

Carbon Incentives and Canada's Managed Forest under Risk

Foothills Research Workshop

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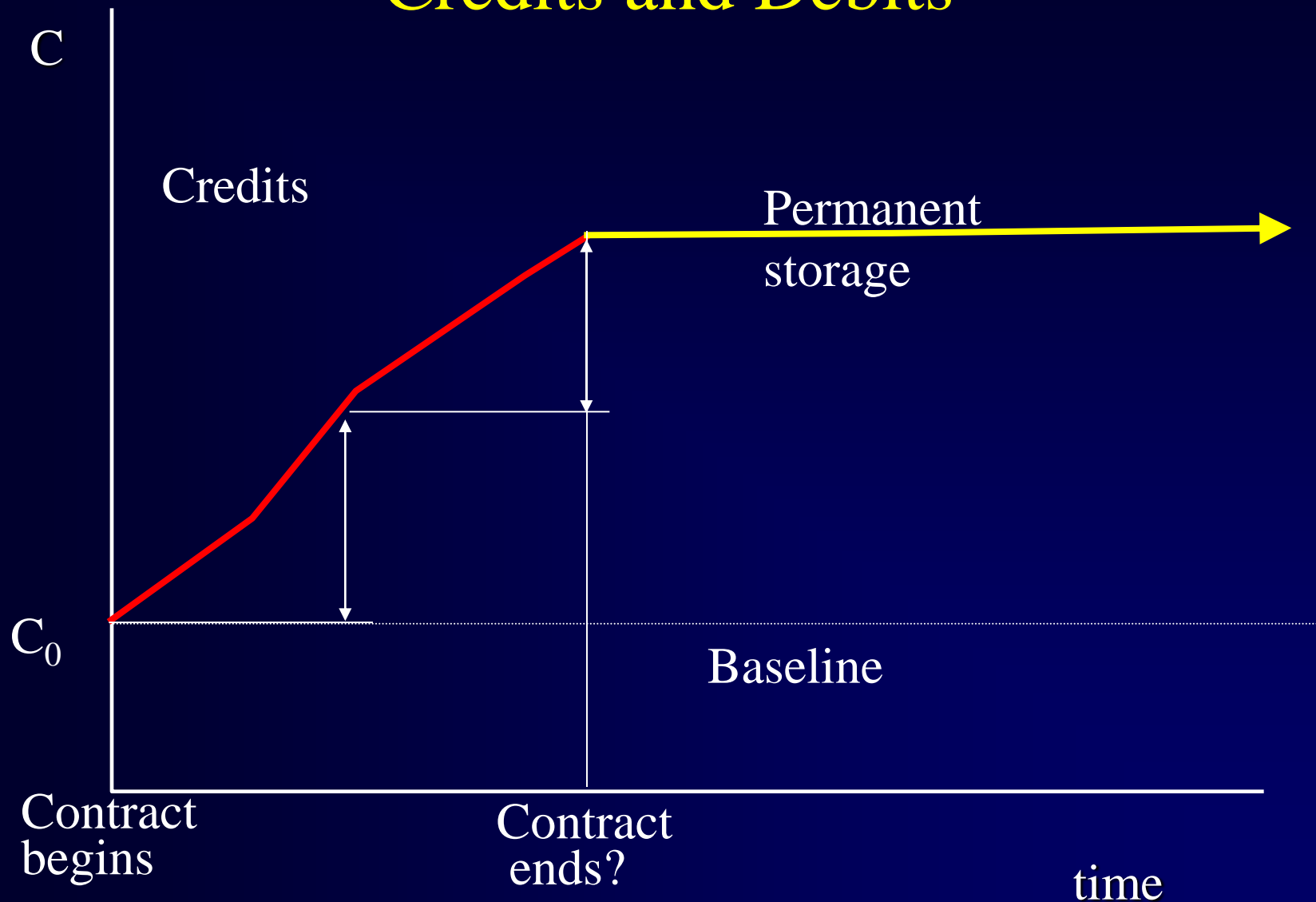
Outline

- Basics of Carbon Credit Trading Contract
- Empirical Model
- Results
- Natural Disturbance Risk
- Policy Implications

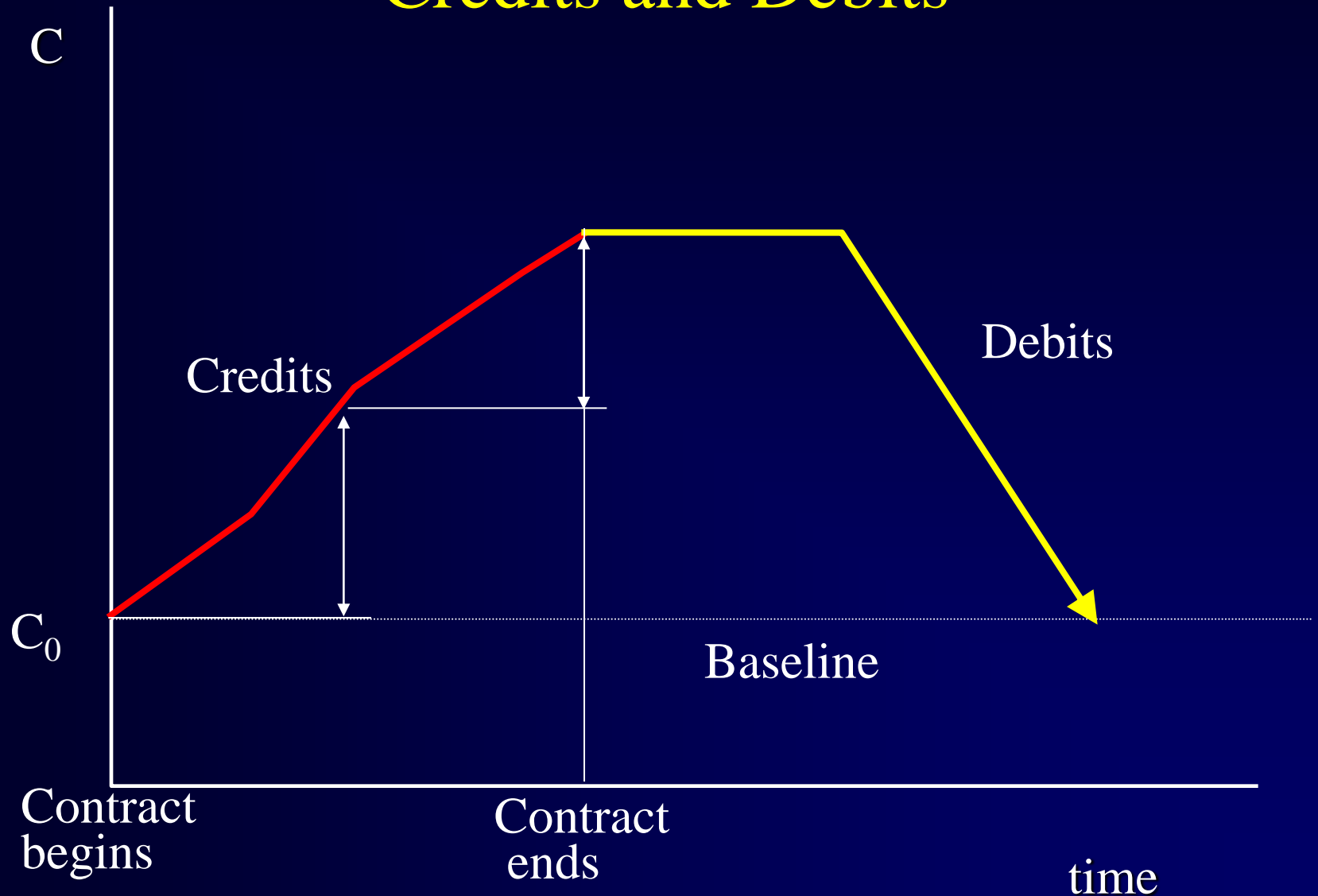
Key Criteria

- Net sequestration/surplus/additionality
 - Baseline establishment
- Permanence
- Leakage

