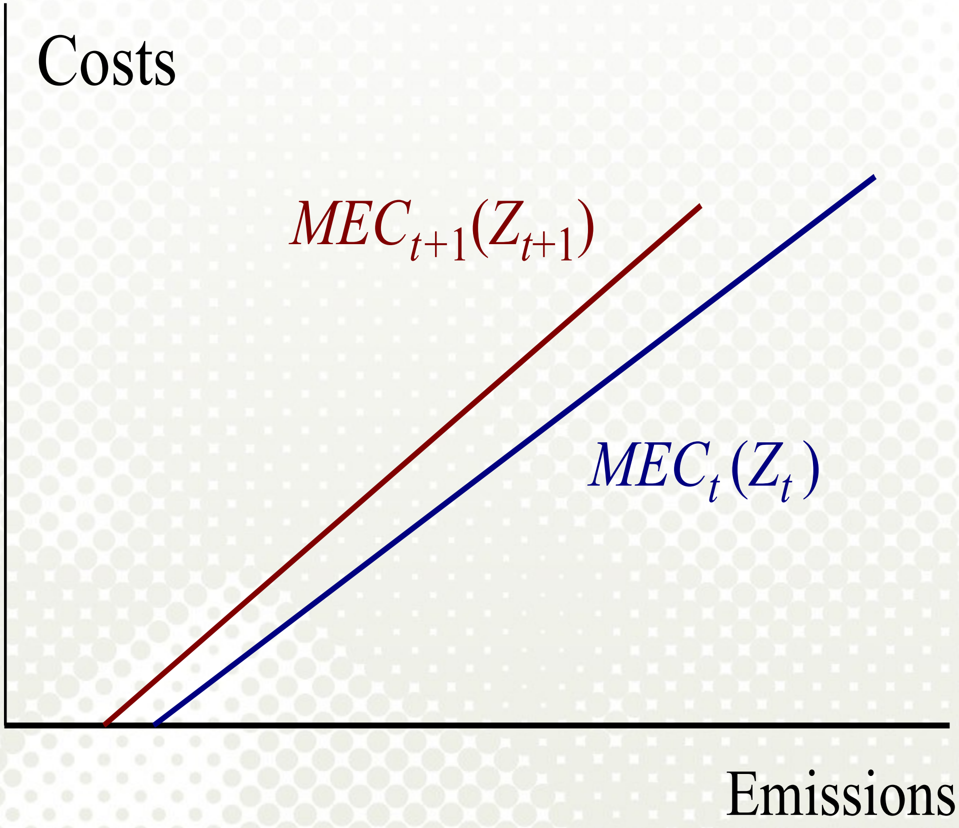
- Dynamic cost effectiveness = least cost:
  - Cost effectiveness across agents (equal MACs)
  - Time indifference: $p_t = (1+r)^t p_0$
  - Time rules … (when the static part OK)
- Dynamic efficiency/optimality
  - Coincidence if static optima were placed on the price path $p_t = (1+r)^t p_0$ through time
  - → trade-off static DW-losses vs. costs being off the time indifference path (Hotelling price path)

Outline

- Stock effects
- Time indifference
- Dynamic cost effectiveness
- Dynamic optimality
- Implications

