Missing Markets

Using benchmarking to identify and create markets

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Outline

Markets and efficiency

Merger analysis

Reallocation analysis

Conclusions

Focus on ideas – not literature or mathematics

Markets and efficiency

Markets

Welfare theorems (Smith, Arrow, Debreu)

- A competitive economy leads to a Pareto efficient allocation
- Any Pareto efficient outcome can be implemented through a price system plus some initial lump sum reallocations

So minimal (governmental or CFEM) interference is necessary

Theoretical exceptions

- Market failures (externalities, natural monopolies, public goods)
- Perfect information and complete markets

Practical experience from e.g. benchmarking

- Firms usually do not use best practices
- Production usually is not optimally allocated
- Matching is often costly

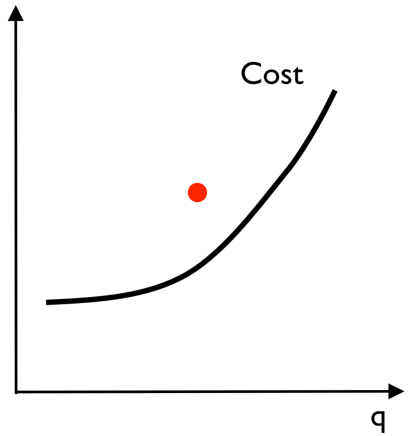
So government or CFEM necessary to make or improve markets

Questions

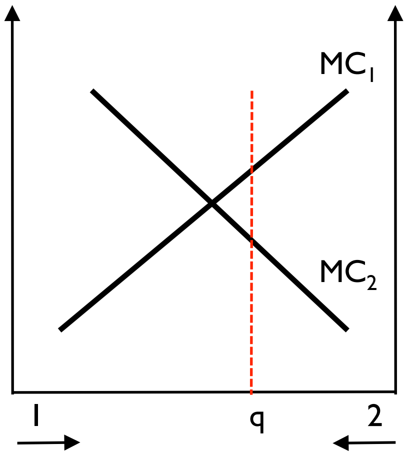
- How identify missing and inefficient markets
- How establish new markets and improve inefficient ones

Inefficiencies

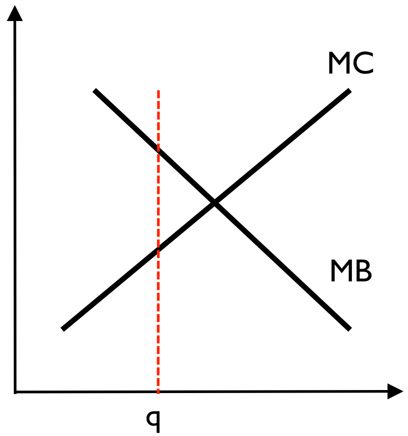
Single product examples



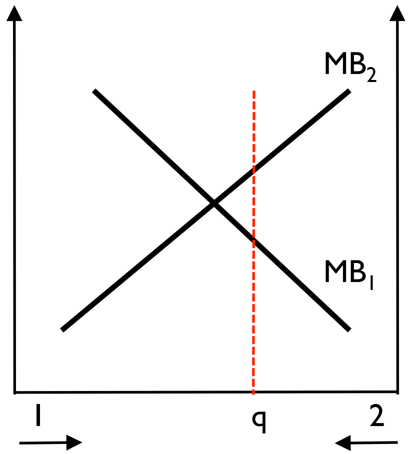
Inefficient managers market, contracts, regulation



Inefficient allocation of production, e.g. sugar beets



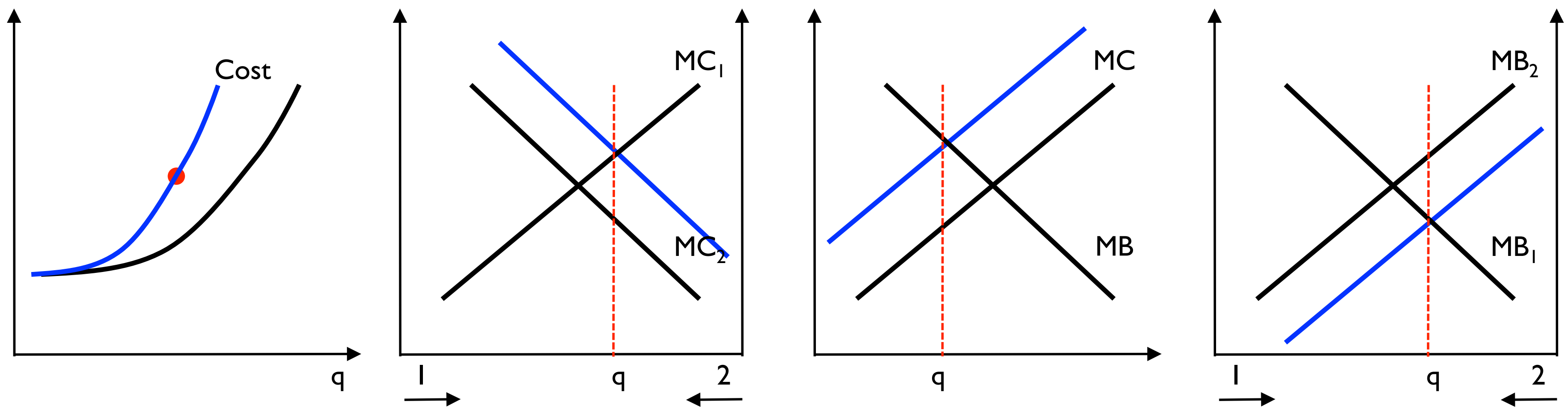
Inefficient production level e.g. pollution control



Inefficient allocation of services, e.g. health services

We need data to estimate functions and hereby identify inefficiencies.