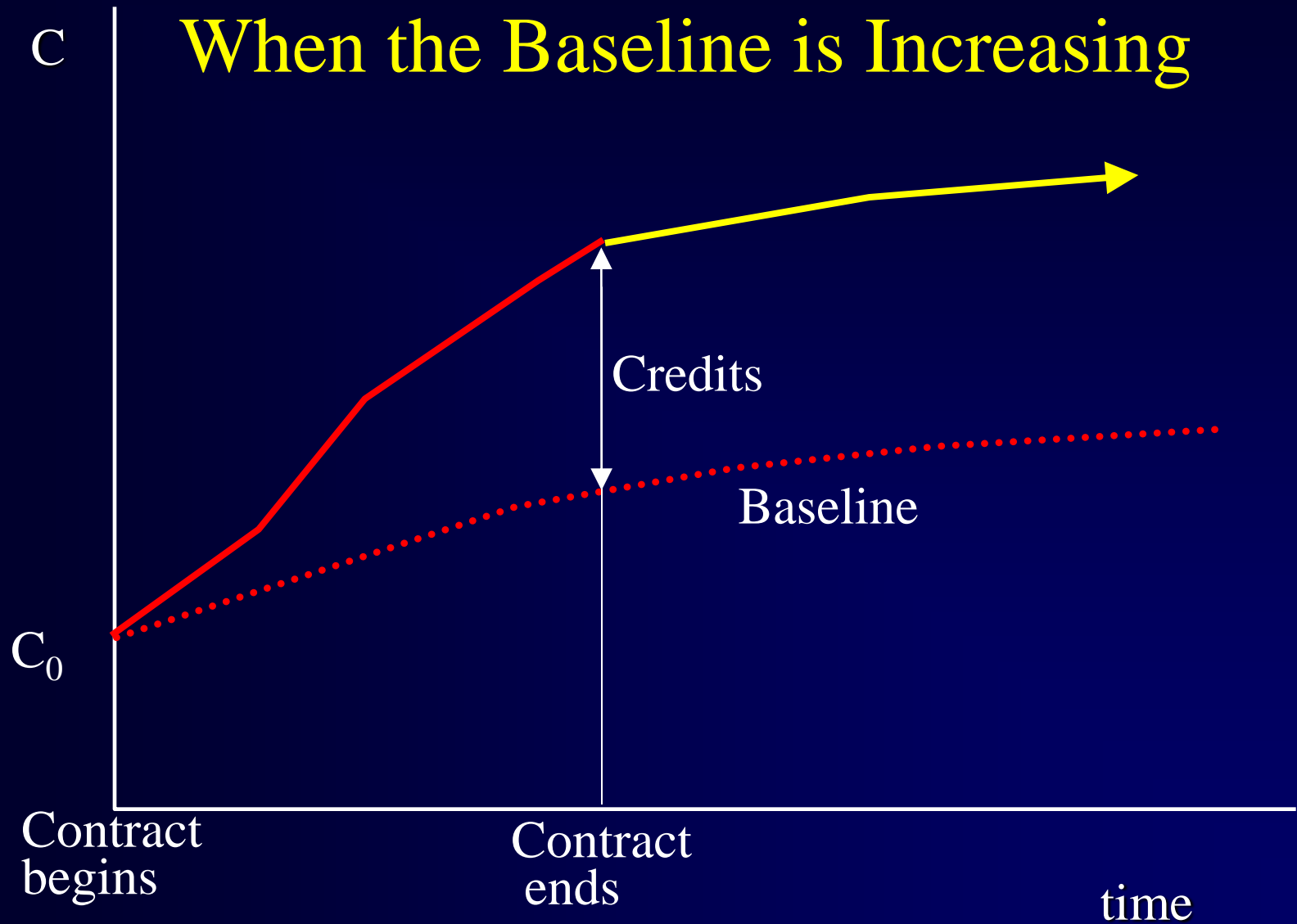
The Structure of a Carbon Contract: Credits and Debits



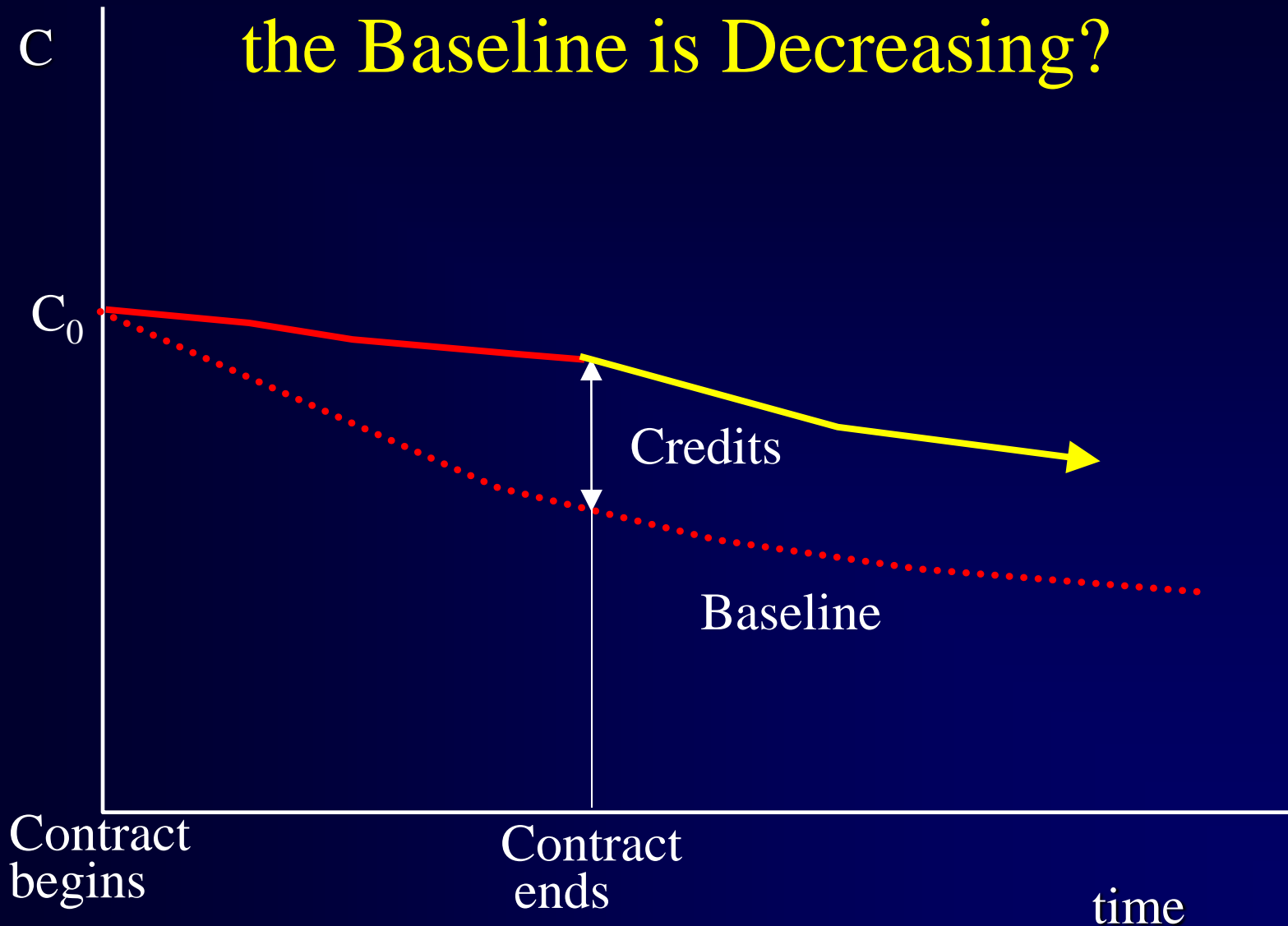
The Structure of a Carbon Contract: Credits and Debits



Carbon Credits



Can Carbon Credits be Generated When the Baseline is Decreasing?



Alternative Contract Arrangements

- Long term nature of sequestration leads to long term contracts
 - Buyers buy credits only
 - Supplier responsible for future debits
 - Buyer buys temporary storage
 - Debits built into the contract
 - Price is lower

Empirical Model

- Math Programming Model
 - Weldwood FMAs in the Foothills
 - Timber harvest scheduling
 - Carbon management
 - Optimization model

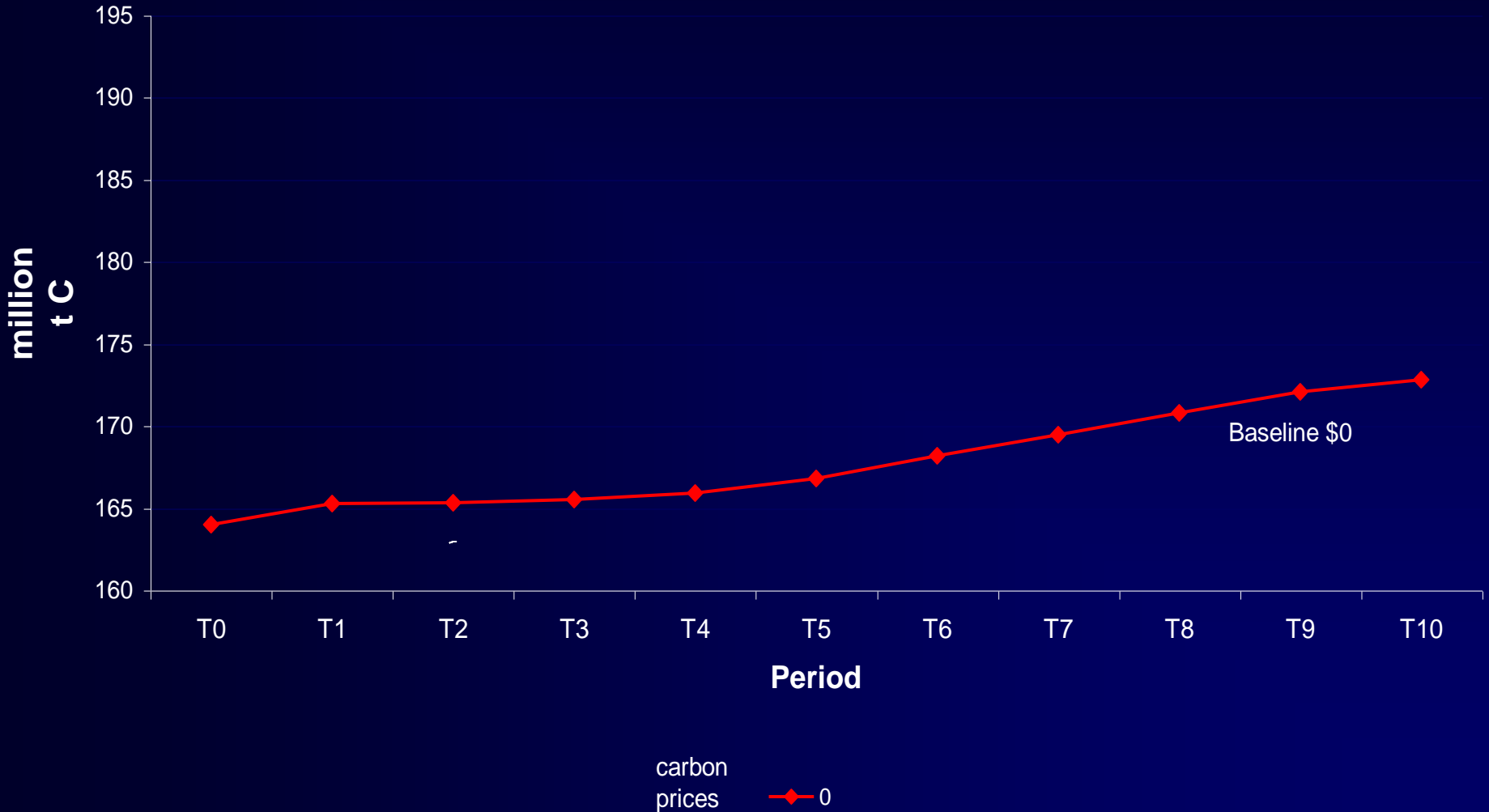
Empirical Model

- Economic objective function
 - Timber and carbon values
 - Carbon values include credits and debits
 - Discounted net revenues
- Harvest scheduling options
- Alternative regeneration prescriptions
 - Extensive, basic, intensive

