

ENCORE workshop – November 13, 2007
BALANCING PROS AND CONS OF VERTICAL SEPARATION
IN NETWORK INDUSTRIES

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Motivation – *vertical separation in network industries*

The net effect of vertical separation and horizontal competition

Cost efficiencies

Efficiencies in regulation

MOTIVATION

Vertical separation, liberalization and deregulation in network industries, such as **Electricity, Railways** and **Telecommunication**.

Characteristic: one production activity (the network) with '*natural monopoly*'-properties.

Advantages of separation and liberalization:

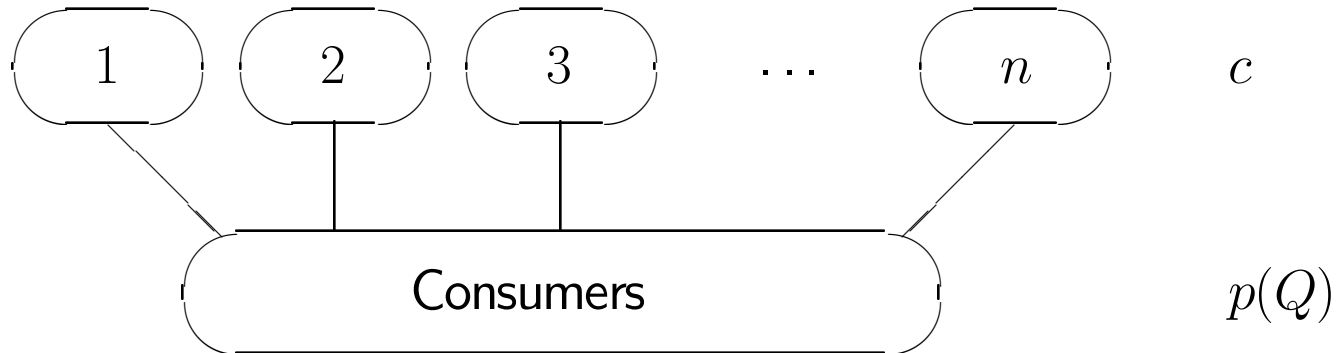
- *Horizontal liberalization* – increase in competition in most layers.
- *Dynamic efficiencies* – cost reduction, product innovation, quality and service.
- *Efficiencies in regulation* – reduction of regulator's information problem.

Disadvantage of separation:

- *Vertical separation* – introduces '*double marginalization*'.

HORIZONTAL COMPETITION

Consider quantity competition by n symmetric firms with constant marginal costs c :



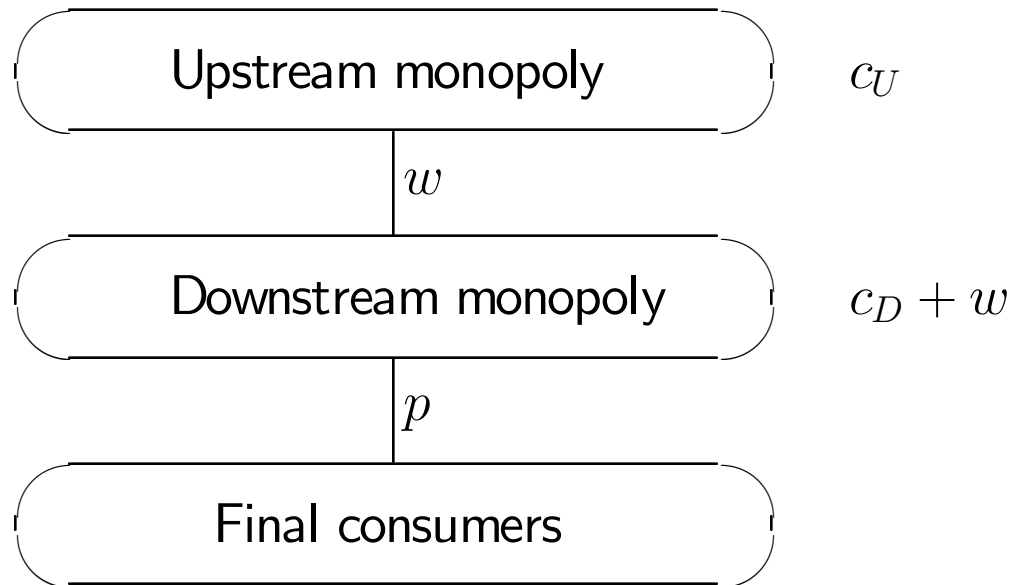
In *Cournot* equilibrium the *markup* is:

$$\frac{p - c}{p} = \frac{1}{n} \times \frac{1}{\varepsilon},$$

where $\varepsilon > 1$ is the (absolute value of) *price elasticity of market demand*.

Competition is good: an increase in n decreases markups and deadweight losses.

