The Length of Contracts and Collusion

Richard Green and Chloé Le Coq

Reported trades by energy volume, Britain, 1 December 2004

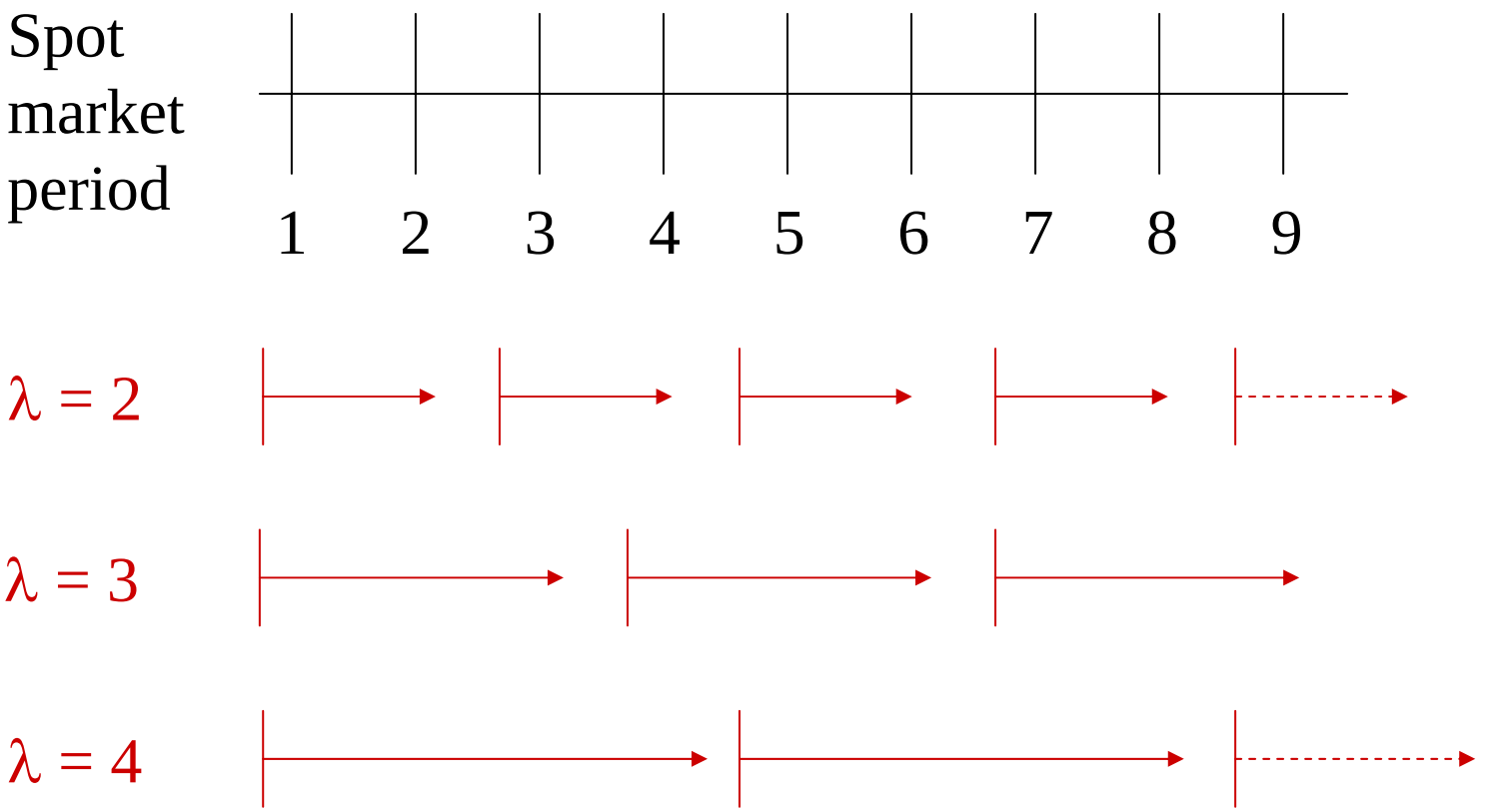
Length of contract	Electricity	Gas
Day	2.1%	22.6%
Week	4.4%	10.5%
Month	29.1%	36.1%
Quarter	26.3%	14.3%
Season	38.1%	16.5%