Stock effects

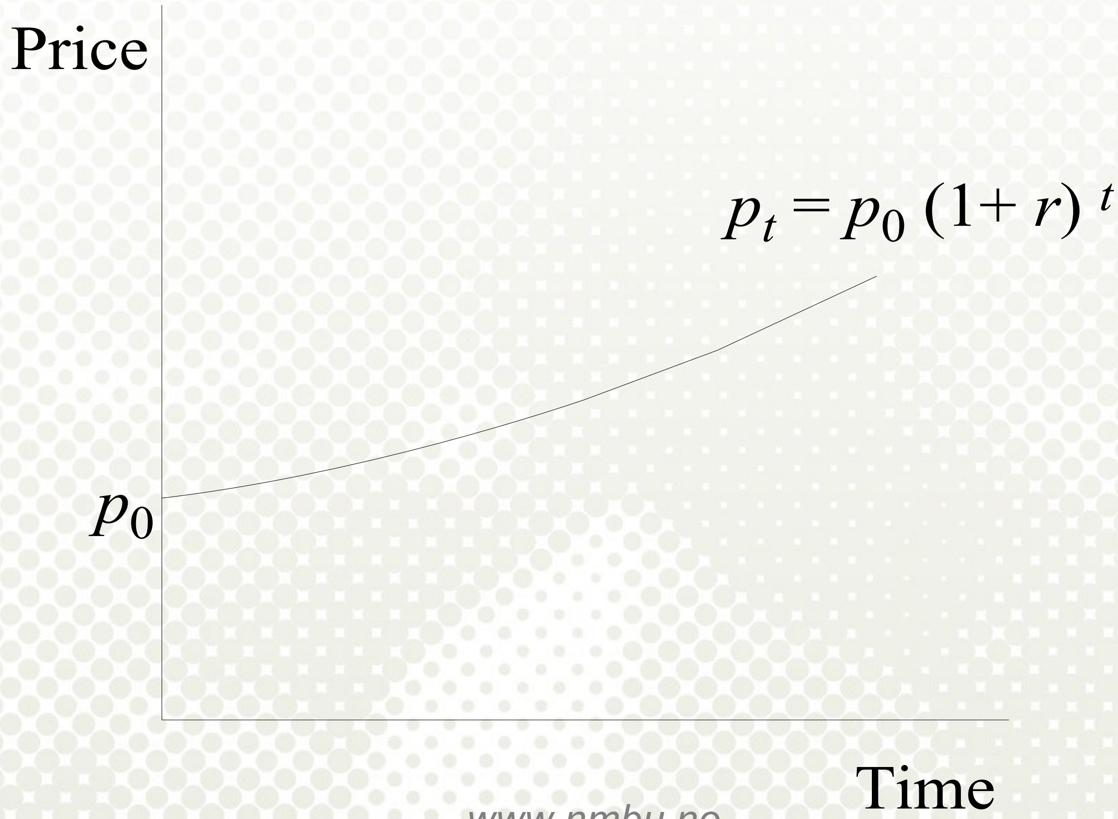
- Net emissions carry over to future periods :: MEC_{t+1}(accumulated past net emissions)
  - shifts back and rotates the MEC
  - dynamic analysis



Time indifference

- Hotelling price path $p_t = (1+r)^t p_0$

  for agents to be indifferent between selling/ buying a good in time period *t* or 0.