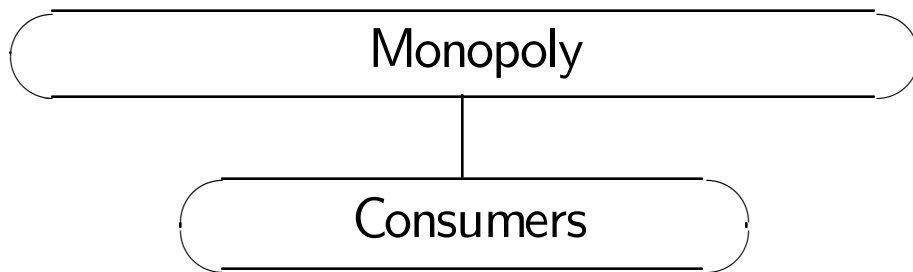
VERTICAL SEPARATION



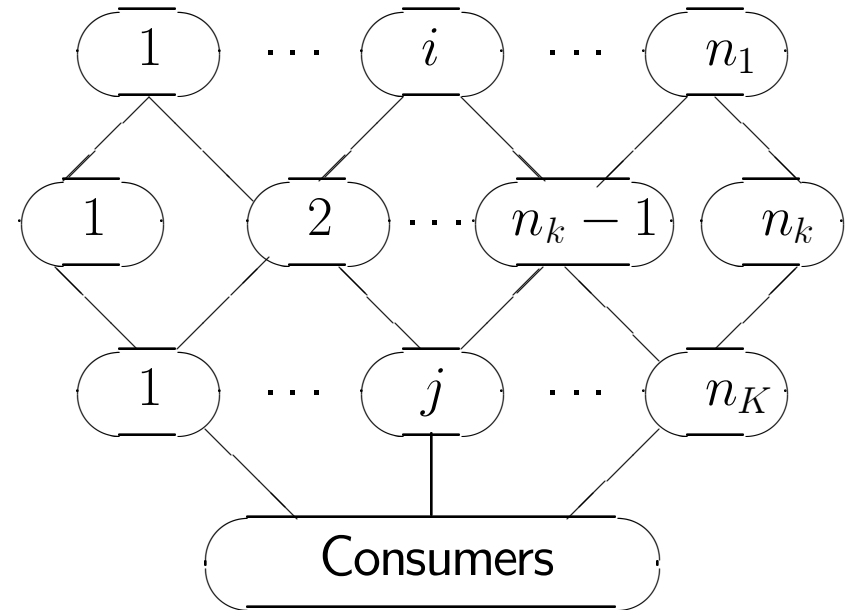
Under *linear pricing* the equilibrium quantity is **lower** than for integrated monopolist with marginal costs $c_U + c_D$: separation of a monopoly into successive monopolies is detrimental to welfare. Loss in consumer surplus **and** profits (e.g. Spengler, 1950).

Intuition: both monopolists price above marginal costs (**double marginalization**).

VERTICAL SEPARATION AND HORIZONTAL COMPETITION



OR



Evaluate *structural vertical separation* by carefully balancing:

- Advantage horizontal liberalization – *more competition*;
- Disadvantage vertical separation – *double marginalization*;
- Potential *efficiencies* in technology and/or regulation.

Horizontal versus vertical competition

Assume that – *after separation* – there are $K \geq 2$ layers with n_k firms in Cournot-competition in layer $k = 1, \dots, K$.

1. If inverse demand is linear, production (and total welfare) increases after *separation* and *liberalization* if and only if

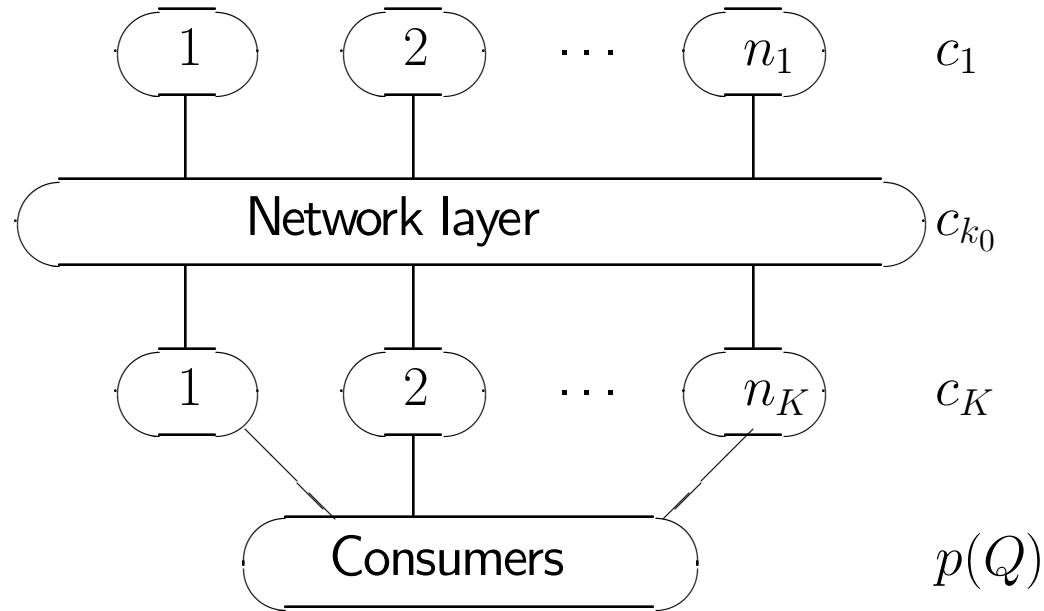
$$\frac{n_1}{n_1 + 1} \frac{n_2}{n_2 + 1} \cdots \frac{n_K}{n_K + 1} > \frac{1}{2}.$$

2. For general inverse demand and two layers ($K = 2$) production (and total welfare) increases after *separation* and *liberalization* if and only if

$$(n_1 - 1)(n_2 - 1) > 2 + Q^M \frac{P''(Q^M)}{P'(Q^M)} \geq 0.$$

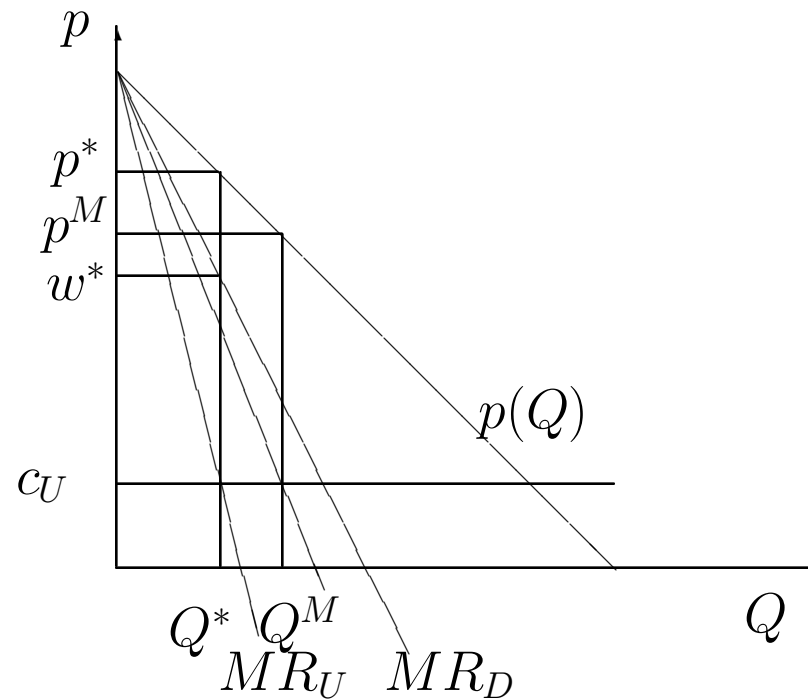
Note: In both cases *separation* and *liberalization* decreases aggregate production if there is a natural monopoly layer ($n_i = 1$ for some i).

Vertical separation in network industries



MAIN FINDING: If one production activity, with *constant marginal production costs*, is separated and liberalized such that *imperfect Cournot competition* results for that activity, then aggregate output decreases.