Source: Heren

The issue

- Commodities sold on spot markets and via long-term contracts
- Contracts make one-shot spot markets more competitive (Allaz & Vila, JET, 1993)
- Repeated spot markets can have collusion
- Do contracts affect this?
  - One-period contracts make collusion worse, (Liski and Montero, JET, 2004)
  - Multi-period contracts, this paper

Timing:
spot periods and contract rounds



The spot market

- 2 firms, constant cost of c per unit
- Future discounted by factor δ
- Demand is $D(p)$
  - Met by contract deliveries and spot sales
  - Does not depend on contract price
- Firms bid prices simultaneously
- Share market if prices are equal
- Lower bidder takes all spot sales if not

Collusion

- Grim trigger strategy
  - Agree collusive price of p^c
  - While collusion holds, set p^c and share sales
  - After defection, set price to c for ever
- Sustain collusion if $\delta \geq ½$, *in the absence of contracts*

The contract market

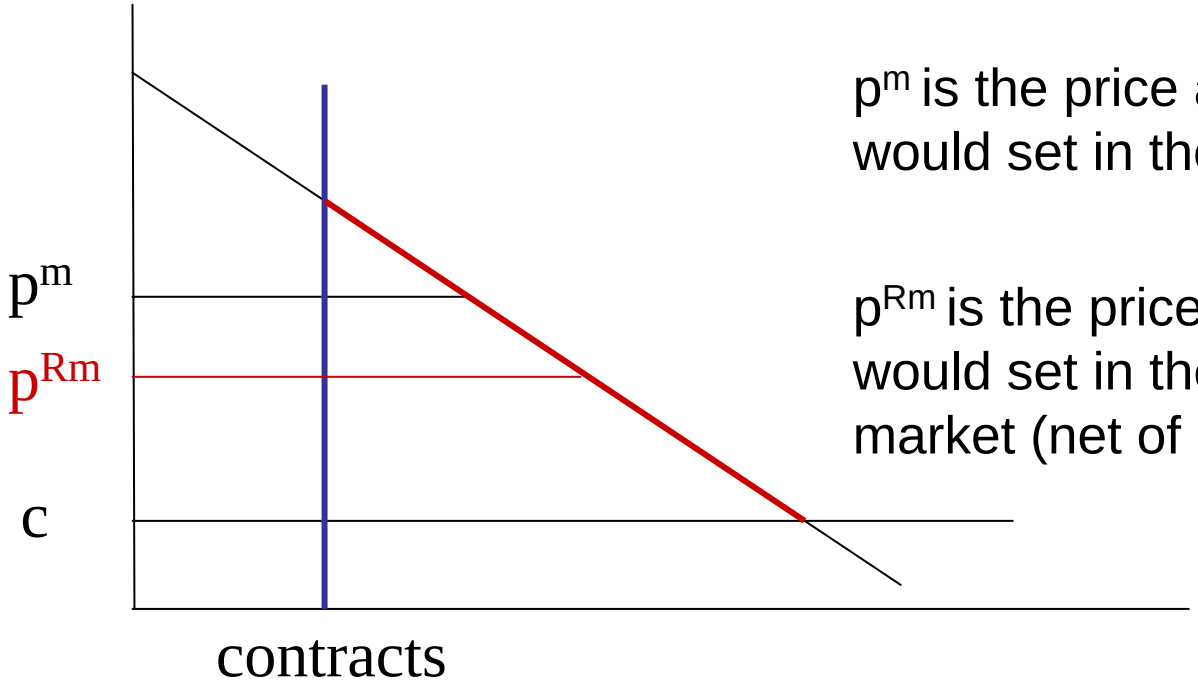
- Sell forward contracts equal to *proportion* $x \in [0,1]$ of expected total sales
- Same amount delivered (& paid for) in each of λ spot periods until next contract round
- No arbitrage condition implies contracts sell for expected spot price
  - Can sell for p^c iff this is a sustainable collusive price in the spot market

Collusion with contracts

- Agree to sell $xD(p^c)/2$ contracts for p^c
- If collusion holds, bid p^c in spot market
- After defection,
  - bid c in spot market in every period
  - sell arbitrary volume of contracts for c
- If collusion holds, continue with contract sales as in previous rounds
- Don’t defect in a contract round!