First or second best



Problem:

– Informational asymmetries and incentive problems may explain inefficiencies

– We should look for second best inefficiencies, not first bests inefficiencies

Solution (?):

– Use data from similar entities to depict the feasible outcomes – whether first best or second best.

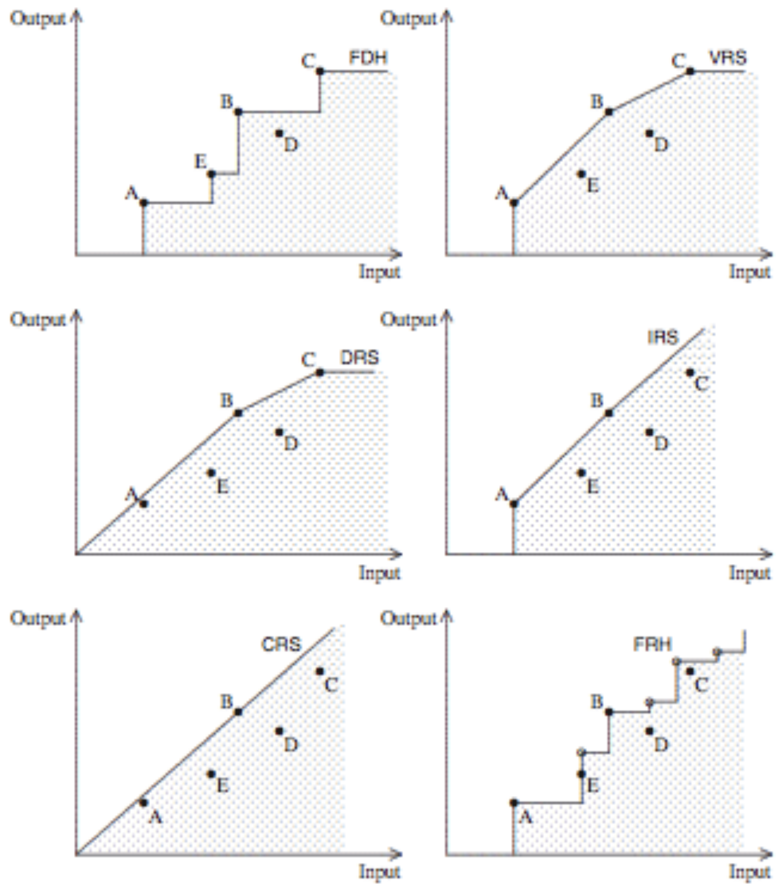
Data

Data

- (x^j,y^j) input-output vectors from firm j, j=1,…,n
- T={(x,y): x can produce y}
- No prices (w,p) or prices already partially used to aggregate inputs and outputs.

Estimate the technology

- T may be estimated from data using DEA, SFA or similar approaches
- Best practice may include second best problems
- DEA examples in 1 input 1 output case:



ig. 4.2 DEA technology sets under different assumptions

Benchmarking

Relative performance evaluation
May support

Learning

- What is the best practice, the impact of managerial skills, new technology, new regulation, etc

Planning and reallocation

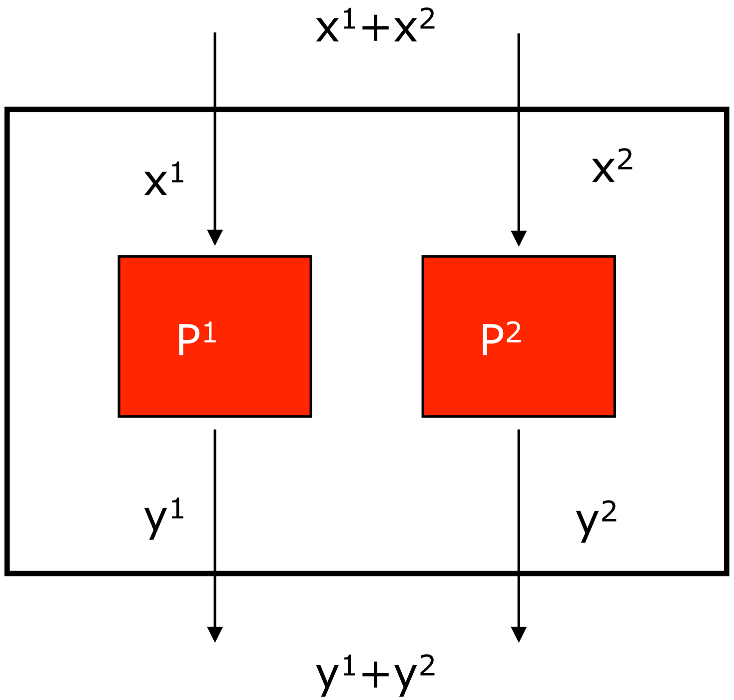
- How should we allocate production in firm or sector?