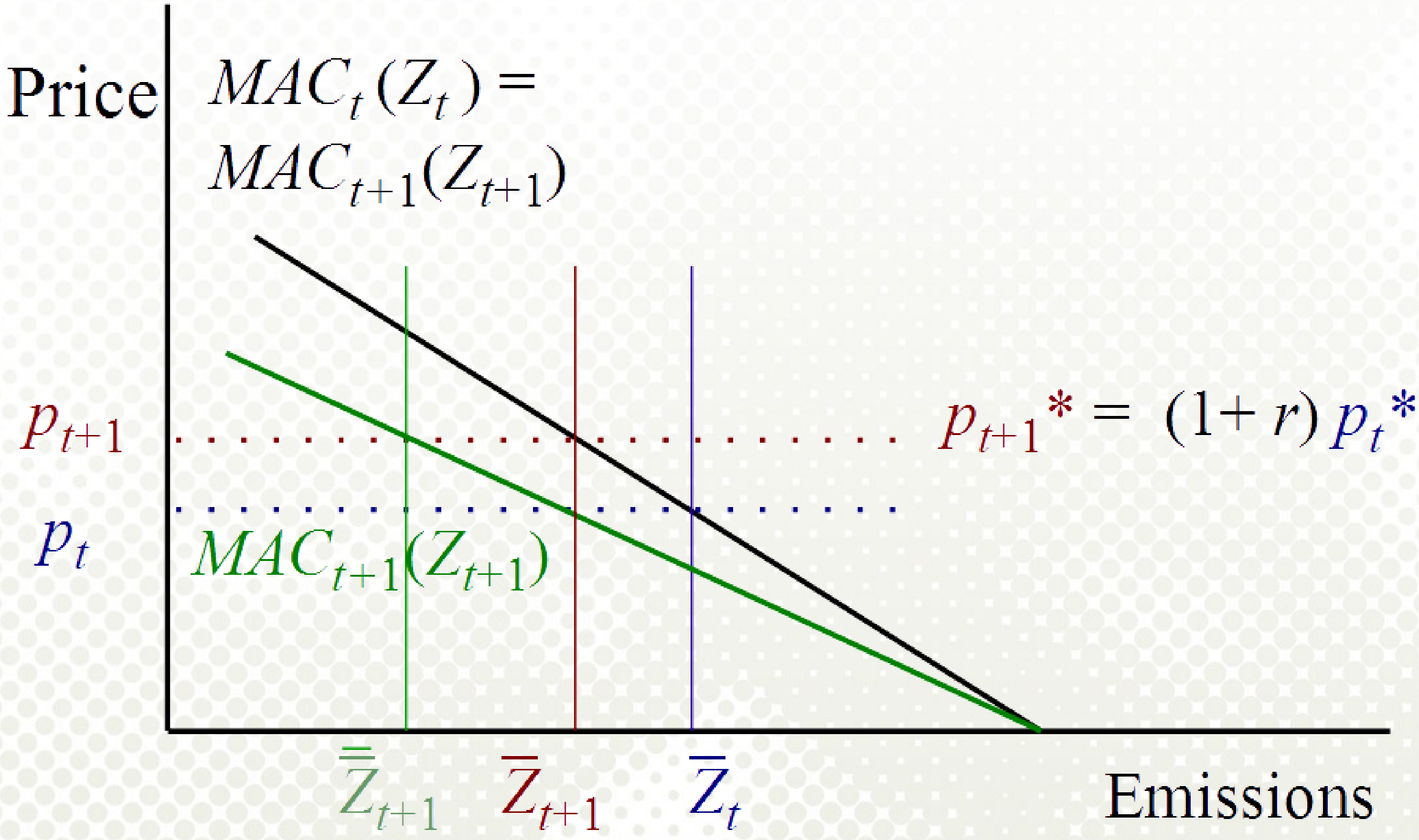
Dynamic cost effectiveness (1)

- Statics: equal marginal abatement costs for each agent, evaluated at that agents emission level :: $MAC_i(z_i^*) = MAC_j(z_j^*)$
  - absence of arbitrage between agents

- Dynamic cost effectiveness = absence of arbitrage over time

$$MAC_{t+1}(z_{t+1}^*) = (1+r)\, MAC_t(z_t^*)$$

… dynamic cost effectiveness (2)



Dynamic optimality (1)

- Static optimality:

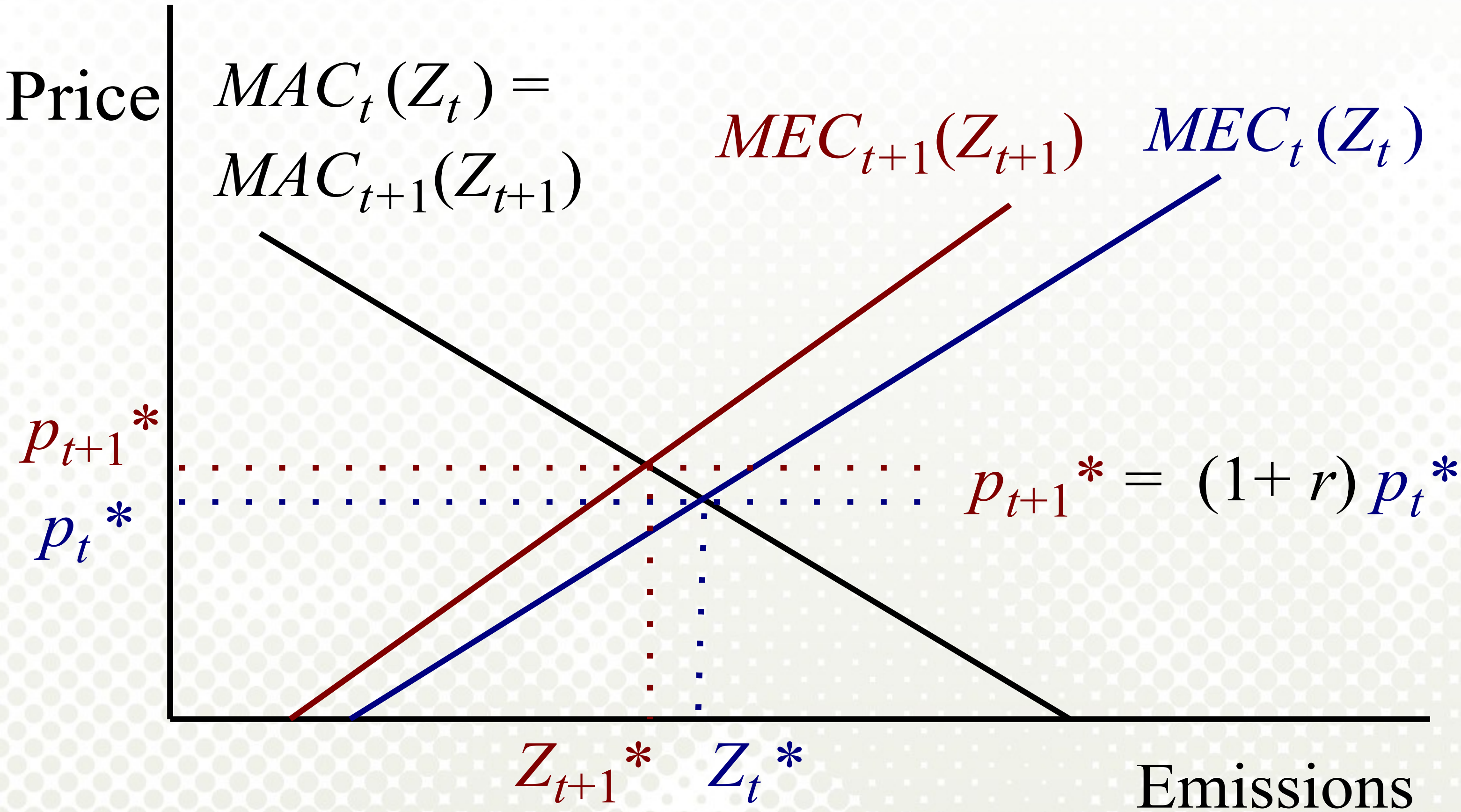
$$MAC_i(z_i^*) = MAC_j(z_j^*) = MEC(\Sigma\, z_k)$$

- Dynamic optimality:

$$MAC_t(z_t^*) = MEC_t(z_t^*) = p_t^*$$
$$MAC_{t+1}(z_{t+1}^*) = MEC_{t+1}(z_{t+1}^*) = p_{t+1}^*$$

- What is the relationship through time in presence of a stock externality?