Graphically



In *Cournot* equilibrium the markup is:

$$\frac{p - (c_D + w)}{p} = \frac{1}{n} \times \frac{1}{\varepsilon} \Rightarrow MR_D = \left(1 - \frac{1}{n\varepsilon}\right) p = c_D + w$$

Analytically

The inverse demand function faced by the monopolist follows from $MR_D = w + c_D$ as

$$w(Q) = \left(1 - \frac{1}{n\varepsilon}\right) p(Q) - c_D.$$

Profits of the *upstream* monopolist are given by

$$\Pi^s(Q) = \left(\left(1 - \frac{1}{n\varepsilon}\right) p(Q) - c_D - c_U \right) Q.$$

Whereas profits of the *vertically integrated* monopolist are given by

$$\Pi^i(Q) = (p(Q) - c_D - c_U) Q.$$

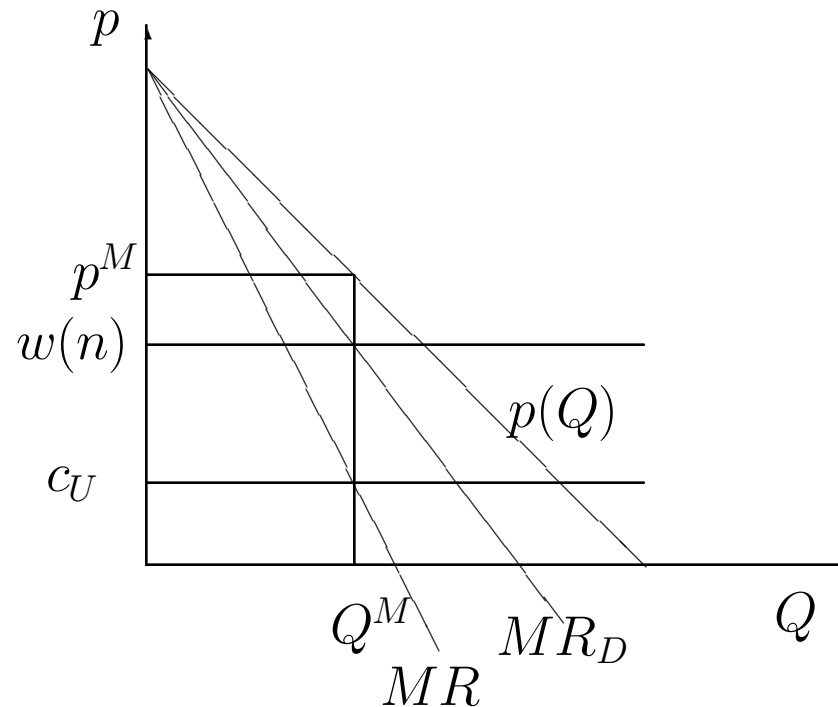
Two limit cases:

1. $n = 1$: classical *double marginalization* problem of successive monopolists;
2. $n \rightarrow \infty$: no downstream distortion, no welfare effect of separation and liberalization.

Costs

- There exist scenarios where production **may** increase after separation and liberalization, provided marginal costs are *strongly increasing* and *downstream competition is fierce*. These scenarios are unlikely when also the integrated monopolist would be able to choose the number of plants optimally.
- Production *decreases further* after separation if there are economies of scale (decreasing marginal downstream costs);
- In addition, total welfare may *decrease even further* if there are fixed costs associated with downstream production;
- Instantaneous *administrative costs* from transforming the industry might be substantial.

Nonlinear pricing



The upstream monopolist can set a nonlinear price scheme (w, M) , with w the unit price and M a fixed (franchise) fee.

Monopolist optimally sets $w = w(n)$ such that $p = p^M$ and $M = \pi_D = \frac{1}{n}Q^M (p^M - w)$.
 Note that $w(1) = c_U$ and $\lim_{n \rightarrow \infty} w(n) = p^M$.

Application of nonlinear pricing

Potential problems:

- Nonlinear pricing schemes may be very complicated and therefore difficult to use;
- Upstream monopolist has incentive to *deter* downstream entry (if downstream fixed costs are positive);
- Separation still does not lead to an *increase* in production.

Summarizing: without (substantial) dynamic efficiencies *separation* and *liberalization* in network industries has little merit.

Possible efficiencies:

1. Marginal cost reductions;
2. Alleviating problem of asymmetric information in regulation.

COST EFFICIENCIES

Separation and liberalization might be worthwhile if they lead to *reduction* in costs.

Let marginal costs **after separation** be given by

$$(1 - \delta) c,$$

where δ is a measure for the reduction in total marginal costs $c = c_U + c_D$.

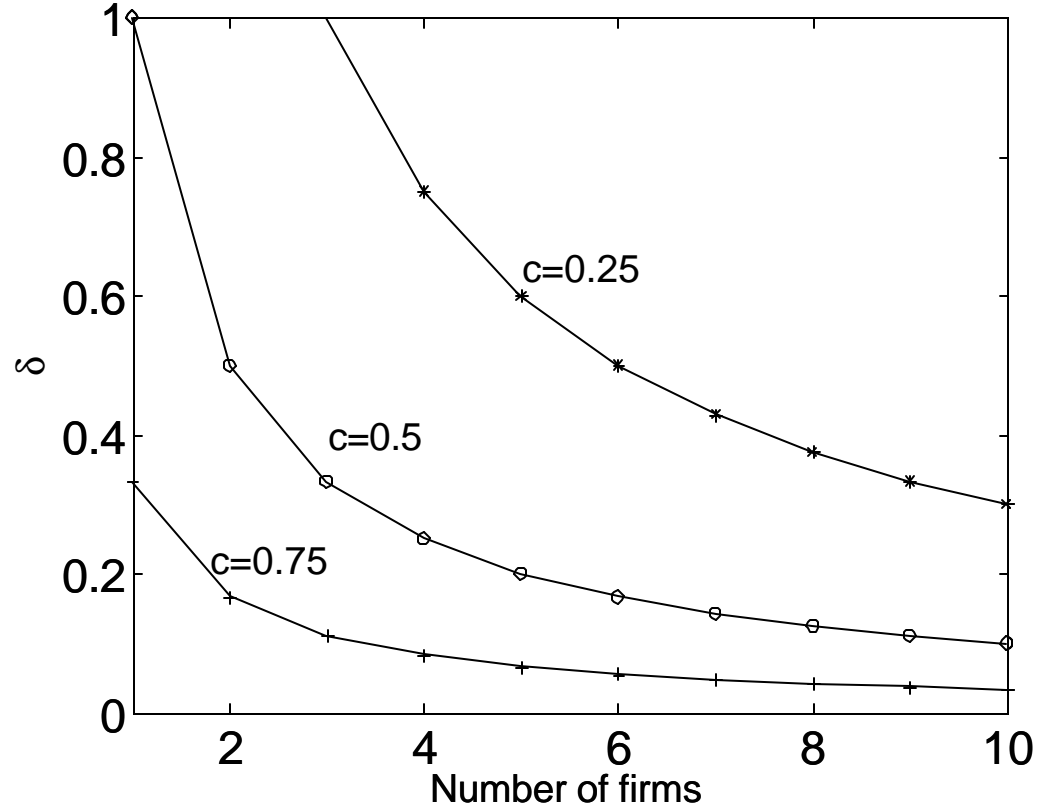
Production (and welfare) *increases* after separation if

$$\delta > \frac{g(Q^M)}{n \times c},$$

with $g(Q) = -Q [2p'(Q) + Qp''(Q)] > 0$. Decreases in n and c .