Empirical Model

- Carbon budget model (Kurz and Apps 1992, 1999)
 - Soil, living biomass (above and below ground)
- Multiple products and carbon storage in products (Apps and Kurz 1999)
- Disturbance Rates
- Regulatory constraints
 - AAC

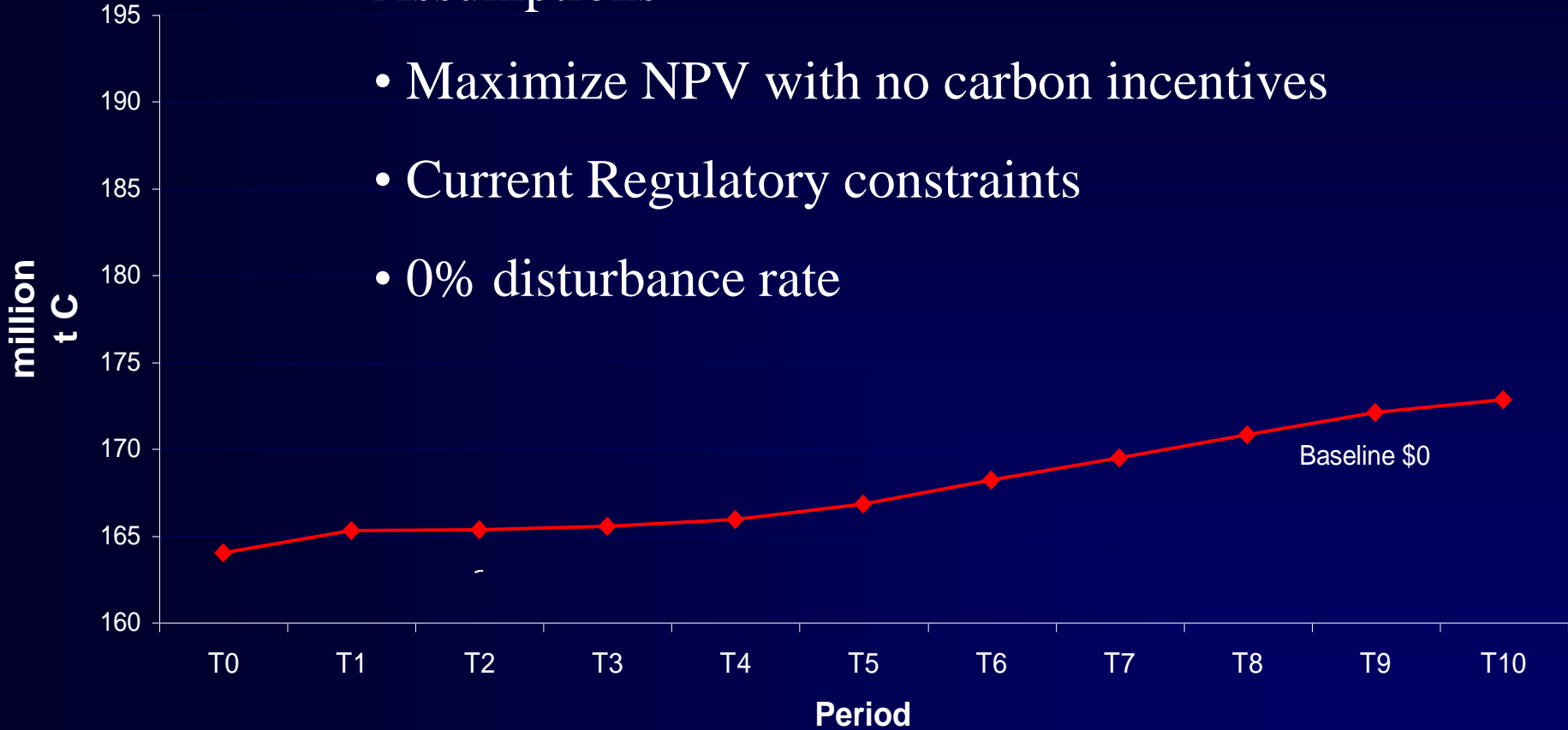
Carbon Stock Baseline Determination



Carbon Stock Baseline Determination

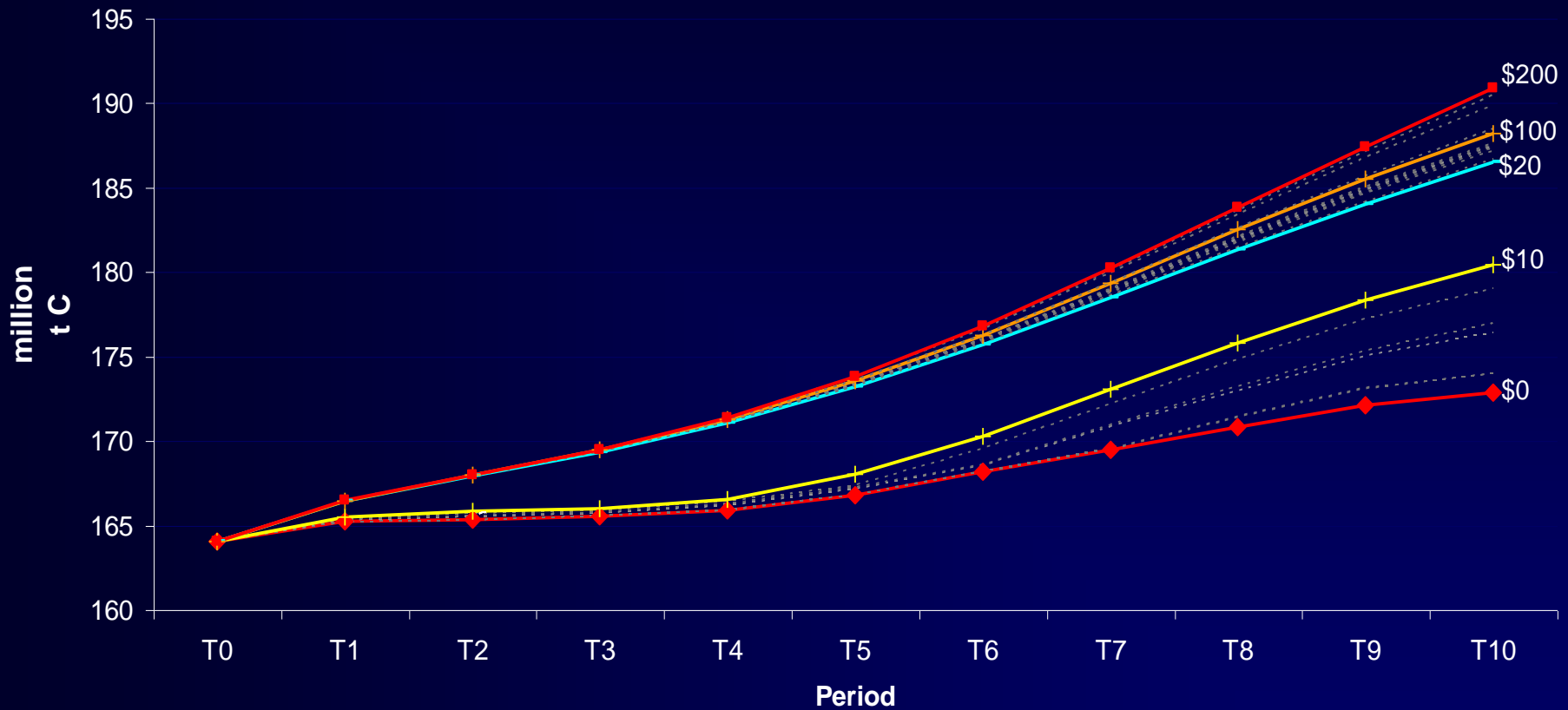
Assumptions

- Maximize NPV with no carbon incentives
- Current Regulatory constraints
- 0% disturbance rate