Deviating in the spot market

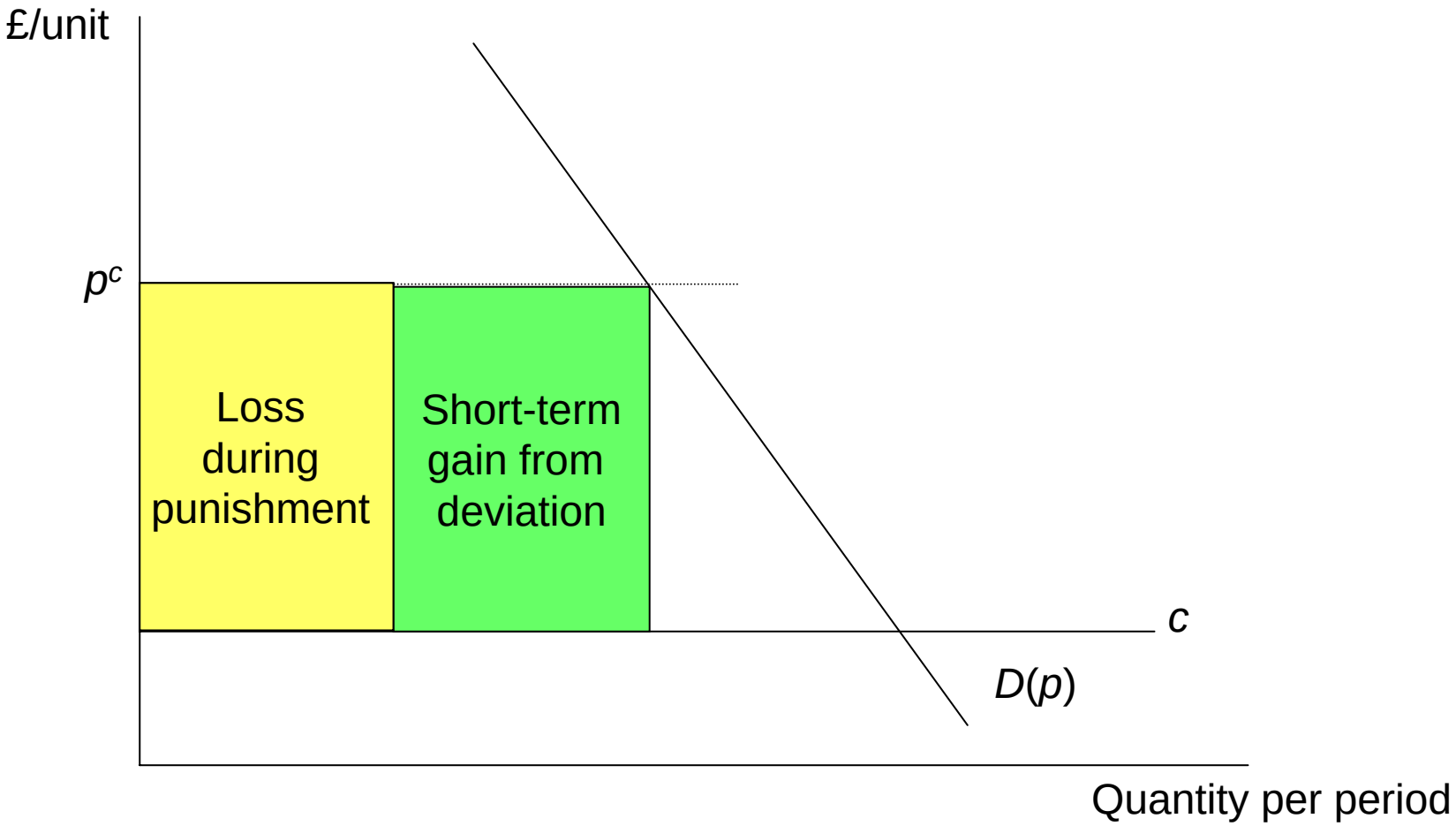
- Choose the lower price of two options:
  - Undercut p^c by a small amount
  - Set residual monopoly price in spot market