Required (net) cost reduction is substantial, particularly when marginal costs are low to begin with.

Required cost reduction for separation - one competitive layer



Required cost reduction, when there is one competitive layer (besides the network);
 $p(Q) = 1 - Q$ and $c = \frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$, respectively.

REGULATION

Asymmetric information: monopolist has better information about marginal costs than regulator and has incentive to report higher marginal costs.

Approach (Baron and Myerson, 1982): regulator devices contracts such that monopolist has the incentive to report the true marginal costs. Optimal regulation typically involves price distortions to restrict transfers to low cost monopolists.

Application of B-M model to "*upstream monopoly – downstream competition*":

- Vickers (1995): investigates whether upstream monopolist should be allowed into downstream industry. Trade-off between: monopolist's incentive to *raise rivals' costs*; and preventing *excess entry* (duplication of fixed costs).
- Lee and Hamilton (1999) extend Vickers' model by analyzing differences in downstream marginal costs between monopolist and 'fringe' firms.

EFFICIENCIES IN REGULATION

Intuition: separating activities alleviates the problem of *asymmetric information* between regulator and monopolist. Regulator only has to regulate part of the chain.

Choice between:

- Full regulation: regulating the *vertically integrated monopolist*.
- Partial regulation: *downstream* production layer is separated, which leads to *Cournot* competition with n firms. Regulator only regulates *upstream* network.

Outline for remainder of presentation:

- I. Optimal (*full* and *partial*) regulation under complete information.
- II. Optimal (*full* and *partial*) regulation under asymmetric information.
- III. Comparing *full* and *partial* regulation (under asymmetric information).

I. Optimal regulation under complete information

Consider welfare function

$$W = V - T + \alpha (n\pi_D + [\Pi_U + T - F]),$$

with:

- V : consumer surplus,
- T : *transfer* from consumers to upstream monopolist.
- $\alpha \in [0, 1]$: *weight* regulator attaches to firm profits ($\alpha = 1$: *total welfare*, $\alpha = 0$: *consumer welfare*)
- $n\pi_D$: *aggregate* downstream profits,
- Π_U : upstream gross profits,
- $F \geq 0$: upstream fixed costs

I.a Full regulation under complete information

Marginal costs up- and downstream are *constant* and given by c_U and c_D , respectively. Consumer demand is given by $Q(p)$.

Regulator knows cost and demand functions and sets consumer price p , taking into account the *participation constraint* for upstream monopolist

$$\Pi_U + T - F \geq 0.$$

Solution of the regulator's problem is:

$$p^r = c_U + c_D \text{ and } T^r = F.$$

I.b Partial regulation under complete information

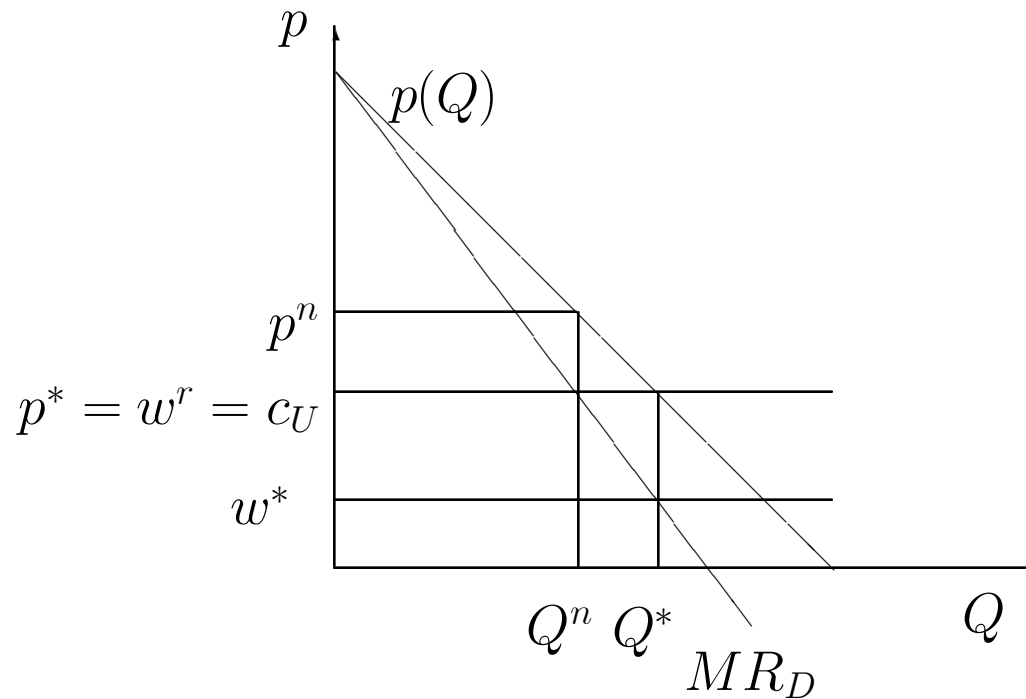
Downstream activity *separated* and *liberalized*: Cournot equilibrium. Regulator sets *upstream price* w . Optimal regulation policy:

$$w^s = w(\alpha; n) \text{ and } T^s = F - (w^s - c_U) Q_n(w^s).$$

There exists $\alpha^* \in (0, 1)$ such that:

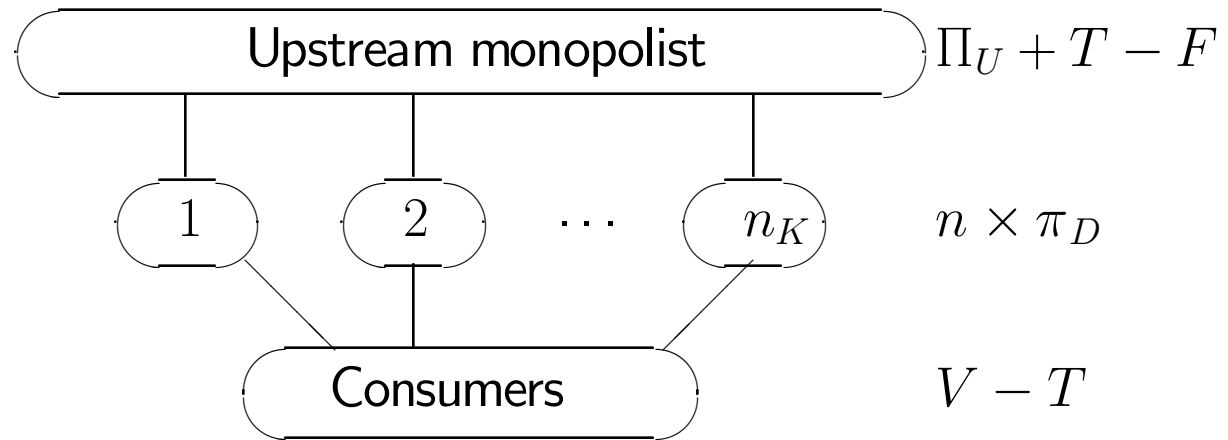
- For $\alpha > \alpha^*$ the upstream price (partially) **repairs** downstream distortion: $w(\alpha; n) < c_U$. Moreover, for $\alpha = 1$ input price w is chosen such that $p = c_U + c_D$.
- For $\alpha < \alpha^*$ the upstream price is used to put **regulatory squeeze** on downstream industry: $w(\alpha, n) > c_U$.

Reparation of distortion ($\alpha = 1, c_D = 0$)



For $\alpha < 1$ the regulator allows for a small distortion of consumer prices since transfers to the monopolist are not welfare neutral.

Regulatory squeeze



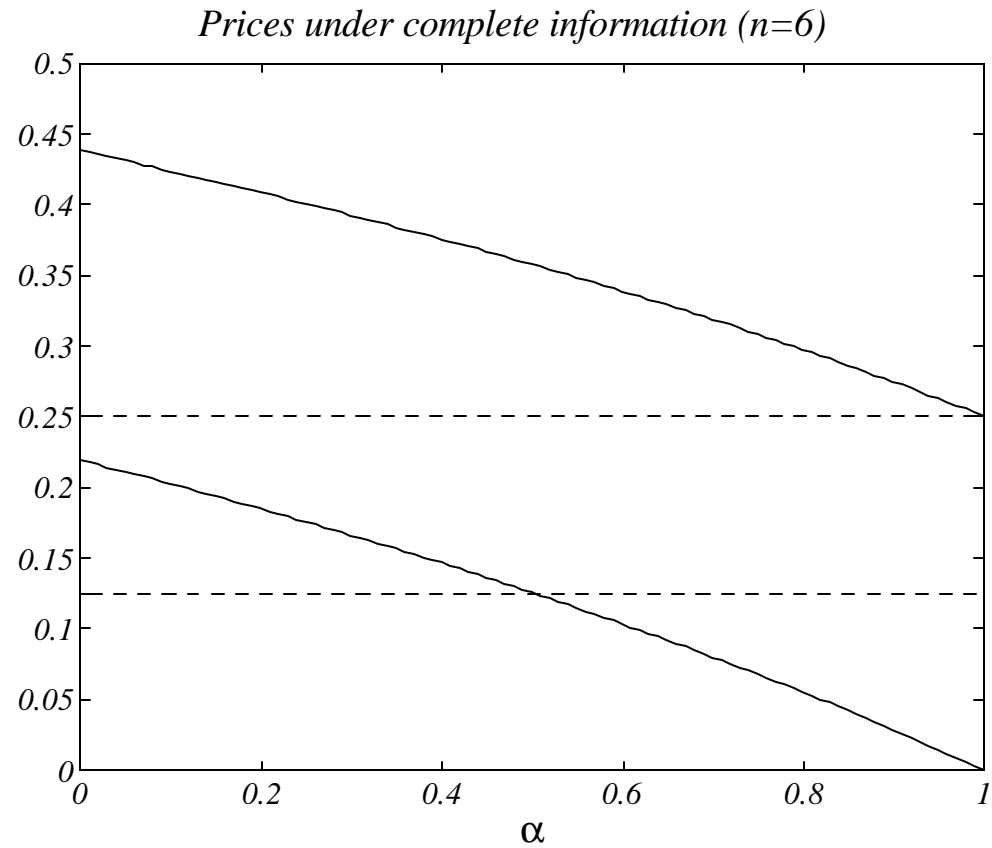
An *increase* in w above c_U has two, partially offsetting, effects:

1. *increase* in consumer price p , *decrease* in downstream profits $\Delta(n\pi_D) < 0$ and *decrease* in consumer surplus $\Delta V < 0$;
2. *increase* in upstream profits $\Delta\Pi_U > 0$ and *decrease* in transfer $\Delta T = -\Delta\Pi_U < 0$.

Second effect dominates when α is small enough:

$$-\Delta(n\pi_D) > \Delta V - \Delta T = \Delta V + \Delta\Pi_U > 0.$$

Example: $Q(p) = 1 - p$, $c_U = c_D = \frac{1}{8}$



Up- and downstream price w and p (—) and marginal costs c_U and $c_U + c_D$ (---)

II. Optimal regulation under asymmetric information

We follow the Baron-Myerson (1982) setup, and extend this with downstream Cournot competition:

- As before: two activities, *upstream* and *downstream*, with constant marginal costs c_U and c_D , respectively.
- Marginal costs, in each layer, are equal to c_L with probability $\frac{1}{2}$, and equal to $c_H > c_L$ with probability $\frac{1}{2}$. Realization marginal costs **unknown** to regulator (*asymmetric information*).