carbon prices — 0

Carbon Stock Response to Carbon Price

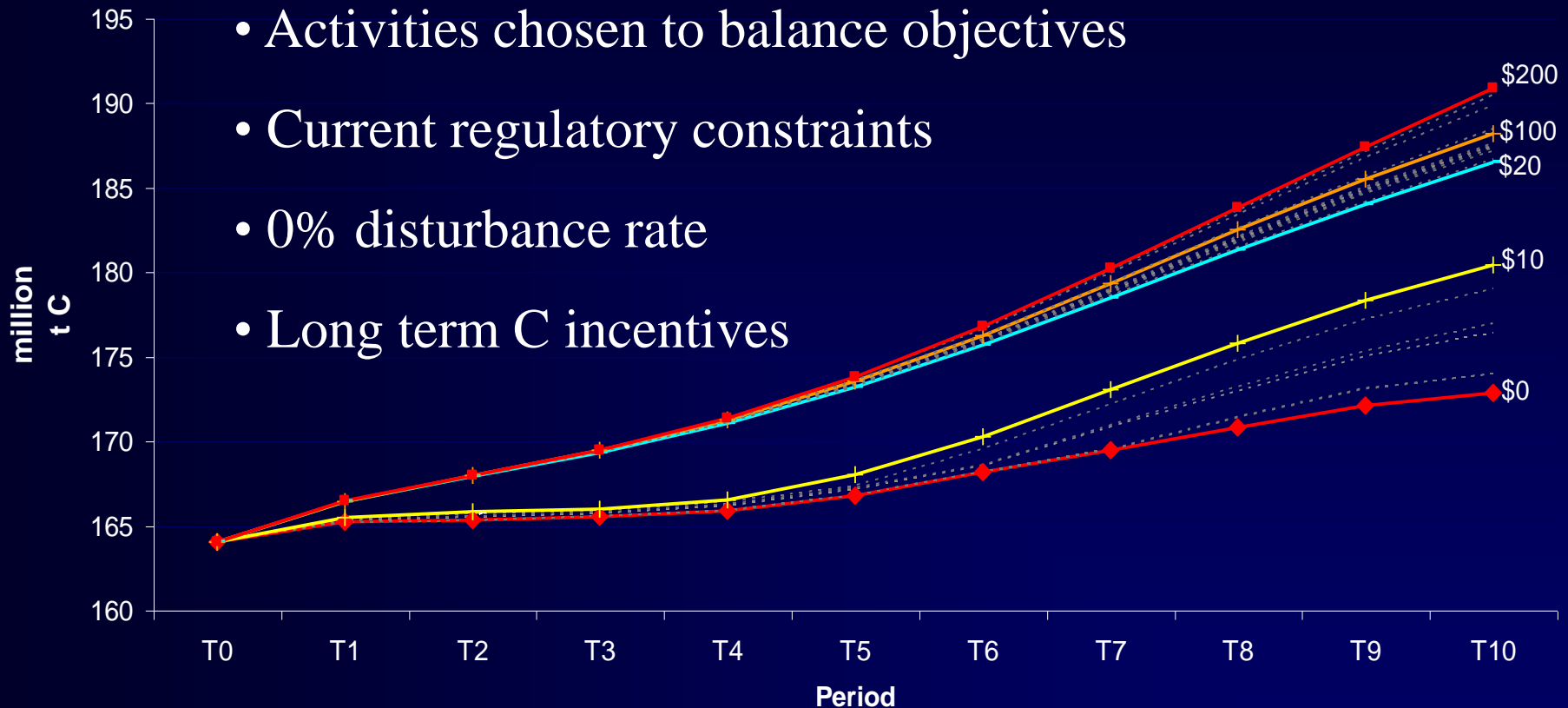


carbon prices

—◆— 0
 - - - - - 1
 - - - - - 2
 - - - - - 4
 - - - - - 6
 - - - - - 8
 —+— 10
 —+— 20
 - - - - - 30
 - - - - - 40
 - - - - - 50
 - - - - - 60
- - - - - 70
- - - - - 80
- - - - - 90
—+— 100
- - - - - 125
- - - - - 150
- - - - - 175
—■— 200

Carbon Stock Response to Carbon Price

- Maximize NPV of timber and C values
- Activities chosen to balance objectives
- Current regulatory constraints
- 0% disturbance rate
- Long term C incentives

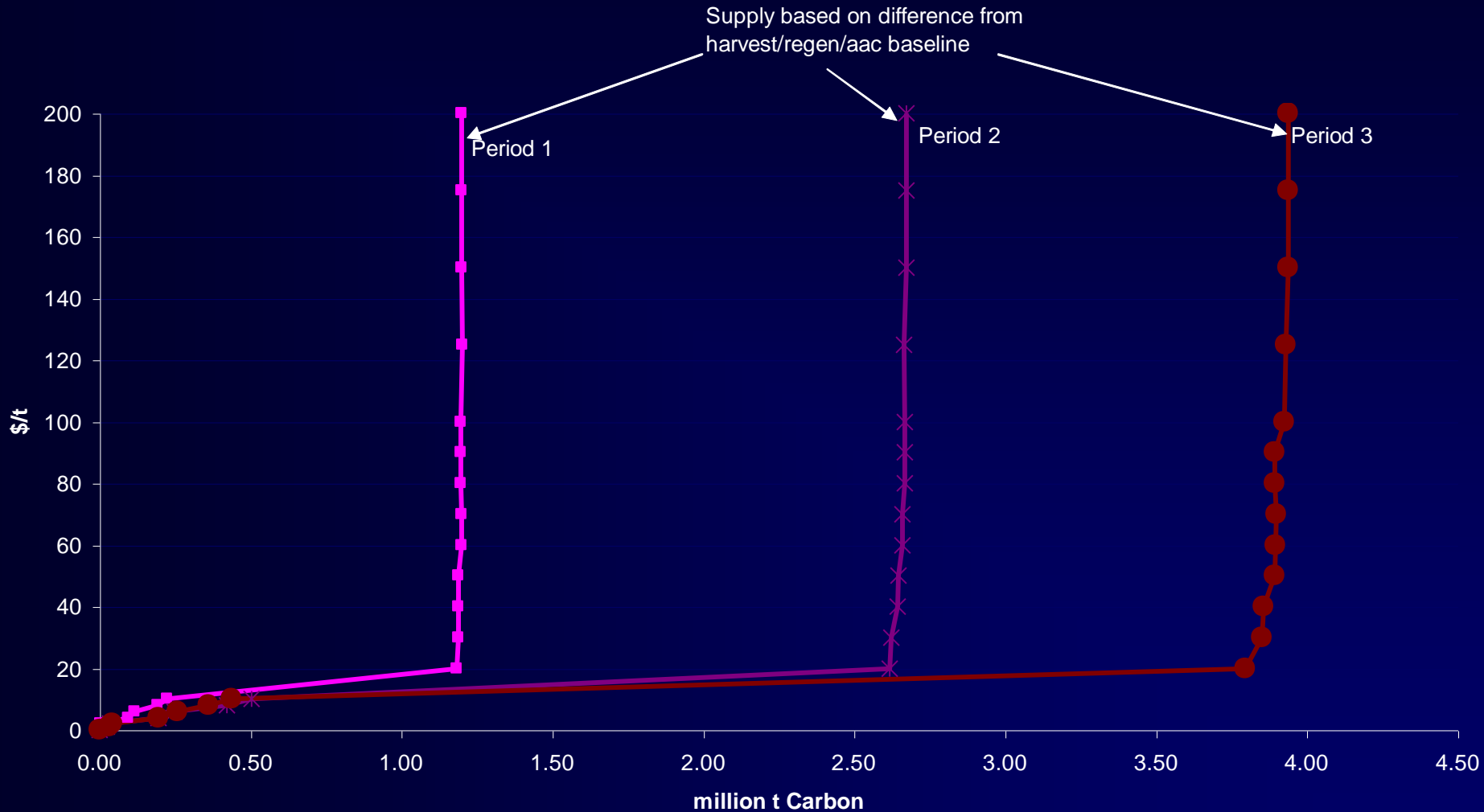


carbon prices

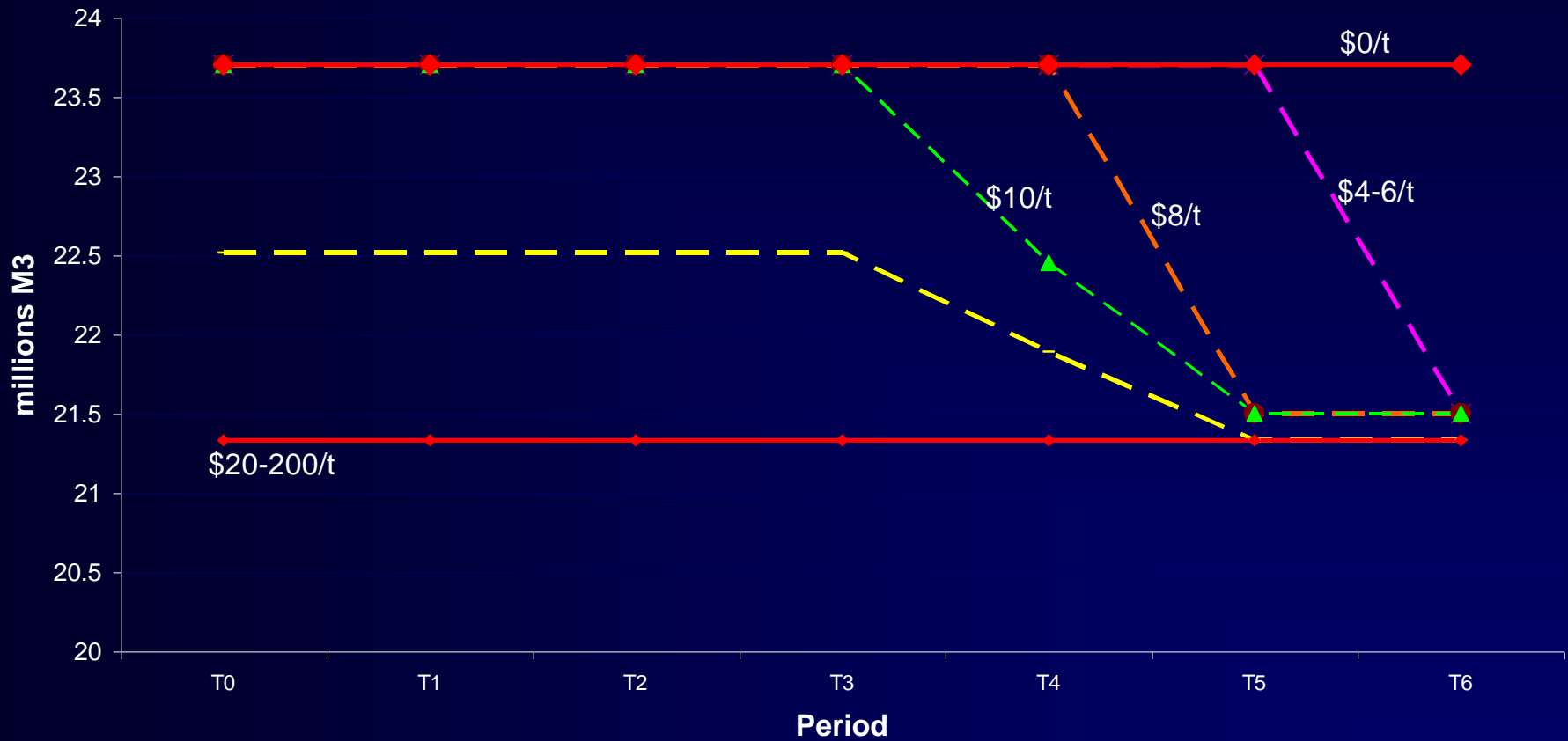
—◆— 0 - - - - - 1 - - - - - 2 - - - - - 4 - - - - - 6 - - - - - 8 —+— 10 —+— 20 - - - - - 30 - - - - - 40 - - - - - 50 - - - - - 60