Incentives

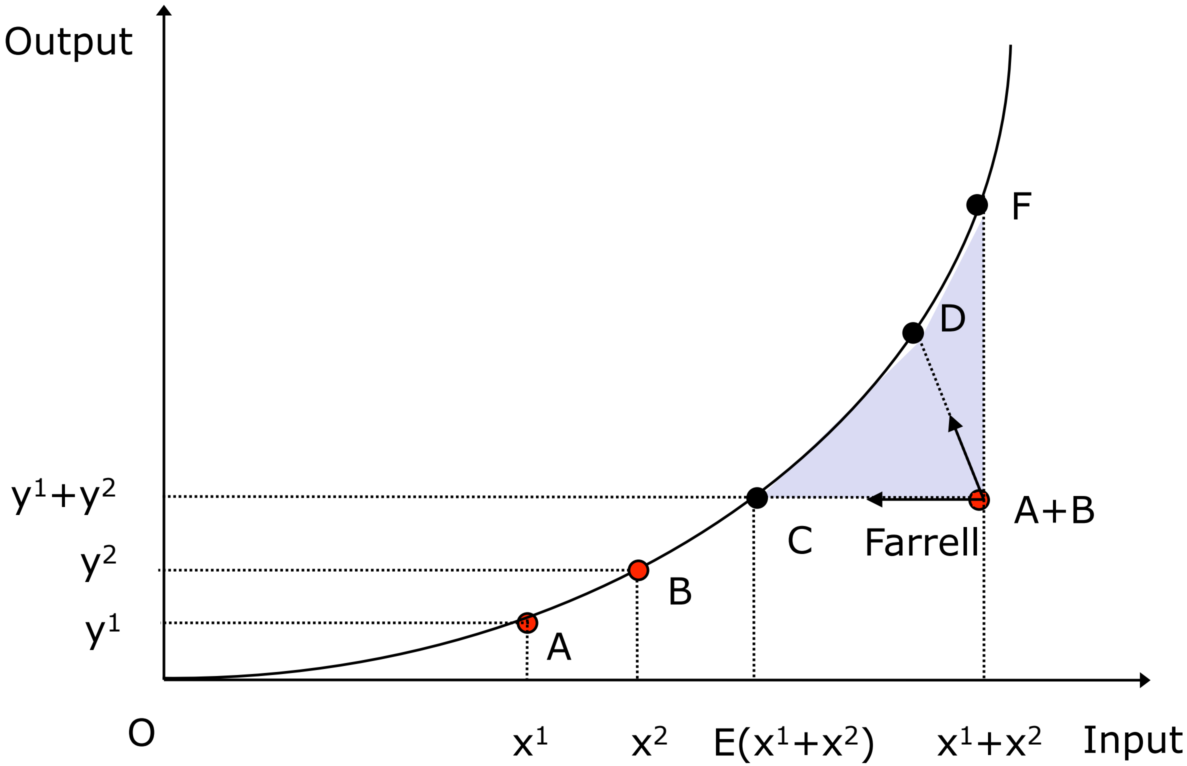
- How design contracts and regulation?

Merger analysis

Horizontal integration



Horizontal integration



Overall horizontal gains

A merger

- Merge DUMs in $J \subseteq \{1, 2, ..., n\}$. Merged unit denoted DMU^J
- Operated individually, DMU^J has used $\sum_{j \in J} x^j$ to produce $\sum_{j \in J} y^j$.
- What can be gained by operating DMU^J as a merged unit ?

Potential overall gains

from merging the J-DMUs is

$$E^J = \text{Min}\{E \in R_0 \mid (E[\sum_{j \in J} x^j], \sum_{j \in J} y^j) \in T\}$$

E<1 is attractive!

- Potential gains = potential savings

LP problem

Potential overall gains

$$\min_{E,\lambda} \quad E$$

$$\text{s.t.} \quad E[\sum_{j\in J} x^j] \geq \sum_{i\in I} \lambda^i x^i$$

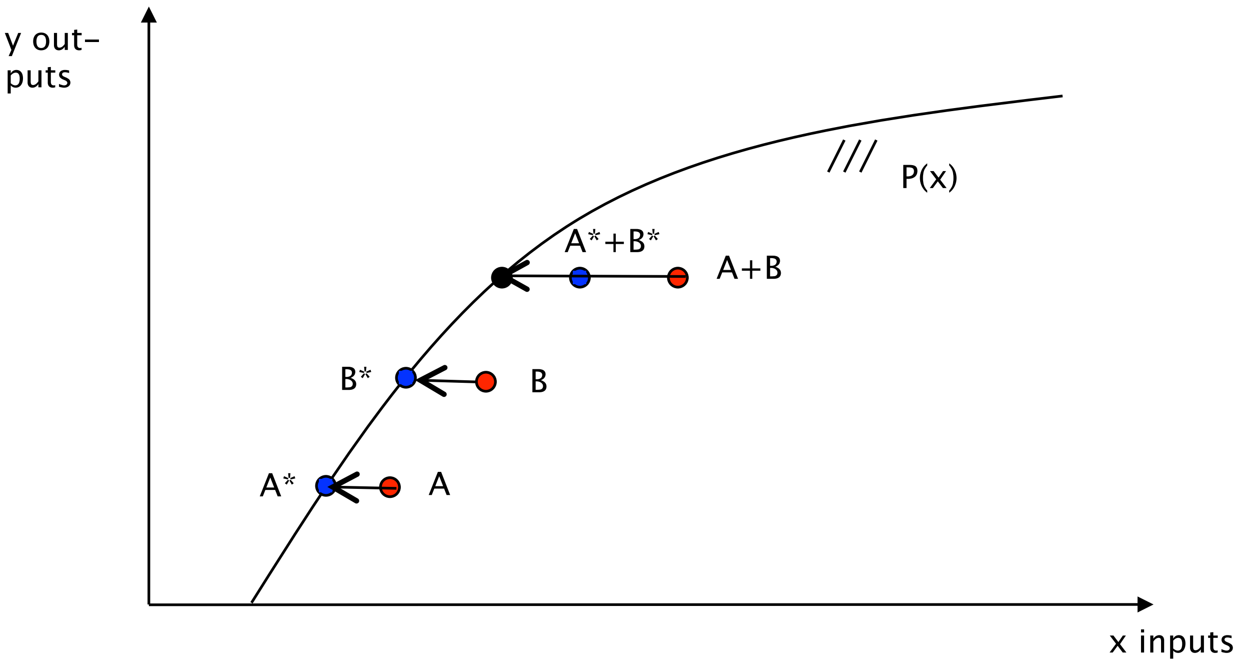
$$[\sum_{j\in J} y^j] \leq \sum_{i\in I} \lambda^i y^i$$