Differences with Vickers (1995) and Lee and Hamilton (1999):

1. We do not allow the upstream monopolist to enter the downstream industry;
2. Under (full) vertical integration realization of *downstream marginal costs* are unknown to the regulator

Asymmetric information

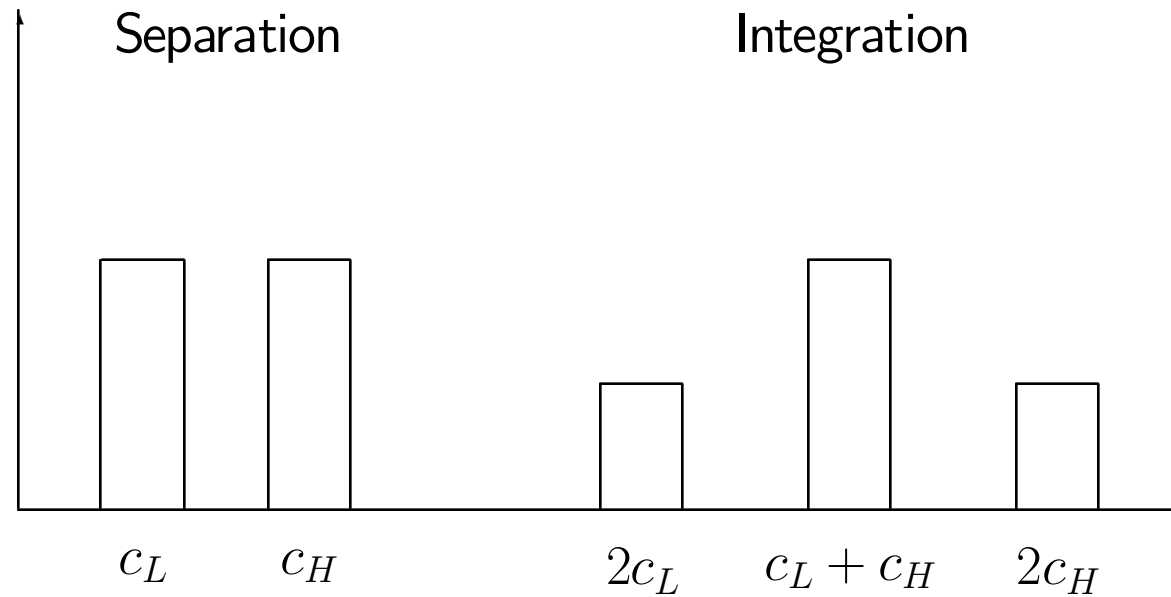
Probability distribution of marginal costs of the *vertically integrated monopolist* is:

$$c_U + c_D = \begin{cases} 2c_L & \text{with probability 0.25} \\ c_L + c_H & \text{with probability 0.50} \\ 2c_H & \text{with probability 0.25} \end{cases} .$$

After separation regulator knows downstream marginal costs and its probability distribution of marginal costs of *upstream monopolist* is then:

$$c_U = \begin{cases} c_L & \text{with probability 0.50} \\ c_H & \text{with probability 0.50} \end{cases} .$$

Asymmetric information



The regulator's probability distribution over marginal costs for:

- The *upstream monopolist* after separation (left);
- The *vertically integrated monopolist* (right).

II.a Full regulation under asymmetric information

The regulator chooses 'contracts' (p_{IJ}, T_{IJ}) in such a way that, if the monopolist reports marginal costs $c_I + c_J$, the regulator sets price p_{IJ} , and combines this with transfer T_{IJ} to the monopolist.

The regulator maximizes *expected welfare* under the restriction that 'contracts' are designed such that:

- Each type of monopolist will be active (*participation constraints*).
- *Revelation principle*: a monopolist has the incentive to report actual marginal costs (*incentive constraints*).

Note that monopolist with low marginal costs makes positive profits (*'information rents'*).

The optimal full regulation policy

$$p_{HH}^r = 2c_H + 3(1 - \alpha)(c_H - c_L)$$

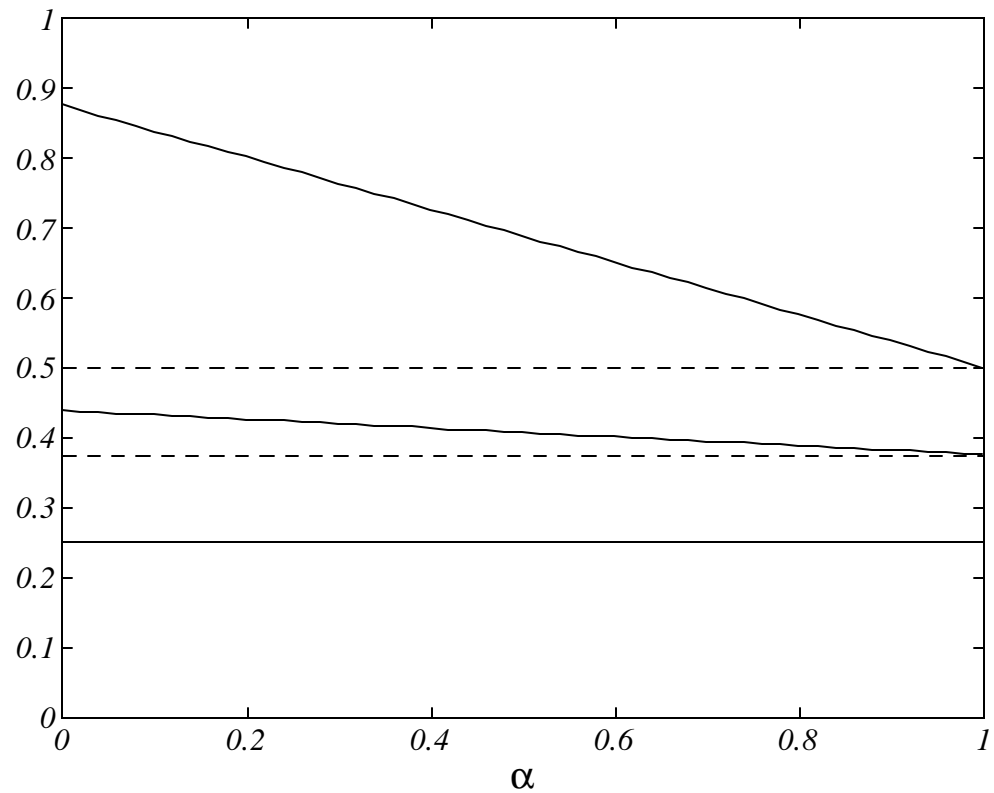
$$p_{HL}^r = c_H + c_L + \frac{1}{2}(1 - \alpha)(c_H - c_L)$$

$$p_{LL}^r = 2c_L$$

1. Price at lowest marginal costs always equal to marginal costs.
2. The regulator sets all prices equal to marginal costs when $\alpha = 1$.
3. For $\alpha < 1$ the price at higher marginal costs lies above marginal costs.

Intuition: transfer from consumers to monopolist not welfare neutral when $\alpha < 1$. Higher price for higher marginal costs decreases transfer to more efficient monopolist.