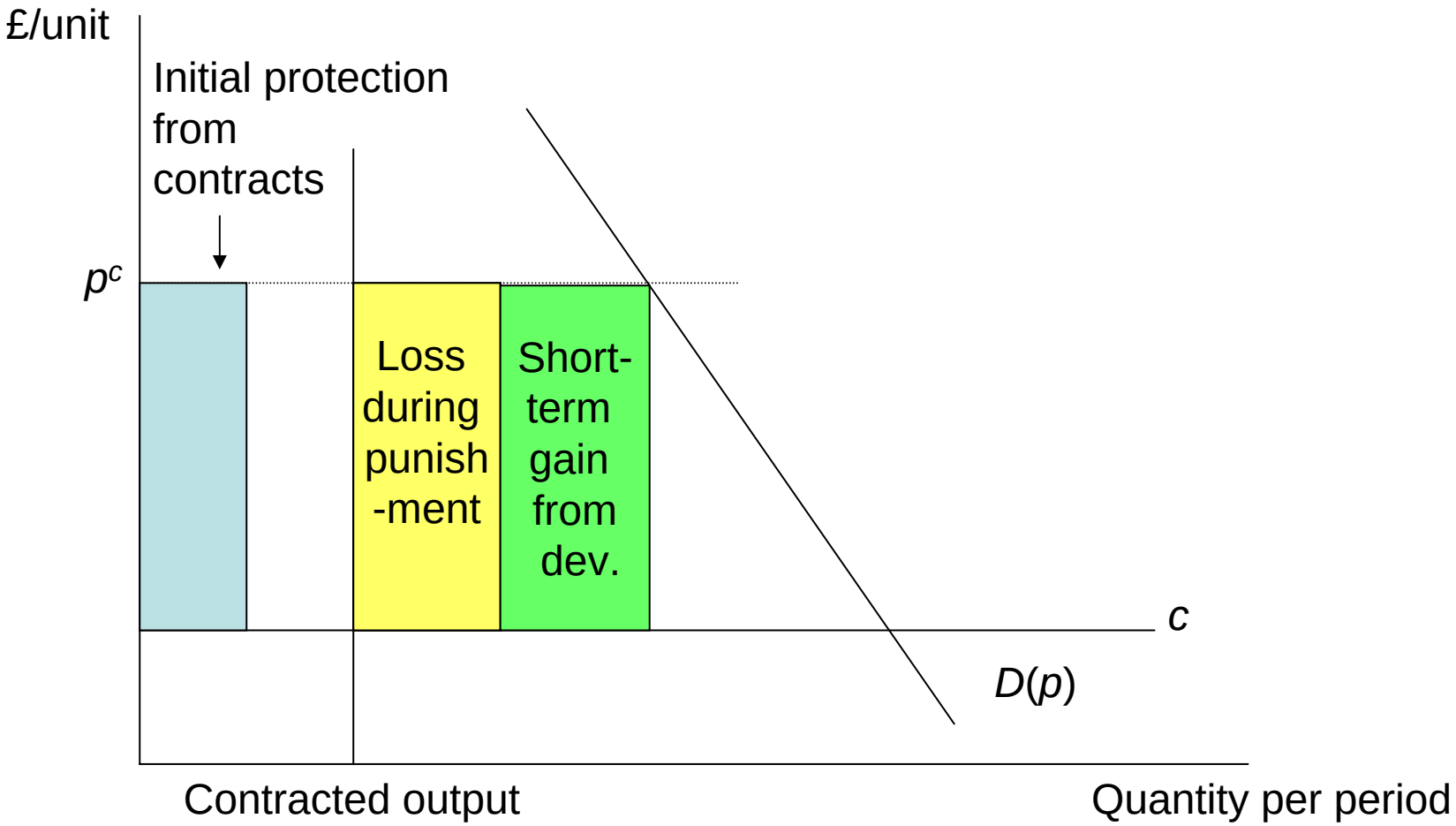
p^m is the price a monopoly would set in the spot market

p^{Rm} is the price a monopoly would set in the residual spot market (net of contract sales)