… dynamic optimality (2)



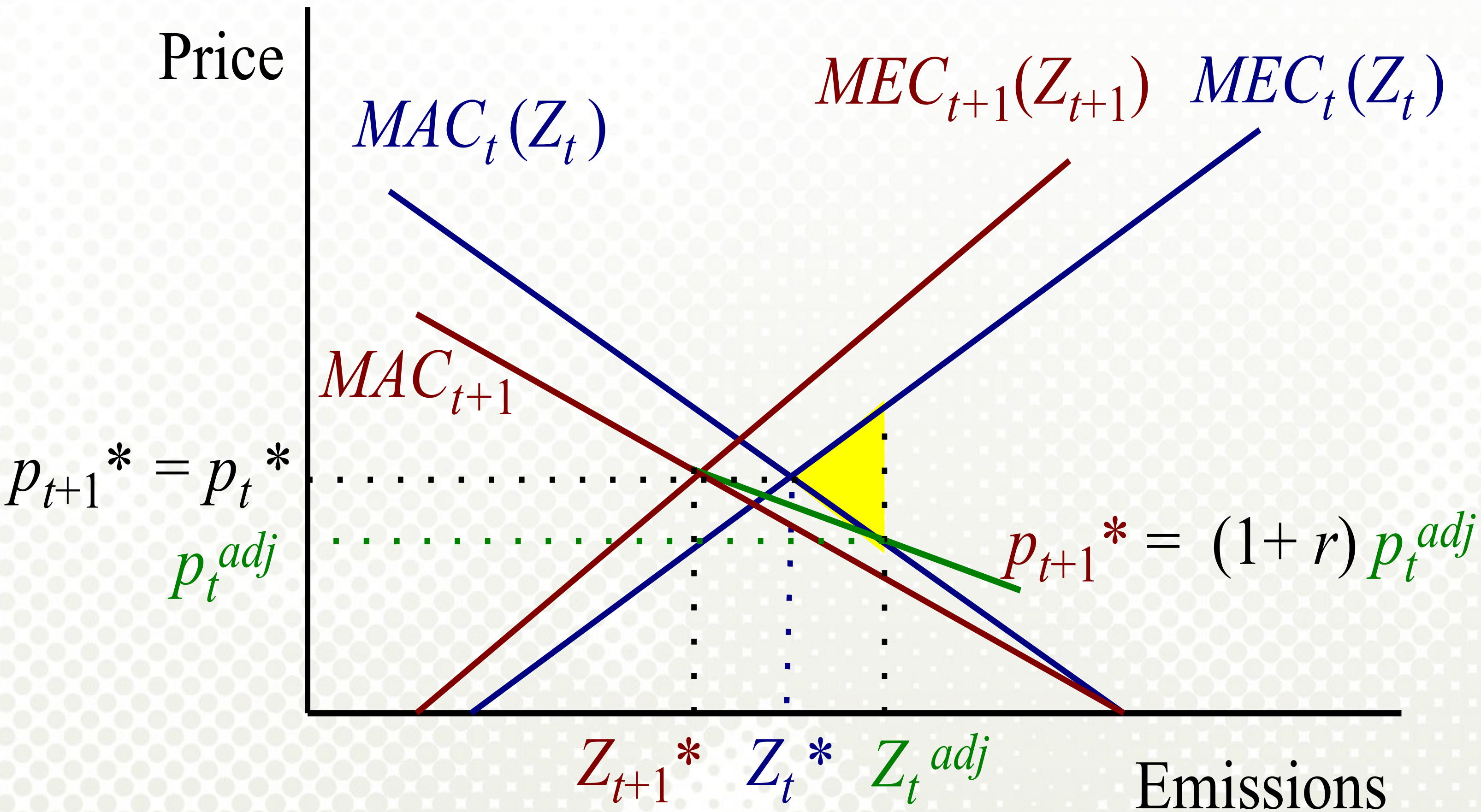
… dynamic optimality (3)

- Strange coincidence if the sequence of static optimal emission levels over time would follow the Hotelling price path