Prices under full regulation, $c_H = 1/4, c_L = 1/8$



From high to low: $p_{HH}^r, 2c_H, p_{HL}^r, c_H + c_L$ and $p_{LL}^r = 2c_L$.

II.b Partial regulation under asymmetric information

The *downstream* activity is *separated* and *liberalized*: Cournot oligopoly with n firms. Final consumer demand which is represented by:

$$Q(p) = 1 - p.$$

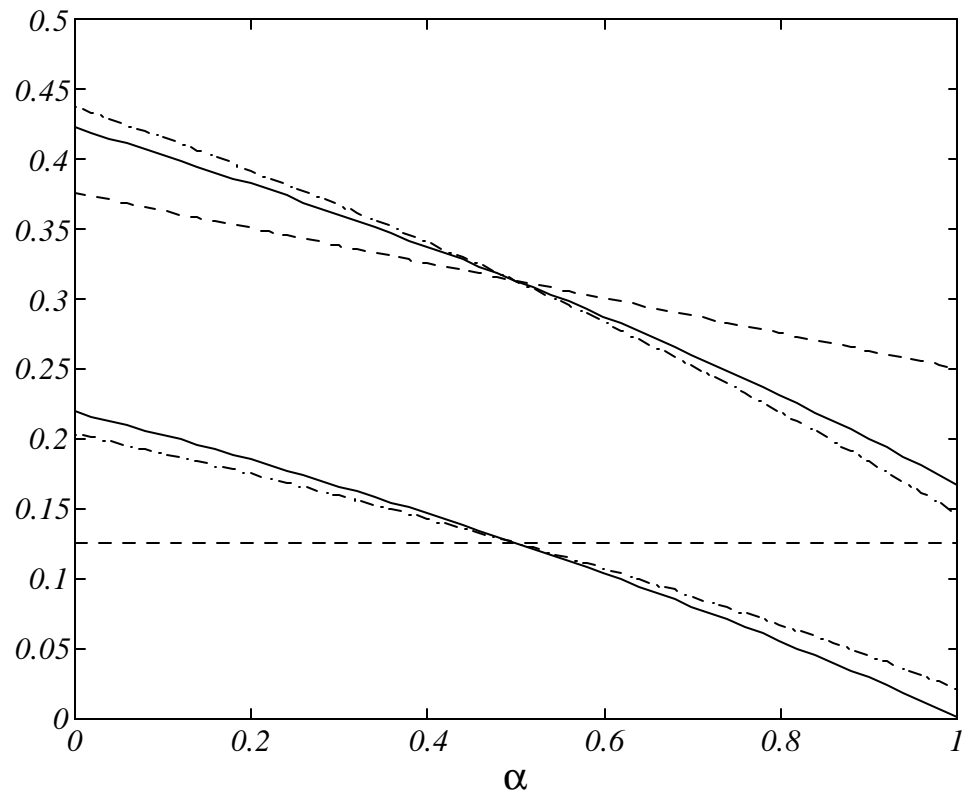
Consequences of separation:

1. Introduces a distortion on *downstream* market.
2. Alleviates the problem of *asymmetric information* with respect to the *upstream* monopoly.

The regulator knows n , c_D and inverse demand and offers (conditional on the realization of c_D) two contracts:

$$(w_H^s(c_D), T_H^s(c_D)) \text{ and } (w_L^s(c_D), T_L^s(c_D)).$$

Regulated prices at separation, $n=6$, $c_H=1/4$, $c_L=1/8$



Solid lines: $w_H^s(c_H)$ and $w_L^s(c_L)$, broken-dotted lines (—·): $w_H^s(c_L)$ and $w_L^s(c_H)$, and broken lines: $w_H^s(c_D)$ and $w_L^s(c_D)$ if $n \rightarrow \infty$ (no downstream distortion).

Discussion of the optimal partial regulation policy

If $n \rightarrow \infty$ and there is no distortion on the downstream market, optimal regulation is similar to that under full regulation (but with better information for regulator).

Two extra effects if $n < \infty$ (compare with *complete* information scenario)

1. $\alpha > \alpha^*$: Regulator uses prices to repair downstream distortion. For α large enough regulated prices lie **below** marginal costs $c_L \setminus c_H$. If $\alpha = 1$ upstream prices are chosen such that consumer prices are equal to $p = c_U + c_D$.
2. $\alpha < \alpha^*$: Regulator chooses prices in order to, at the expense of downstream industry, decrease transfers from consumers to monopolist further: **regulatory squeeze**.

III. Welfare comparisons: To separate or not?

Let

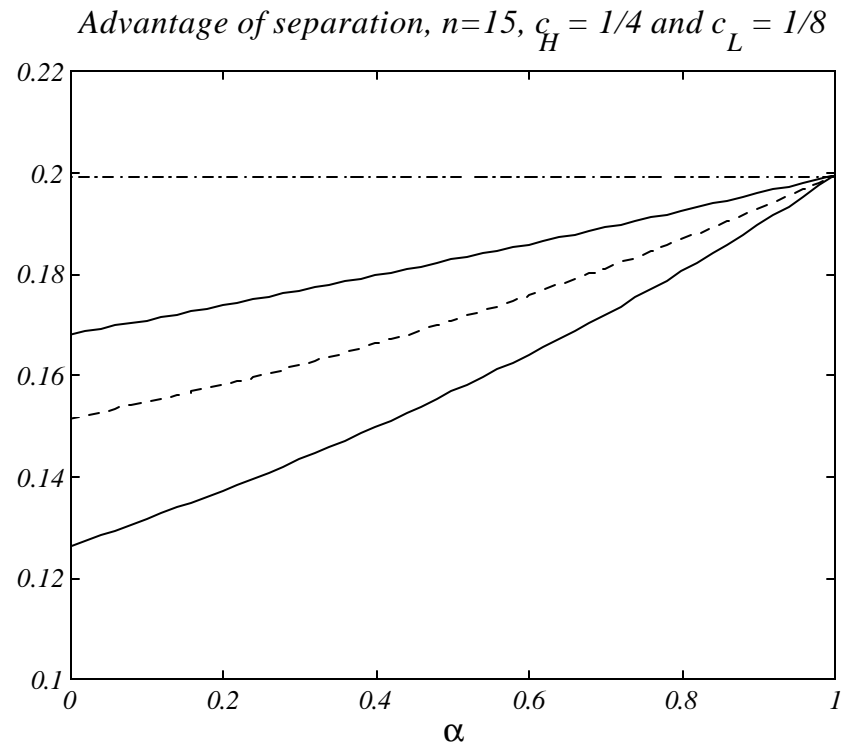
$W^r(\alpha, c_H, c_L)$: expected welfare under *full regulation*.