The consequences of deviation



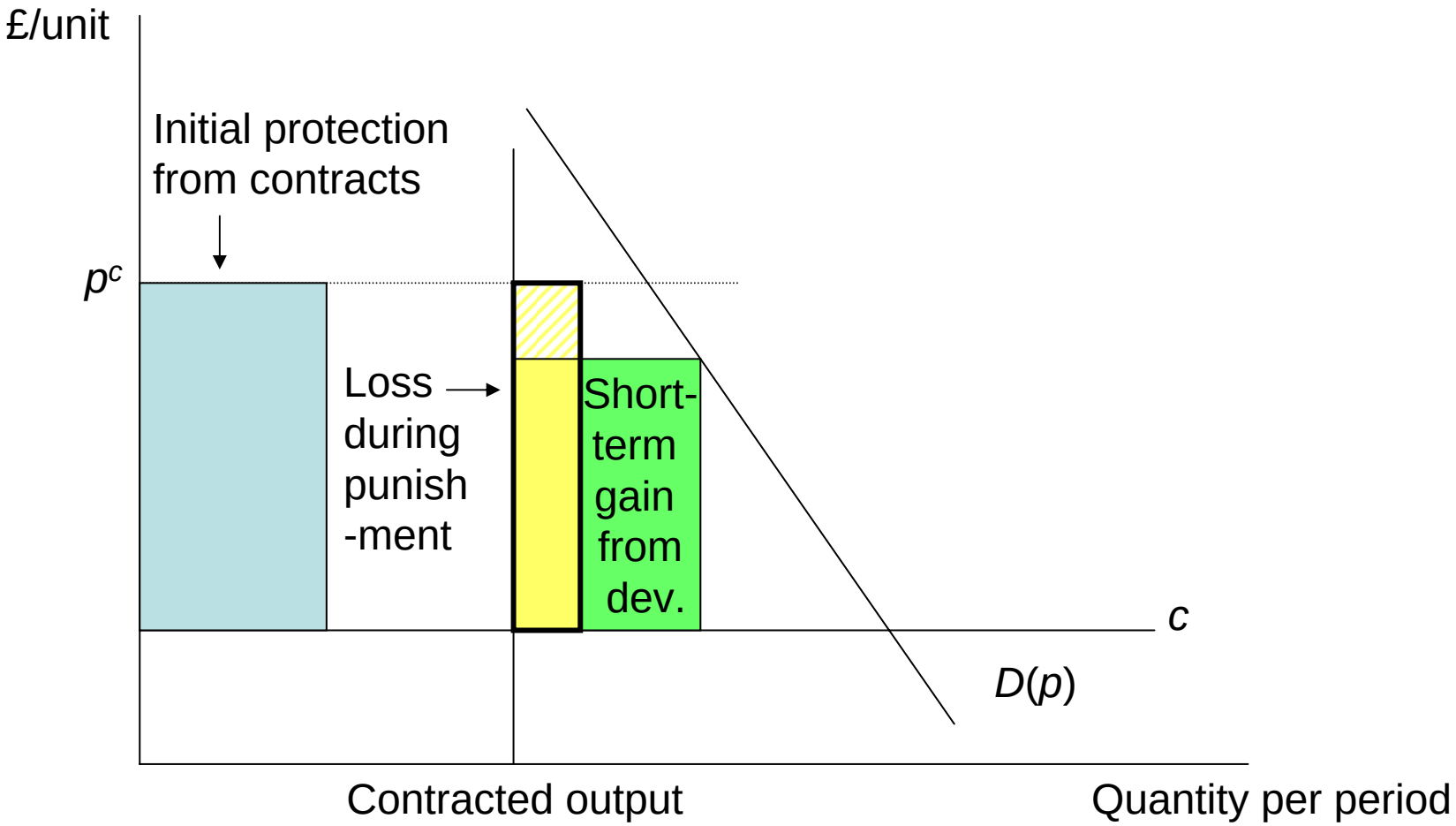
The consequences of deviation



Two effects

- Gain-cutting effect
  - reduces the initial gain from deviation, relative to collusive profit
- Protection effect
  - reduces the loss during the punishment, until the contracts expire
  - applies if contracts last more than one period