$$\lambda \in \Lambda(k)$$

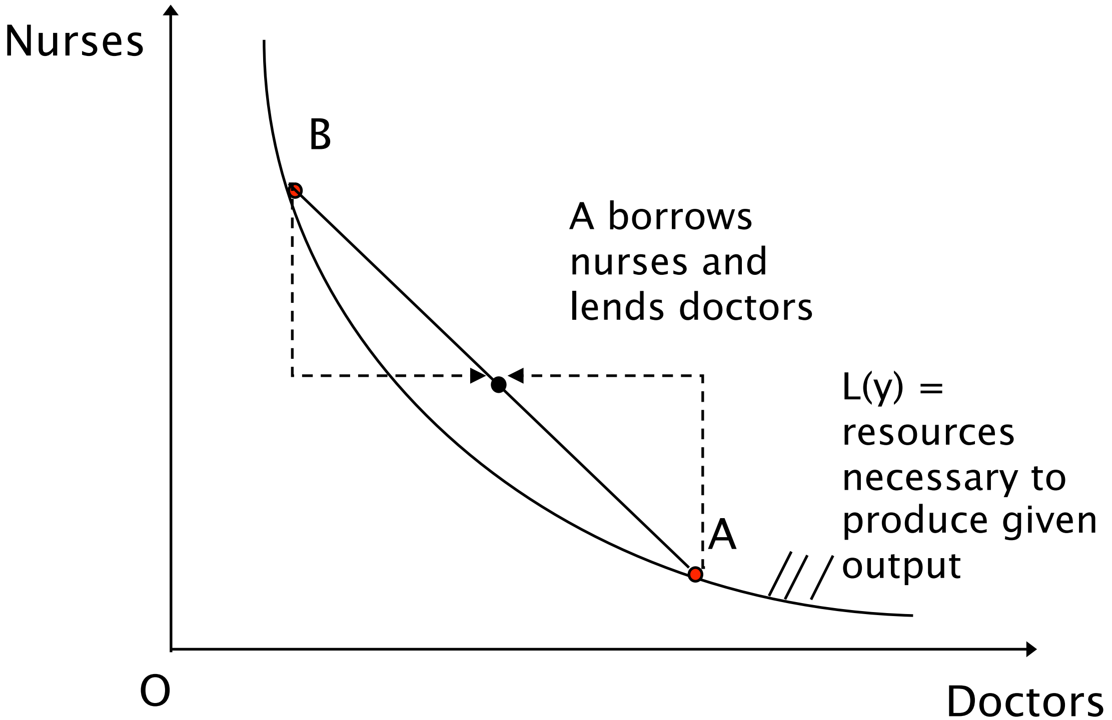
Practical steps

- Add inputs used in units in J: x^J
- Add outputs used in units in J: y^J
- Evaluate efficiency of (x^J, y^J) in technology spanned by the original data