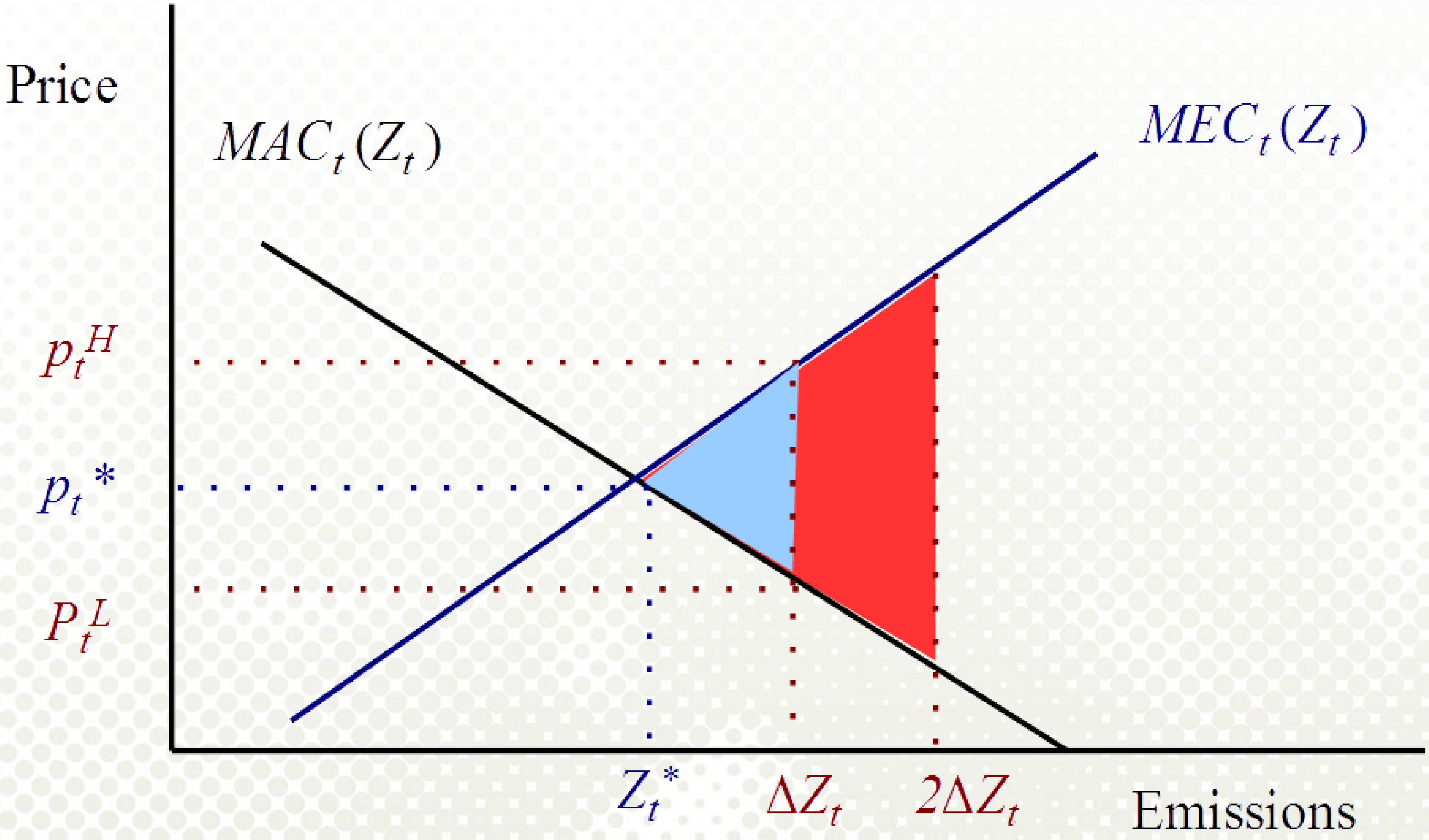
$$p_{t+1}^* = (1+r)^t \, p_0^*$$

- How to trade off time preference (given by the Hotelling price path) and the sequence of static optima?