- - - - - 70 - - - - - 80 - - - - - 90 —+— 100 - - - - - 125 - - - - - 150 - - - - - 175 —◆— 200

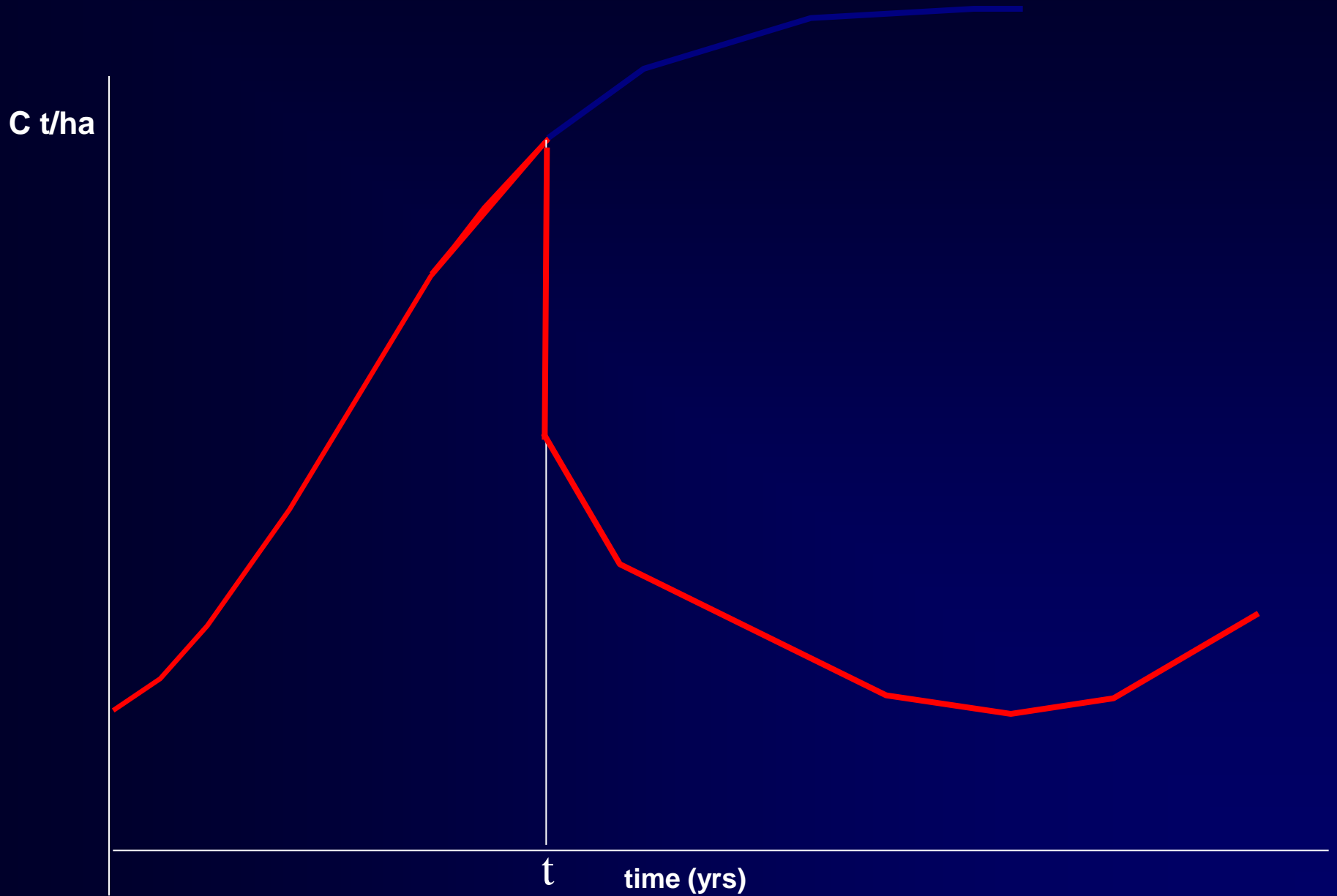
Carbon Supply Curves



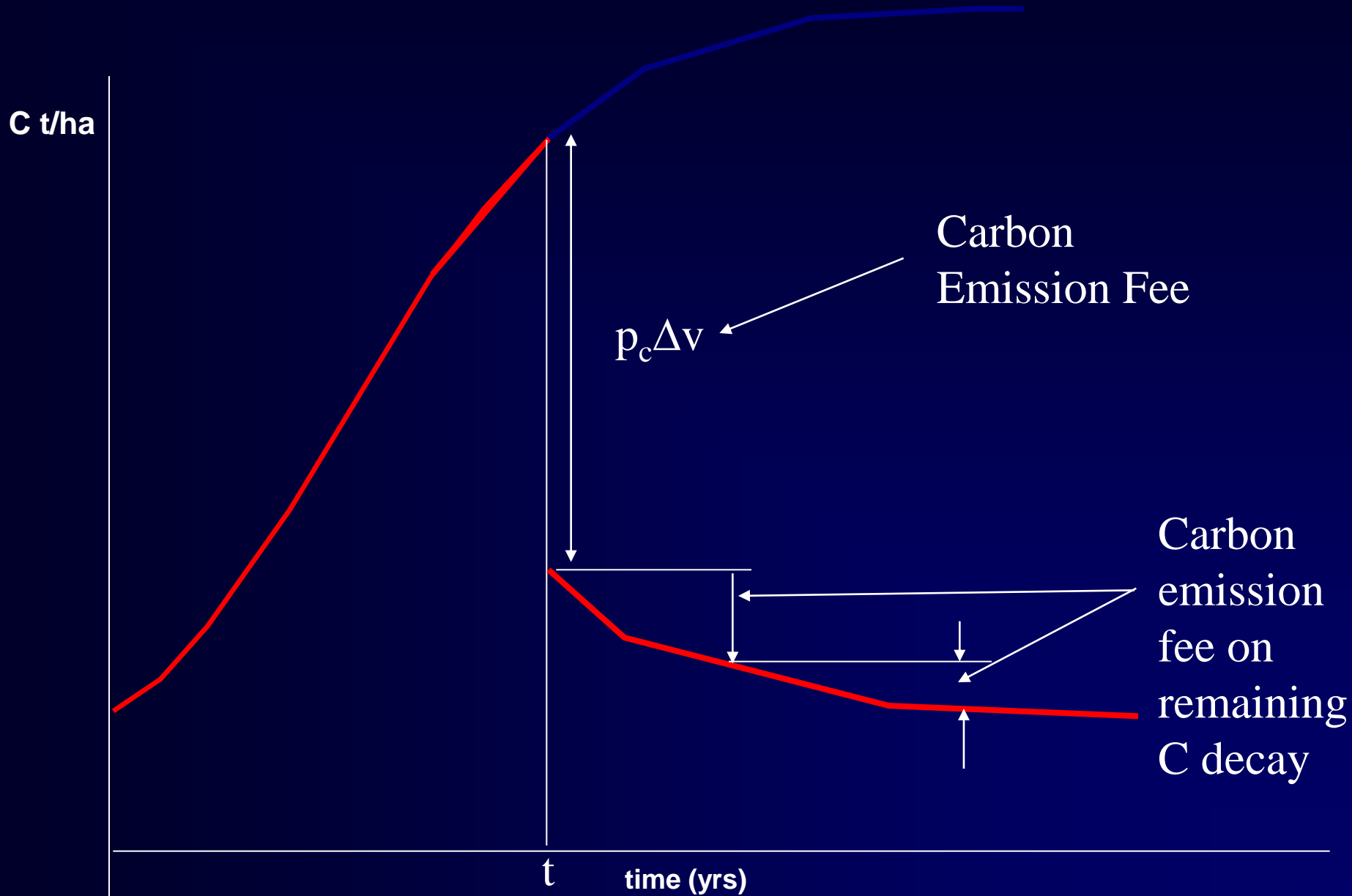
Carbon/Timber Supply Tradeoffs