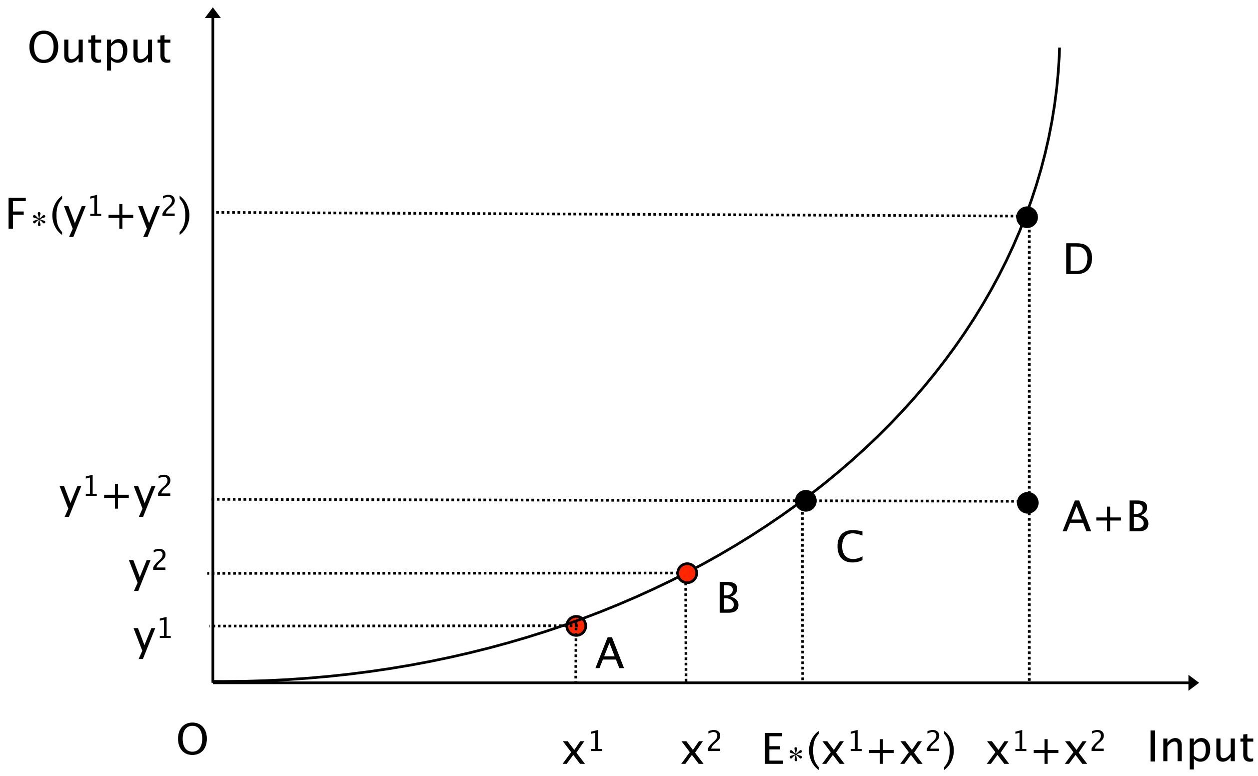
Individual learning



Scope (Harmony)



Scale (Size)



Decomposition Horizontal

Total potential

- $E^J = \text{Min}\{E \in R_0 \mid (E[\sum_{j \in J} x^j], \sum_{j \in J} y^j) \in T\}$

Adjusted (ex learning) potential

- $E^{*J} = \text{Min}\{E \in R_0 \mid (E[\sum_{j \in J} E^j x^j], \sum_{j \in J} y^j) \in T\}$

Technical efficiency (learning)

- $T^J = E^J / E^{*J}$

Scope (mix, harmony)

- $H^J = \text{Min}\{H \in R_0 \mid (H[|J|^{-1} \sum_{j \in J} E^j x^j], |J|^{-1} \sum_{j \in J} y^j) \in T\}$

Scale (size)

- $S^J = \text{Min}\{S \in R_0 \mid (S[H^J \sum_{j \in J} E^j x^j], \sum_{j \in J} y^j) \in T\}$

Total decomposition

- $E^J = T^J * H^J * S^J$

Note

- All simple LP problems when T is modeled via DEA

Examples crs and vrs

$E^J = T^J * H^J * S^J = T^J * E^{*J}$

Potential gains = Learning * Harmony *Size

Merger	E	E*	TE	H	S
4 & 89	0.78	0.95	0.81	0.95	1.00
20 & 90	0.81	0.97	0.84	0.97	1.00
29 & 30	1.00	1.00	1.00	1.00	1.00
30 & 31	0.89	1.00	0.89	1.00	1.00
30 & 91	0.83	1.00	0.83	1.00	1.00
31 & 91	0.77	0.96	0.80	0.96	1.00
34 & 92	0.80	0.94	0.85	0.94	1.00
34 & 93	0.67	0.95	0.71	0.95	1.00
35 & 41	0.81	1.00	0.81	1.00	1.00
……..	……..	……..	……..	……..	……..

Merger	E	E*	TE	H	S
……	……	……	……	……	……
31 & 91	NA	NA	NA	0.85	NA
34 & 92	0.94	1.01	0.94	0.86	1.17
34 & 93	0.87	1.08	0.80	0.86	1.26
35 & 41	0.92	1.09	0.85	0.98	1.11
38 & 45	1.19	1.35	0.88	0.98	1.38
……	……	……	……	……	……

Interpretations and remedies

Effect	Remedy
Efficiency	Learn, incentives, change event
Scope / Mix	Exchange/trade inputs and outputs
Scale	Merge

Applications

Denmark

- Agricultural extension service
- Merging of local offices
- Individual advise on relevant partners