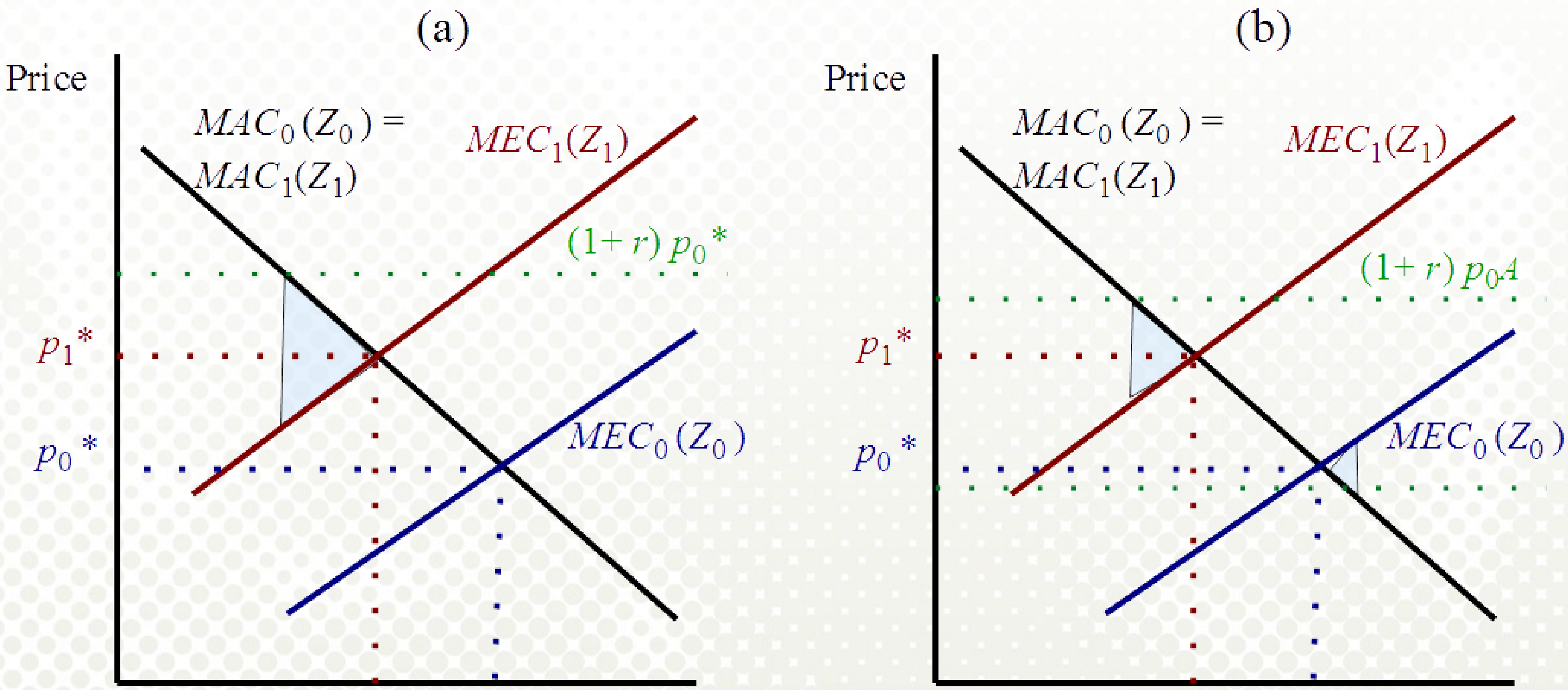
… dynamic optimality (4)