The consequences of deviation



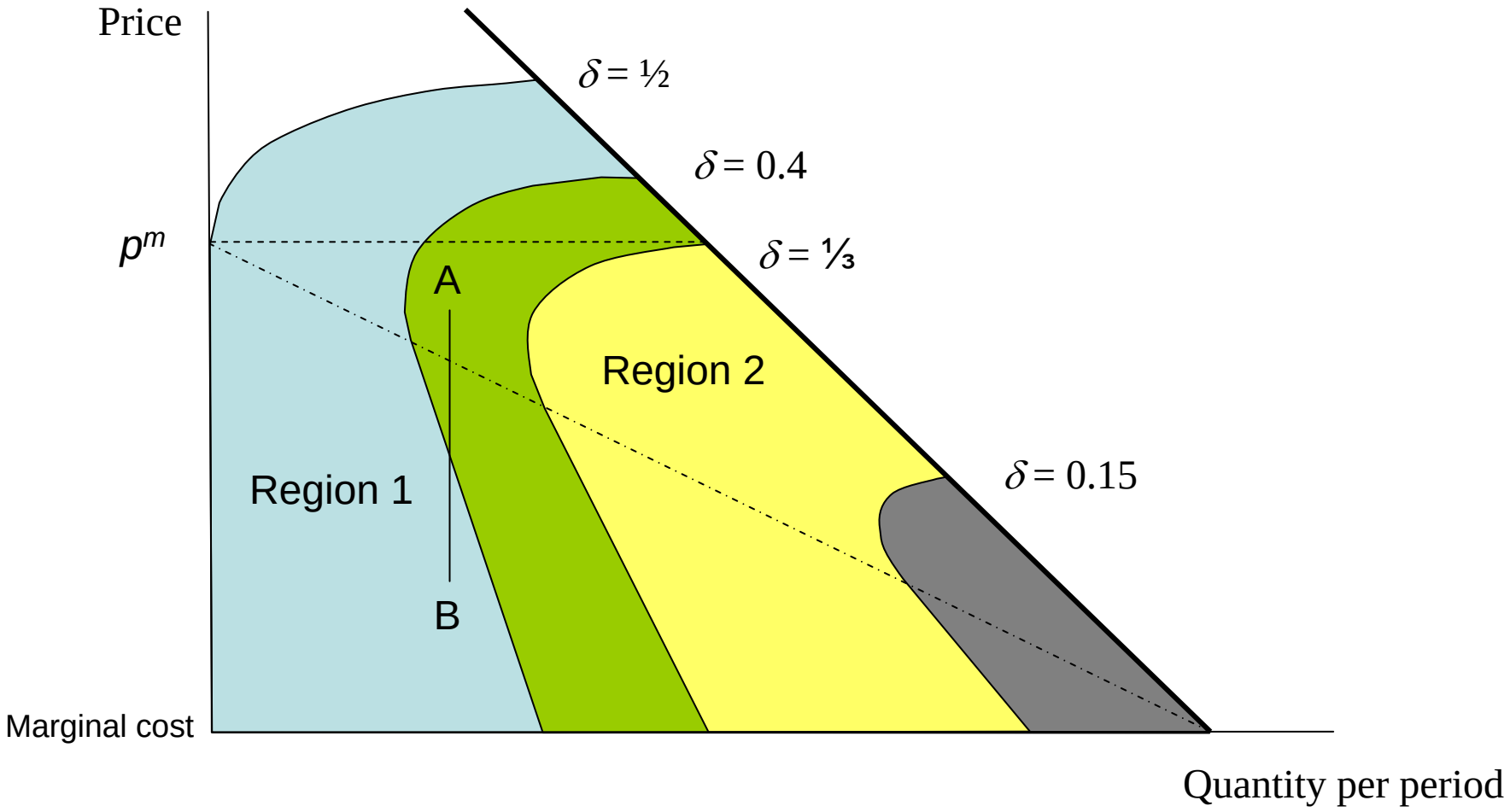
Sustaining collusion

- Whether collusion is sustainable depends on δ, x, λ, and p^c
- Minimum δ rises as λ increases
  - Protection effect grows stronger, collusion is harder
- Minimum δ may rise or fall as x increases
  - Both protection effect and gain-cutting effect grows stronger