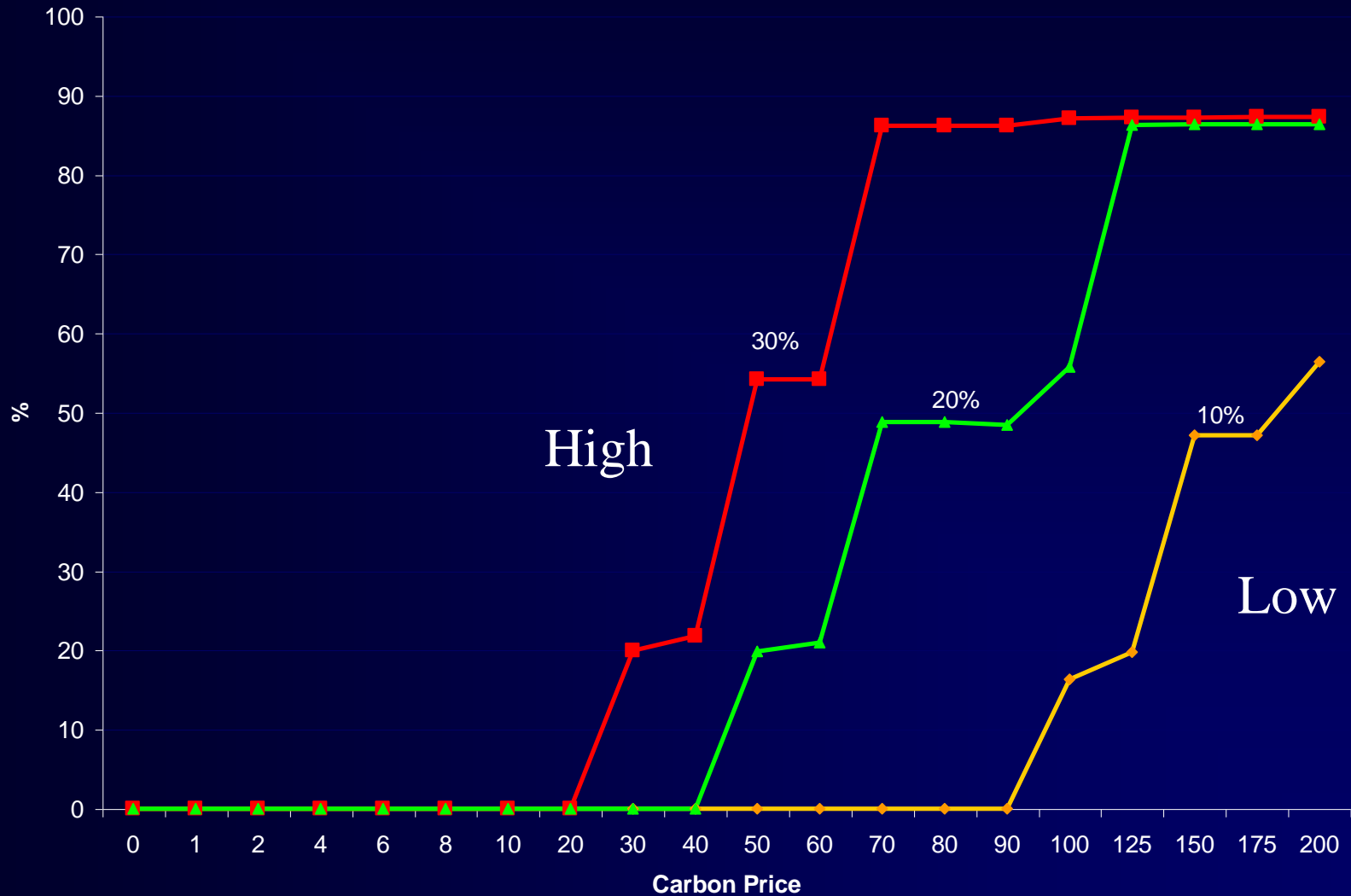
Stand carbon over time



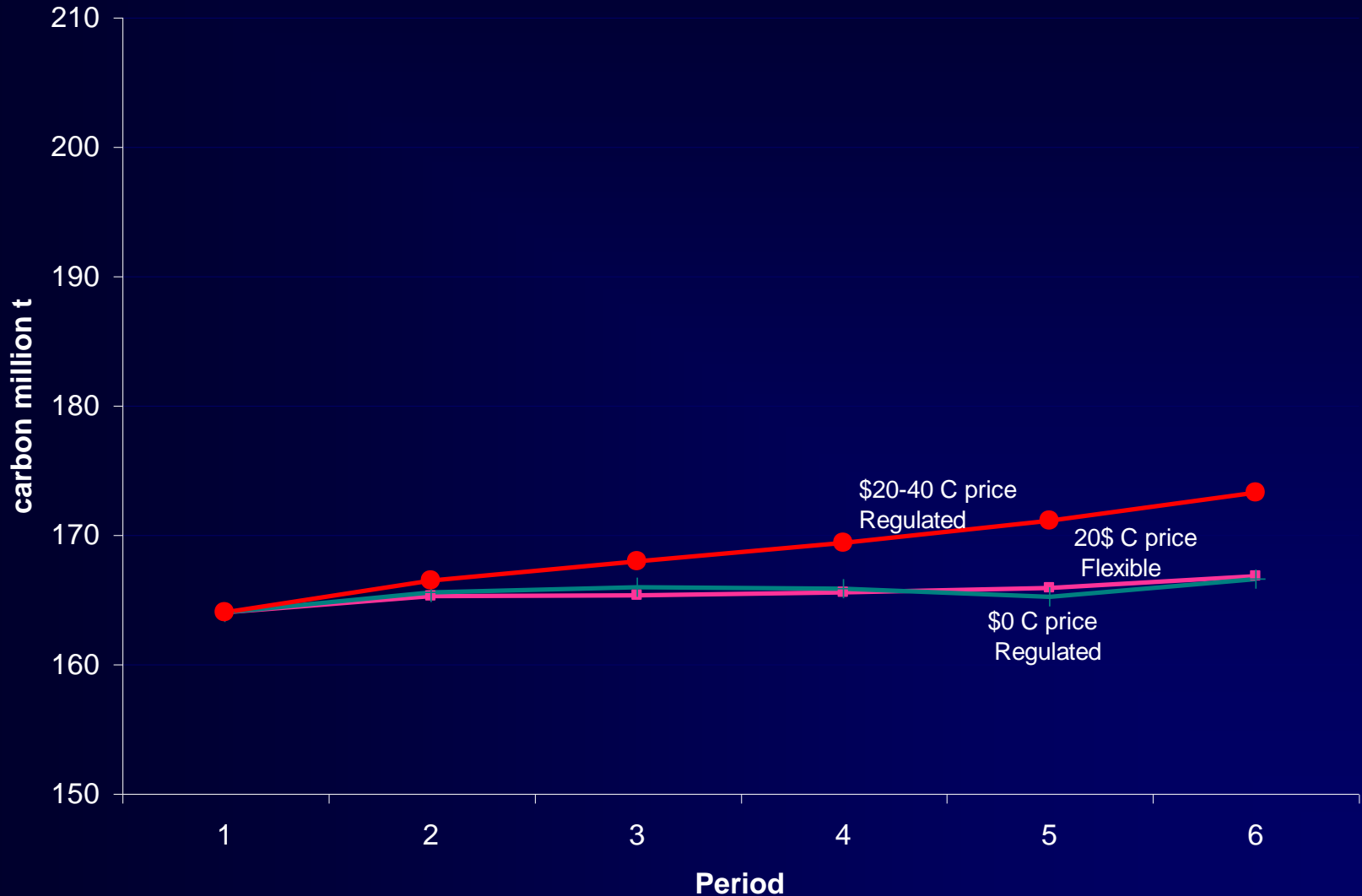
Carbon Incentives: Debits on harvest



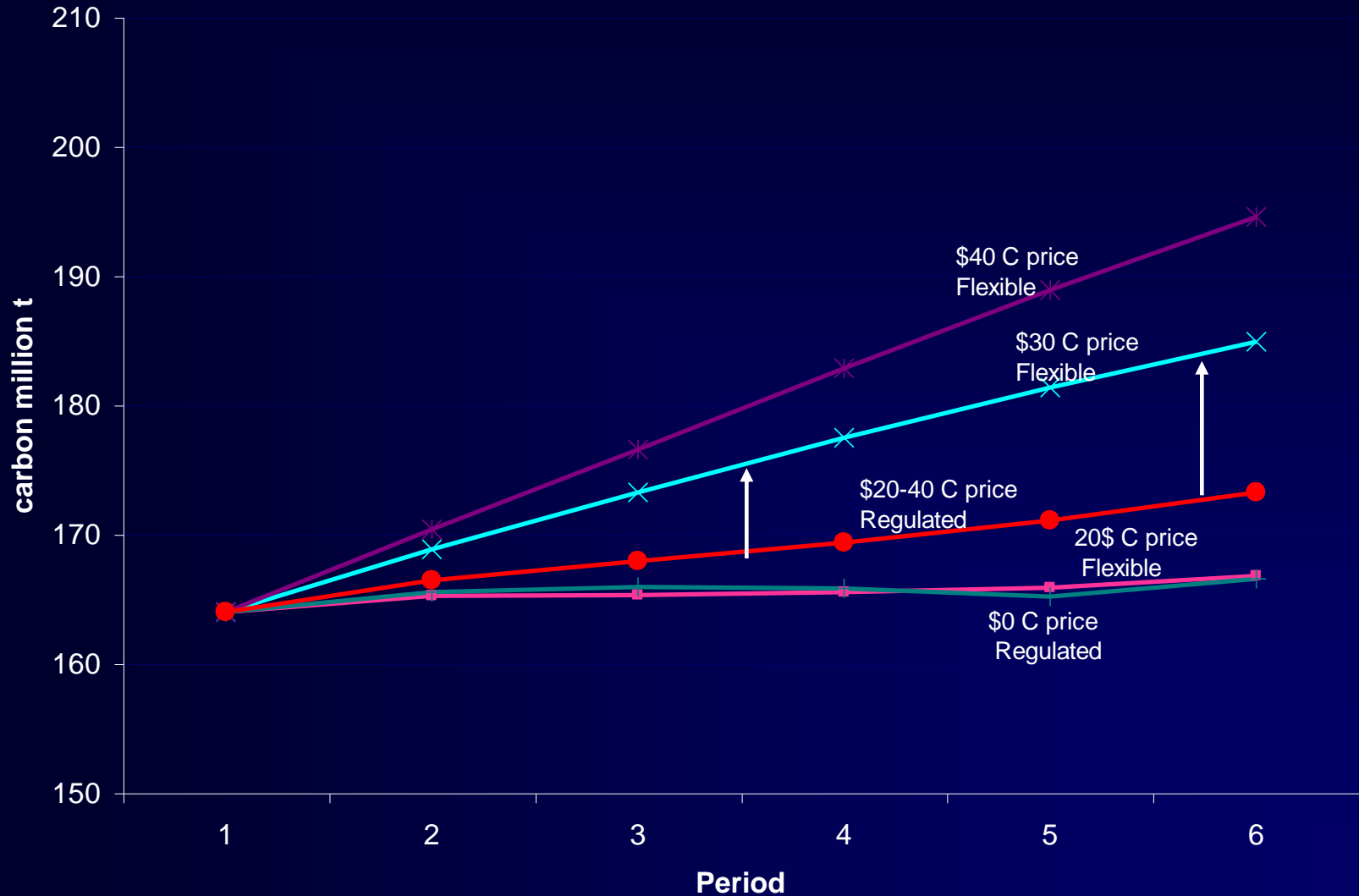
Sensitivity Analysis of Intensive Management on Yield Increase Assumption