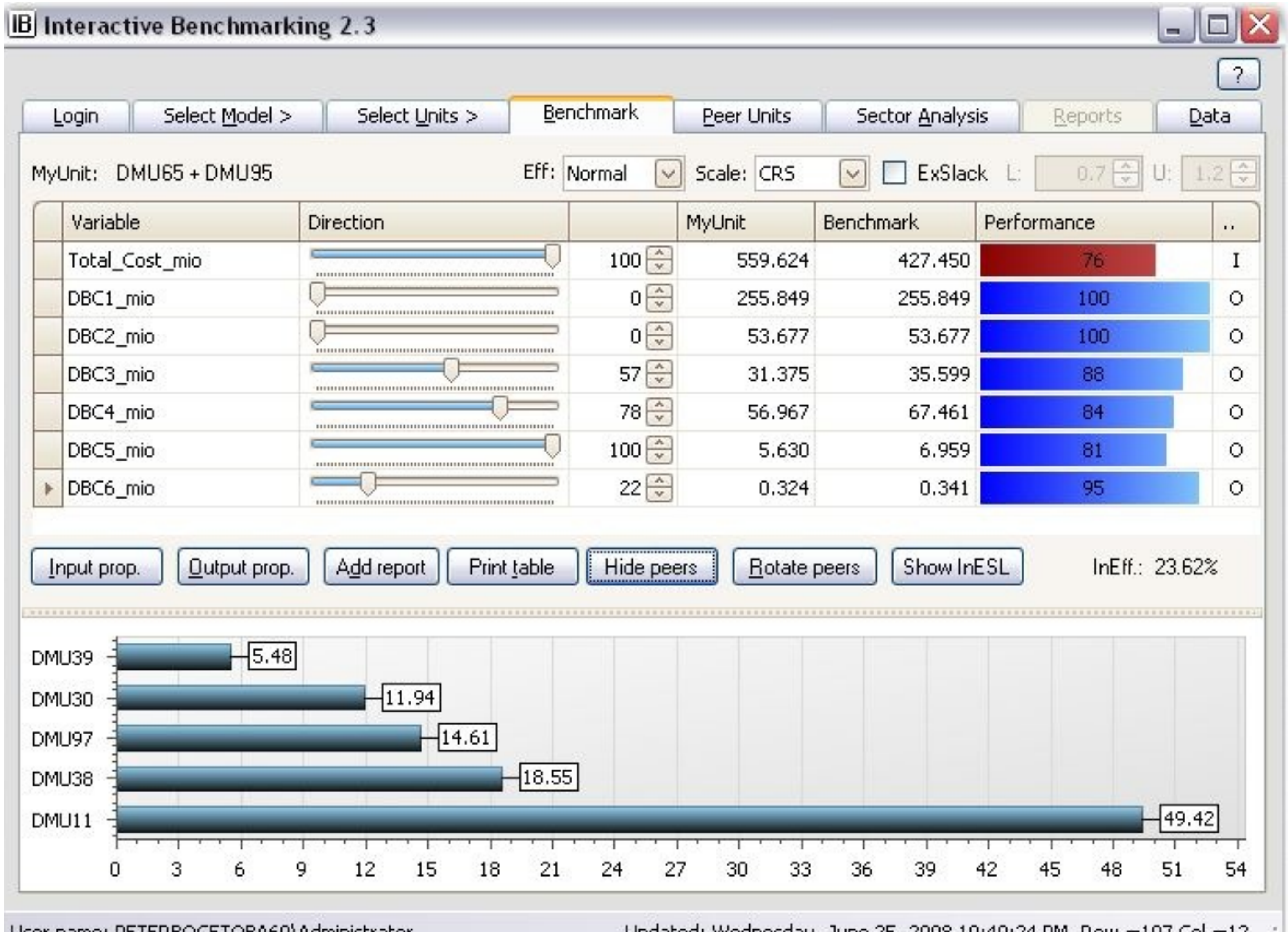
Netherlands

- Used by regulator to evaluate proposed mergers
- Costs gains versus competitive losses
- Most of learning and scope gains available without integration

Norway

- Norwegian DSOs under yardstick revenue cap
- 10 years of sharing of H gains with consumers
- Balance restructuring and consolidation with number of observations on benchmarking (like competitive pressure)

Dutch model



Interactive Benchmarking 2.3
Login
Select Model >
Select Units >
Benchmark
Peer Units
Sector Analysis
Reports
Data
MyUnit: DMU65 + DMU95
Eff: Normal
Scale: CRS
ExSlack
Variable
Direction
MyUnit
Benchmark
Performance
Total_Cost_mio 100 559.624 427.450 76 I
DBC1_mio 0 255.849 255.849 100 O
DBC2_mio 0 53.677 53.677 100 O
DBC3_mio 57 31.375 35.599 88 O
DBC4_mio 78 56.967 67.461 84 O
DBC5_mio 100 5.630 6.959 81 O
DBC6_mio 22 0.324 0.341 95 O
Input prop.
Output prop.
Add report
Print table
Hide peers
Rotate peers
Show InESL
InEff.: 23.62%
DMU39 5.48
DMU30 11.94
DMU97 14.61
DMU38 18.55
DMU11 49.42
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54