$W^s(n, \alpha, c_H, c_L)$: expected welfare under *separation* and *partial regulation*.

$W^*(c_H, c_L)$: expected welfare in *Pareto-optimum*.

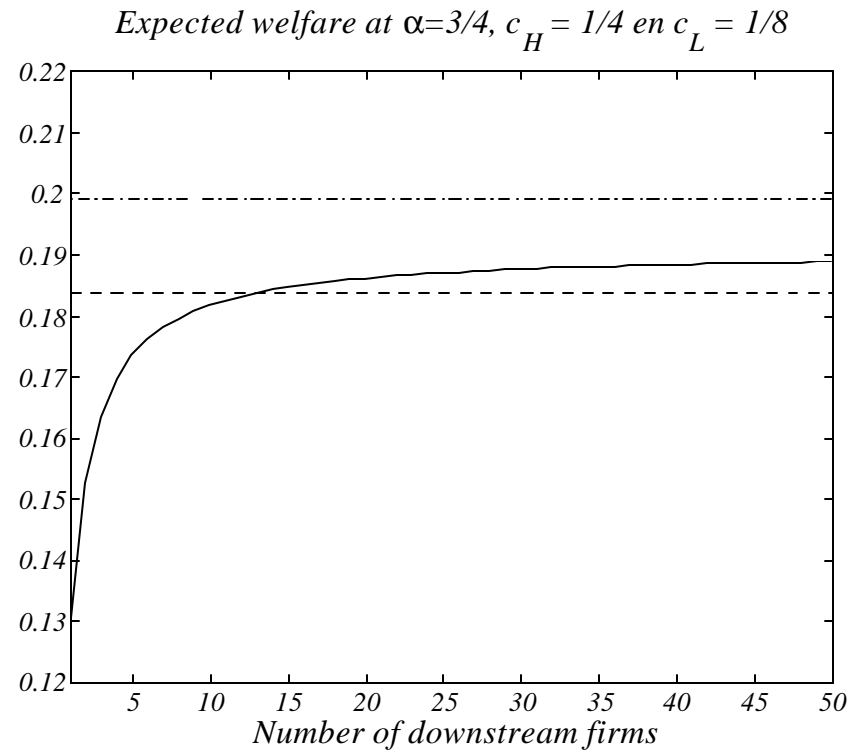
Results:

- If $\alpha = 1$ the *Pareto-optimum* will always be obtained.
- Separation *welfare enhancing* if:
 - *Downstream* industry competitive (n large).
 - Problem of *asymmetric information* is big ($c_H - c_L$ relatively large).



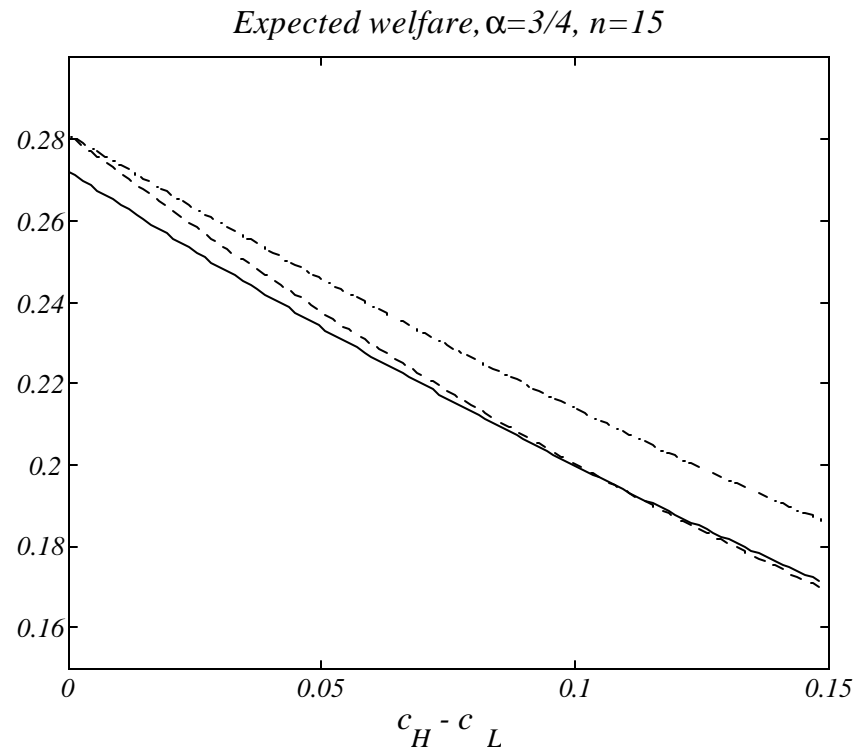
From top to bottom: expected welfare at Pareto-optimum, $W^* \left(\frac{1}{4}, \frac{1}{8} \right)$; *separation* with perfect competition *downstream*, $W^s \left(\infty, \alpha, \frac{1}{4}, \frac{1}{8} \right)$; *full regulation*, $W^r \left(\alpha, \frac{1}{4}, \frac{1}{8} \right)$; and *separation* with $n = 6$ firms *downstream*, $(W^s \left(6, \alpha, \frac{1}{4}, \frac{1}{8} \right))$.

Impact of n



From top to bottom (at $\alpha = 0$): $W^* \left(\frac{1}{4}, \frac{1}{8} \right)$ ($- \cdot$), $W^r \left(\frac{3}{4}, \frac{1}{4}, \frac{1}{8} \right)$ ($- -$) and $W^s \left(n, \frac{3}{4}, \frac{1}{4}, \frac{1}{8} \right)$ ($-$).

Impact of $c_H - c_L$



From top to bottom: $W^*(c_H, c_L)$ ($- \cdot$); $W^r(\frac{3}{4}, c_H, c_L)$ ($- -$); $W^s(15, \frac{3}{4}, c_H, c_L)$ ($-$).

DISCUSSION

Conclusion: In absence of (substantial) dynamic efficiencies, or efficiencies in regulation the net effect of vertical separation and liberalization is negative.

Intuition: Separation introduces additional layer of (*potentially distorting*) competition.

Conditions for separation in network industries to be beneficial:

1. *Isolation* and *tight regulation* of the network / natural monopoly.
2. Facilitate *fierce competition* in separated activities.
3. Potential *cost efficiencies* should be substantial – typically impossible when marginal costs are relatively low.
4. Potential *efficiencies in regulation* should be substantial.