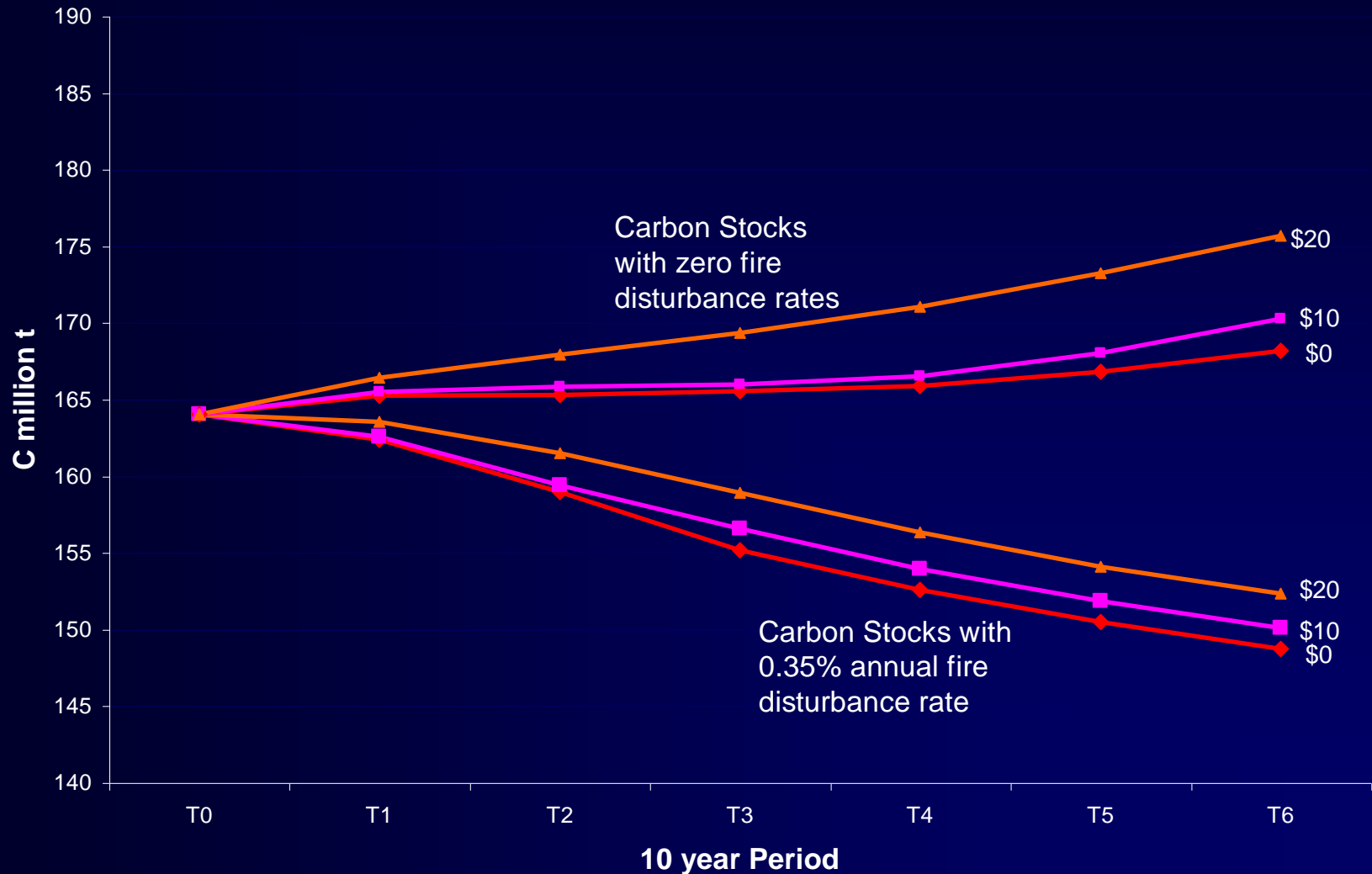
Relaxing the Regulatory Constraints



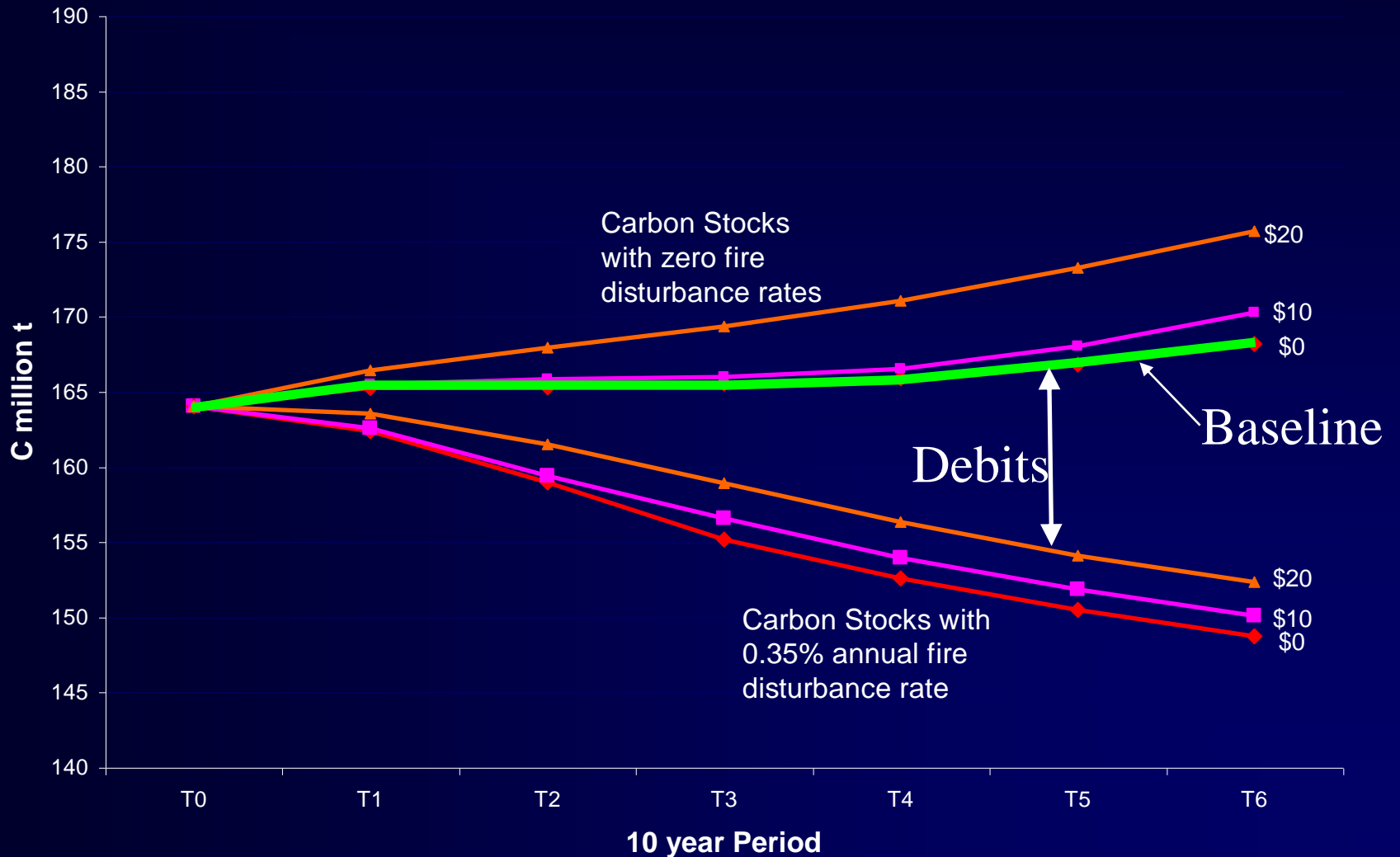
Relaxing the Regulatory Constraints



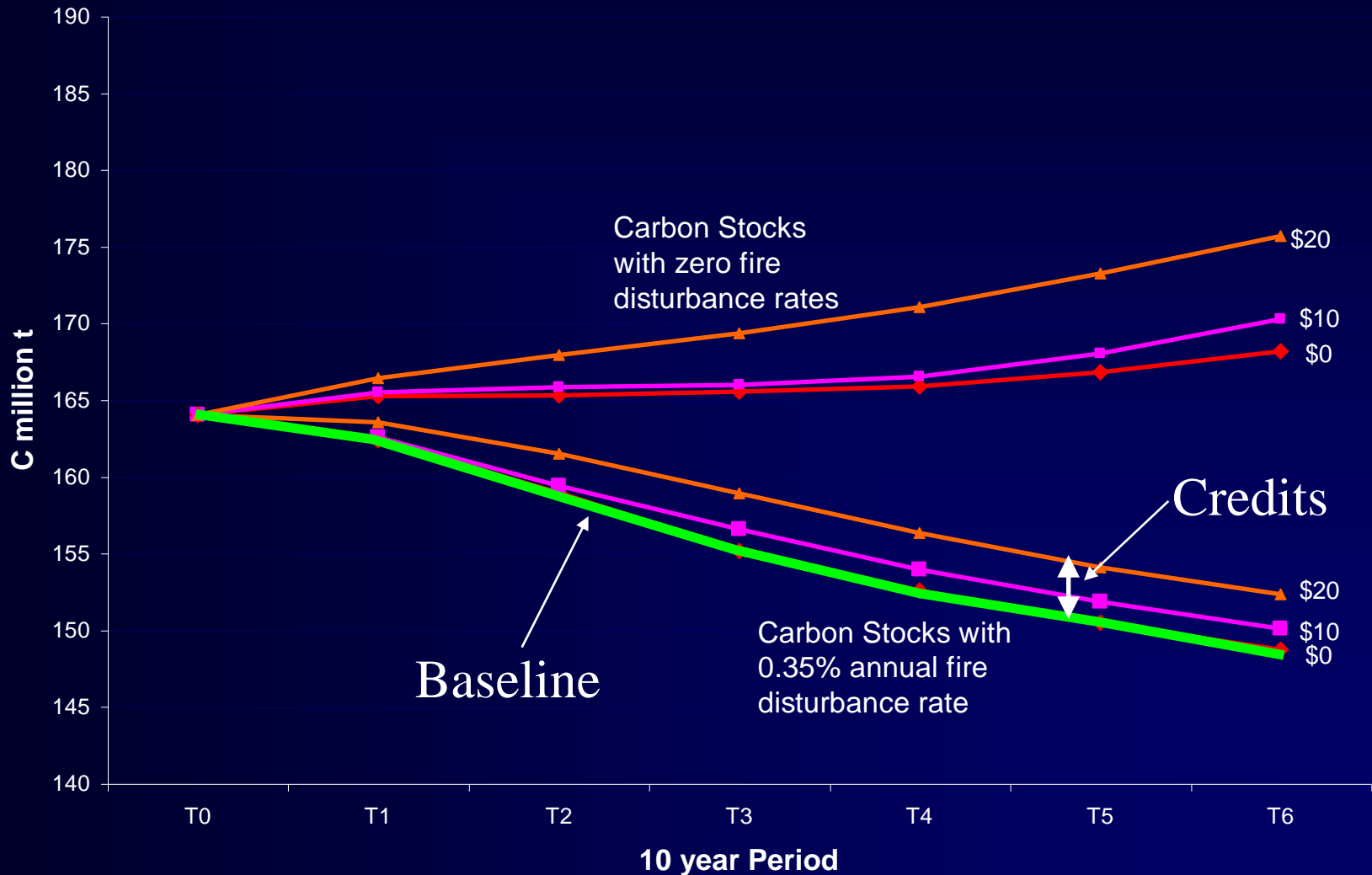
The effect of an increase in disturbance rate on C stocks



Underestimating the natural disturbances

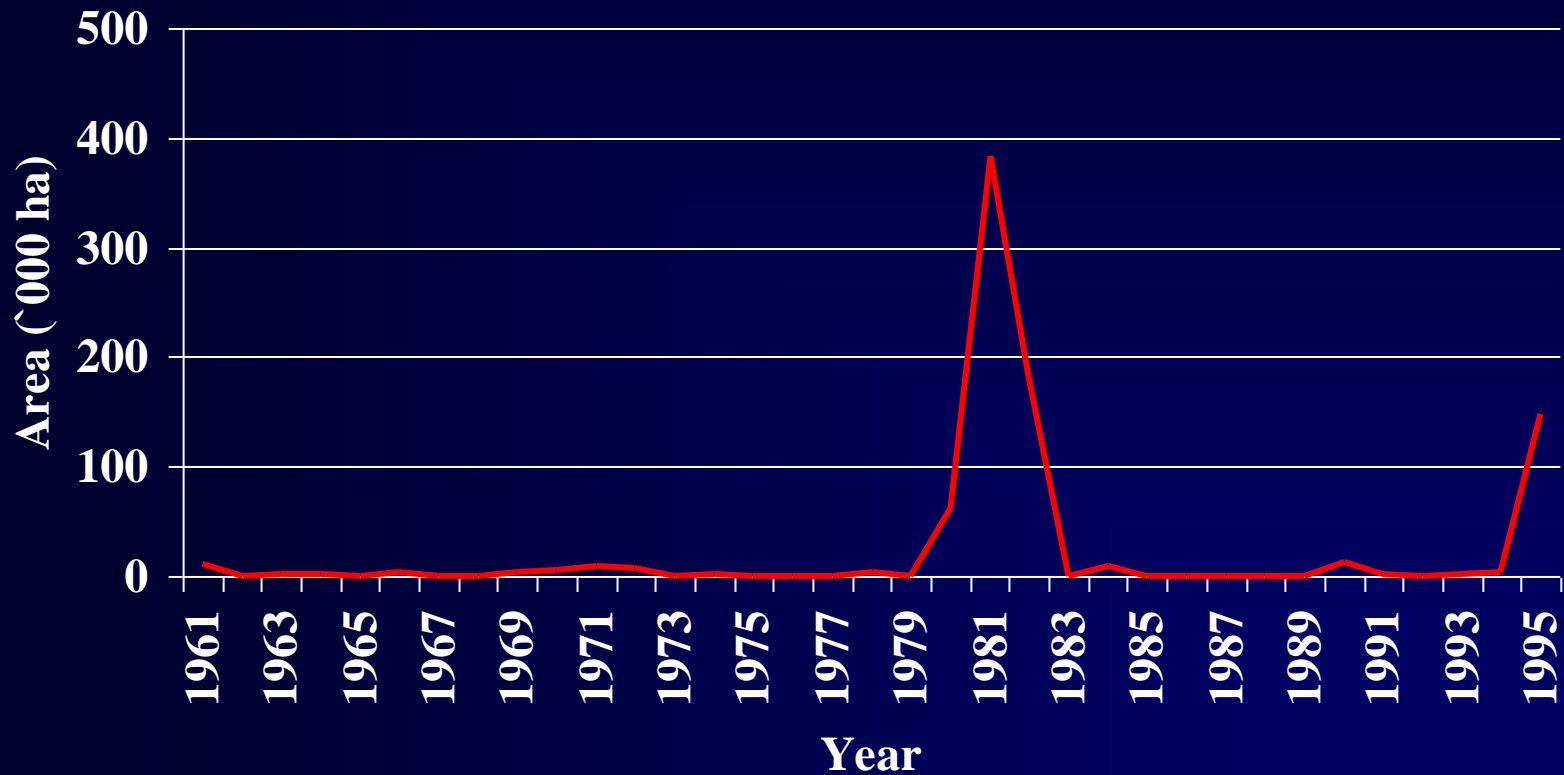


Correctly forecasting disturbance rates



Economic Consequences Under Risk

Annual Area Burned



Source: Armstrong G.W. 1999

Decision Making Under Natural Disturbance Risk

- NPV of Carbon
- Carbon Price = \$10/t

Forecasted
Disturbance Rate

		0%	0.35%
Realized Disturbance Rate	0%	4.1	56.6
	0.35%	-48.8	3.6

Policy Implications

- Intensive management
 - Carbon price $>$ \$20/ton
 - Minimal short term impact on carbon stocks
 - Larger long term impact on carbon stocks
- Change in Harvest Emphasis
 - Proportion of harvest by species group

Policy Implications

- Timber/Carbon Stock Tradeoff
 - Reduced harvest
 - Largest influence on carbon stocks given disturbance rate
 - Forest carbon reserves (eg. SaskPower/SaskEnv trade)
 - Barriers to option
 - FMA holders have limited rights to control of harvest levels
 - Regulated to harvest within percentage of AAC
 - Quota holders
 - Short term efficient use of capital stocks

Policy Implications

- Regulatory Flexibility
- Risk Management Strategies
 - Declining baselines
 - Carbon discounts
 - Insurance
 - Design Incentive Mechanisms to Reduce Risk
- Fire, Insect and Disease Protection