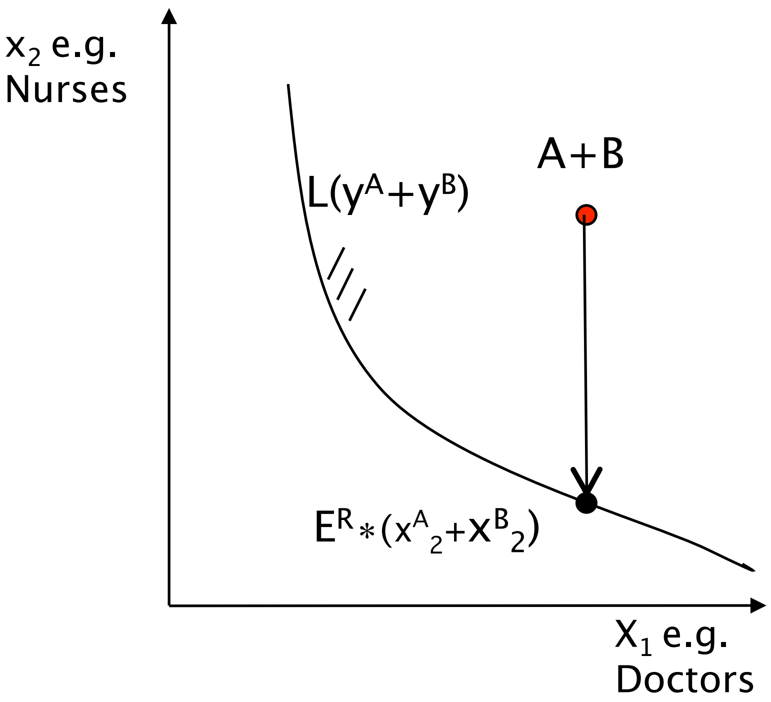
H rationale

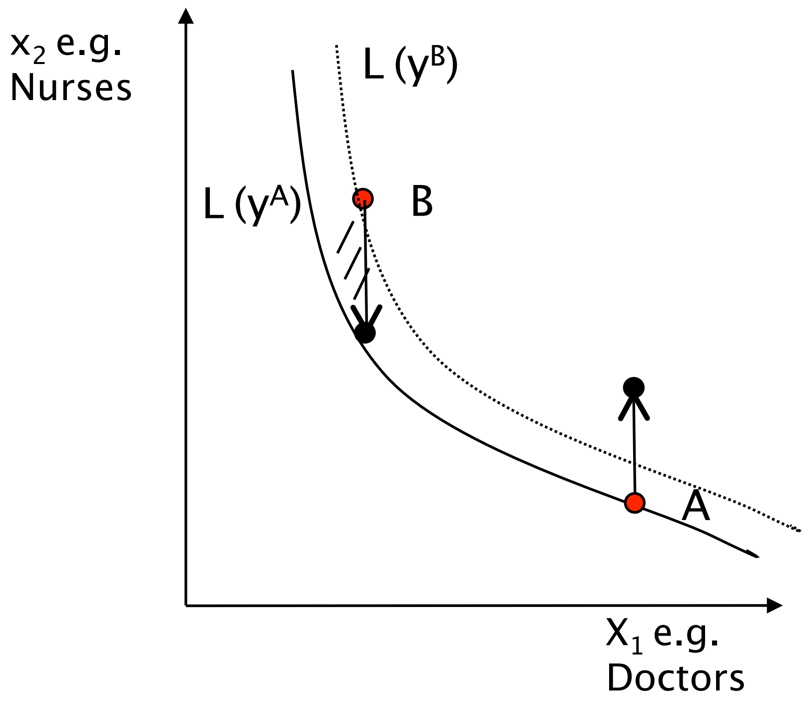
H is also solution to pure reallocation problem

$$\text{Min} \quad h$$
$$(x^{\#j}, y^{\#j}),\ j \in I$$
$$\text{s.t.} \quad h \sum_{j\in J} E^j x^j \geq \sum_{j\in J} x^{\#j}$$
$$\sum_{j\in J} y^j \leq \sum_{j\in J} y^{\#j}$$
$$(x^{\#j}, y^{\#j}) \in T$$

So H is actually the most you can gain from making markets for resources and obligations among the J firms.

Controllability and transferability





Controllability and transferability

Restricted controllability (Variable versus Fixed)

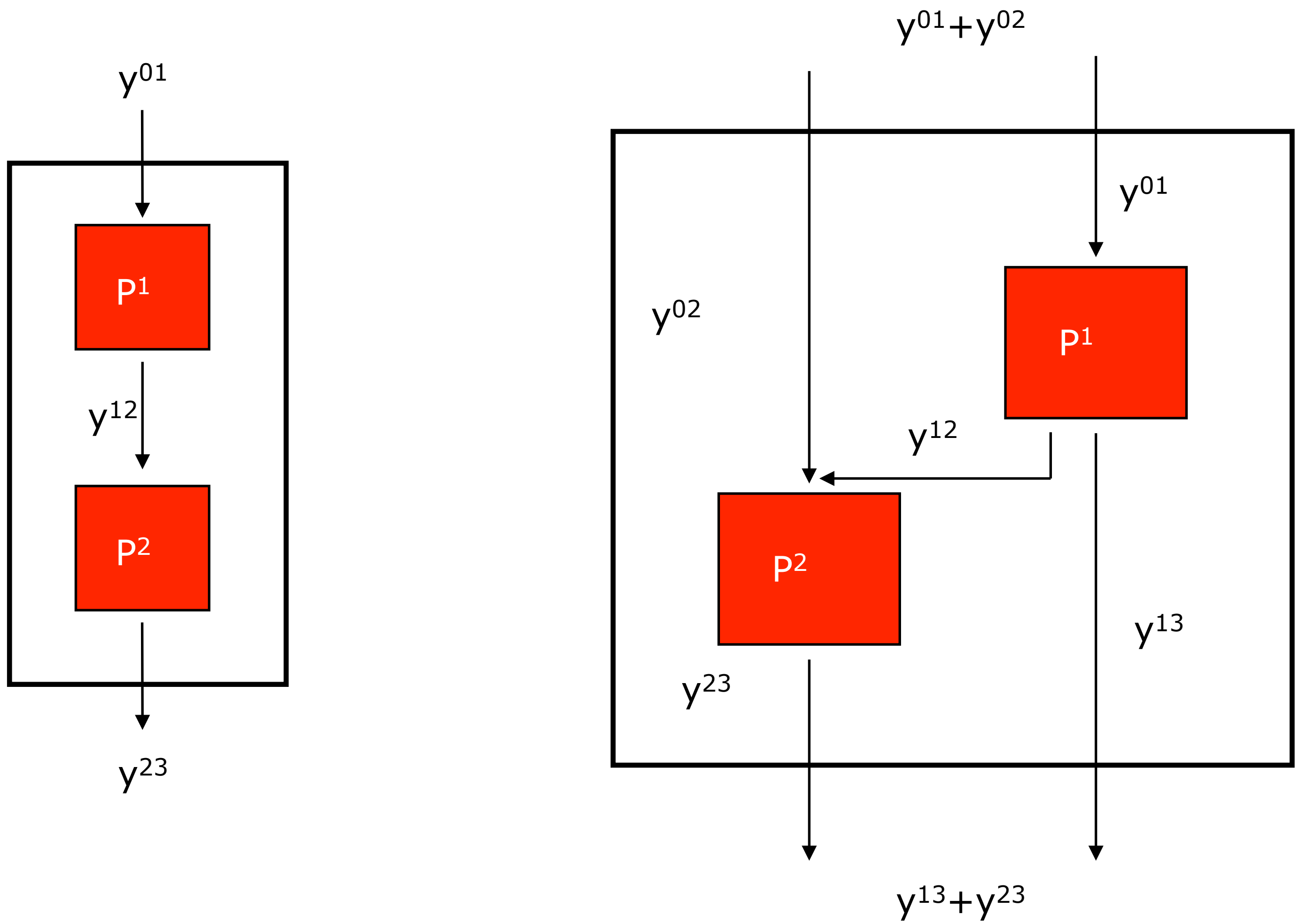
$E^J_V = \text{Min}\ \{E \in R_0 \mid (E[\sum_{j\in J} x^j_V], [\sum_{j\in J} x^j_F], \sum_{j\in J} y^j) \in T\}$