Dynamics – statics matter



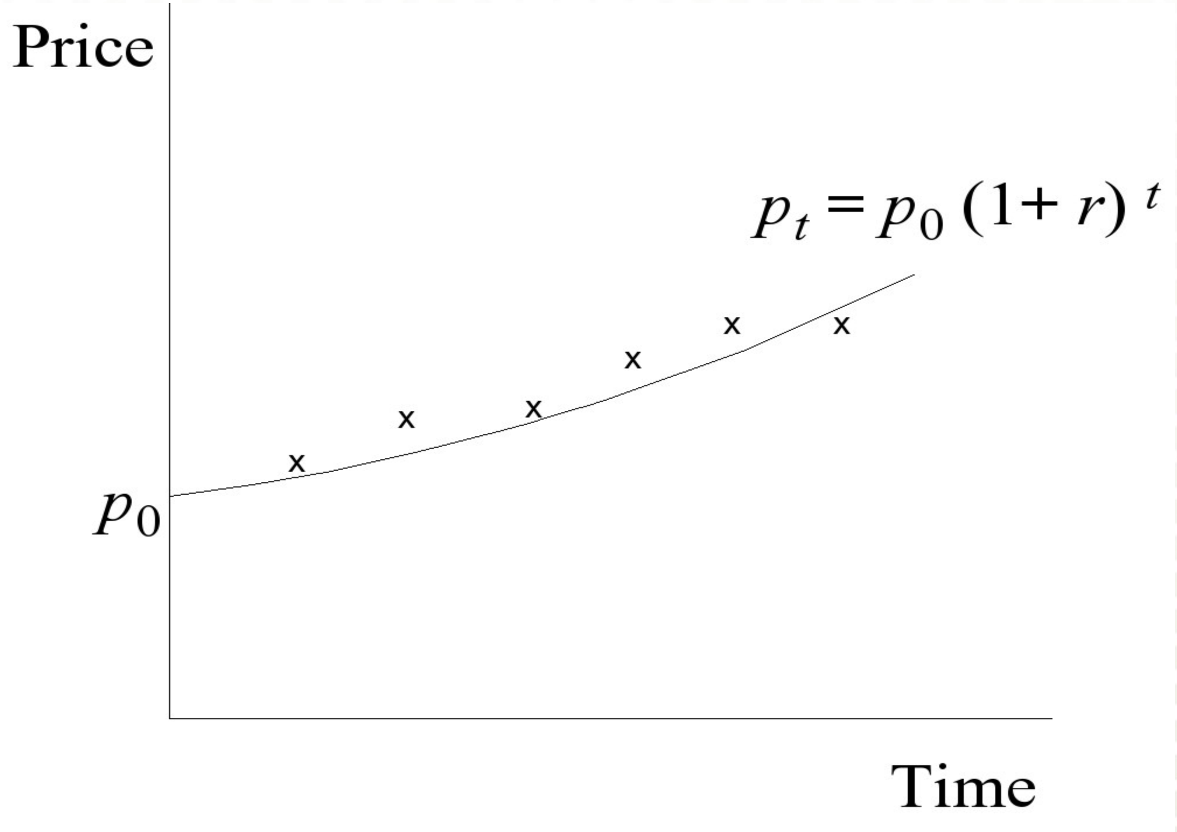
… dynamics – 2-period full info cases



Optimal solution – an outline (1)

- Minimize the discounted losses caused by the two perspectives
  - dynamic (DW-losses from the expected statically optimal prices) and
  - statics (deviation from the Hotelling price path compared to the expected dynamically optimal prices)

.. optimal solution – an outline (2)



(1) adjusted expected HPP (discount rate, tech. progr)
(2) expected static optima

… optimal solution – an outline (3)

- Current (period 0) static optimum form base for Hotelling price path, p_t^H
  - Adjust emissions Z_t* to minimize discounted sum of losses from the expected optimal path
  - off the path: $\Delta L_t(Z_t^*) = \left| p_t^* Z_t^* - p_t^H Z_t^H \right|$
  - DW losses: $DW_t(Z_t^*)$
- Choose {Z_t*} for t = {0,1, …, T}:

$$\theta = \sum_{t=0}^{T} \beta^t \left[\Delta L_t(Z_t^*) + DW_t(Z_t^*) \right]$$

Concluding remarks

- Dynamic cost effectiveness – trivial
  (← no extra factors to account for)
- Sequence of static optima and dynamic optimality do not generally coincide
  - Solution principle: minimize discounted static DW-losses & costs being off HPP
- Contribution:
  - corrects old "belief" that static optima are on the Hotelling price path when stock externalities are present
  - viable solution principle