Maximum sustainable price

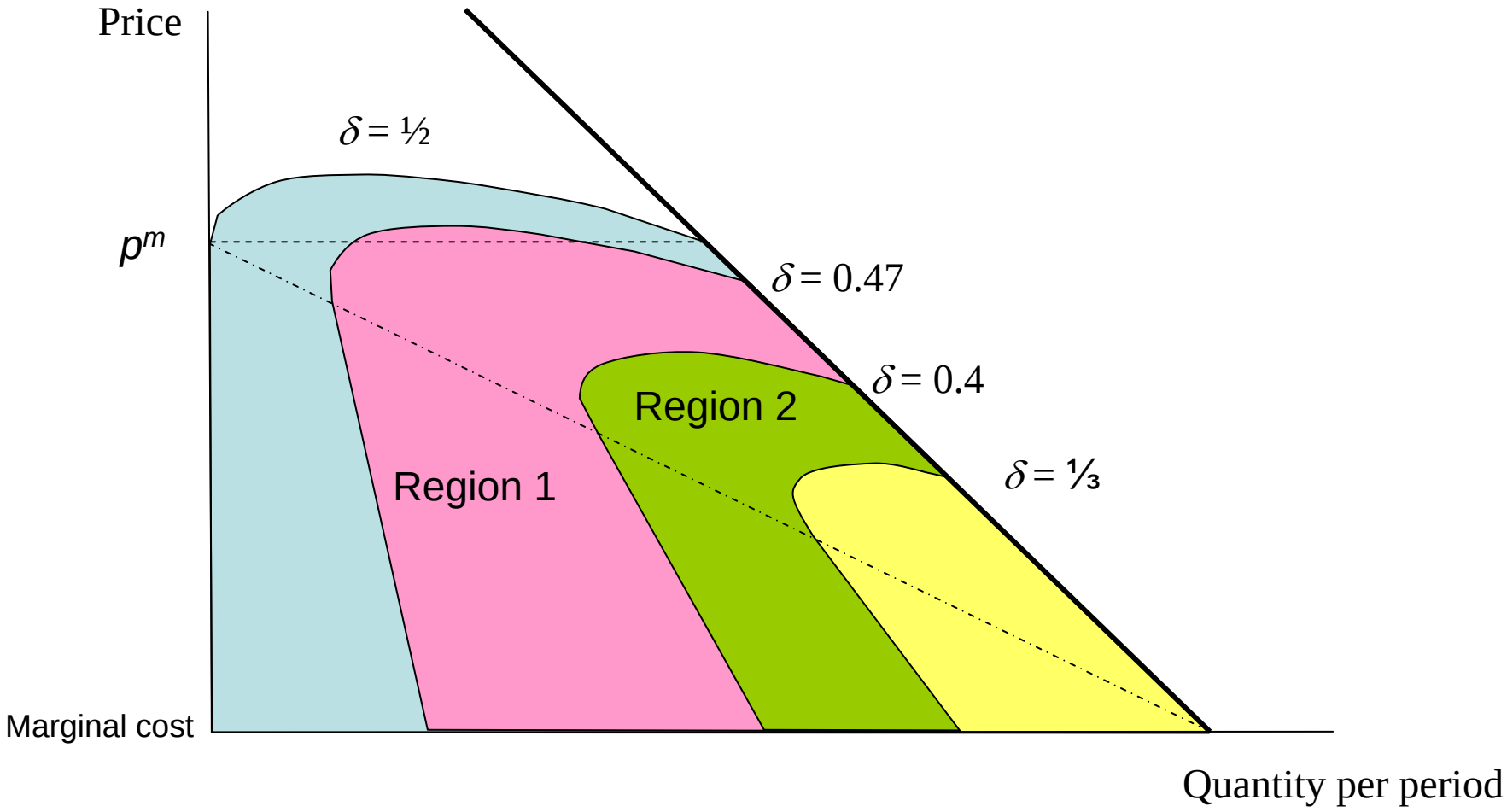
- Increases with the discount factor
  - Punishment has a greater weight, collusion is easier
- Decreases as contract length increases
  - Protection effect is stronger, collusion harder
- May rise or fall as *x* increases
  - Protection effect and gain-cutting effect are stronger

Linear case: Sustainable collusive prices with $\lambda = 1$



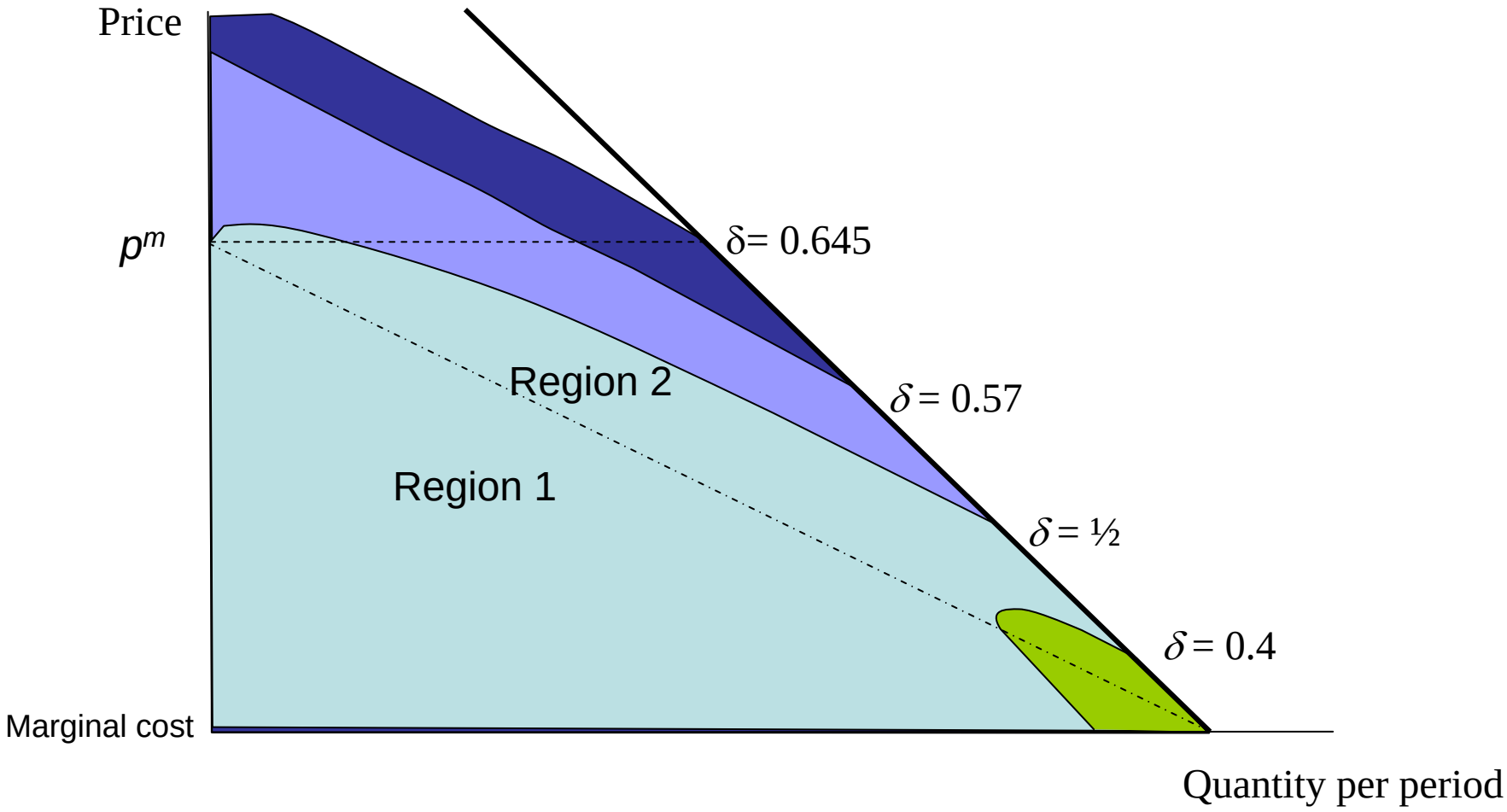
In region 1, deviate with a small price cut, in region 2, with a large one

Linear case: Sustainable collusive prices with $\lambda = 2$



In region 1, deviate with a small price cut, in region 2, with a large one

Linear case: Sustainable collusive prices with $\lambda = 4$



In region 1, deviate with a small price cut, in region 2, with a large one

A surprising result?

For *any* discount factor and *any* contract length,

given an appropriate level of contracts,

firms can sustain *some* price above marginal cost

But in general, longer contracts make collusion harder to sustain!