and similar for E*, H and S

Restricted transferability (Local versus Global)

$$
\begin{aligned}
&\text{Min} \quad H \\
&H, (x^{*j}, y^{*j}),\ j\in J \\
&\text{s.t. } H[\textstyle\sum_{j\in J} E^j_V x^j_V] \geq \textstyle\sum_{j\in J} x^{\#j}_V && \text{: we reduce use of variable factors} \\
&\quad x^{\#j}_L \leq x^j_L && \text{: local factors must be saved locally} \\
&\quad \textstyle\sum_{j\in J} x^{\#j}_{GF} \leq \textstyle\sum_{j\in J} x^j_{GF} && \text{: global fixed factors not reduced} \\
&\quad y^{\#j}_L \geq y^j_L && \text{: local service produced on-site} \\
&\quad \textstyle\sum_{j\in J} y^{\#j}_G \geq \textstyle\sum_{j\in J} y^j_G && \text{: global serv. can be prod. off-site} \\
&\quad (x^{\#j}, y^{\#j}) \in T \text{ all } j\in J && \text{:all plans technically feasible}
\end{aligned}
$$

Vertical and network structures



Dis-integration

$$
\begin{aligned}
E = \quad & \text{Min} \quad E \\
& (x^1, y^1), (x^2, y^2) \\
& \text{s.t.} \quad Ex^J \geq x^1 + x^2 \\
& \qquad\quad y^J \leq y^1 + y^2 \\
& \qquad\quad (x^1, y^1) \in T \\
& \qquad\quad (x^2, y^2) \in T
\end{aligned}
$$

Interpretations, remedies and CFEM

Effect	Remedy	Market
Efficiency	Learn, incentives, change event	Regulation, peers groups, contracting
Scope / Mix	Exchange/trade inputs and outputs	Broker or market maker (central/ de-central)
Scale	Merge	Broker, corporate dating system

Reallocation analysis

Extended reallocations

Extend the set of firms and arrangements:

- Subset of firms -> all firms in a sector
- One merger -> new industrial structure with several mergers, splittings, exits etc
- Still explicit matching, restrictions on what can be reallocated, restrictions of ex post efficiency etc
- May even look across sectors

LP problems

Blok- angular structure

- Individual firms models
- Common constraints
- Dual prices predicts market prices

$$\max_{(x_S, y_S, q, F)} \sum_{k=1}^{K} (p y_S^k - w x_S^k) - \Gamma\left[(x_S, y_S, F), (x_S^*, y_S^*, F^*)\right]$$

$$\text{s.t.} \qquad (x_S^k, x_F^{*k}, F^k y_S^k, y_F^{*k}) \in T \qquad (k = 1, \ldots, K)$$

$$y_S^k \leq q^k \qquad (k = 1, \ldots, K)$$

$$\sum_{k=1}^{K} q^k \leq Q$$

$$x_s^k \geq 0,\ y_s^k \geq 0, \qquad q_s^k \geq 0,\ F^k \geq 1 \qquad (k = 1, \ldots, K).$$

Applications

Fishery quota

Sugar beet production

Study helped convince market participant

Model EC-MC

$$\Pi = \max_{(\lambda^{vv}, CPY^{v}, VCPY^{v})} \sum_{v=1}^{V} \left(\sum_{m=1}^{M} P_m \cdot CPY_m^{v} - \sum_{n=1}^{\tilde{N}} VCPY_n^{v} \right)$$

s.t.

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot CPY_m^{obs\ v} \geq CPY_m^{v'} \qquad m = 1,\ldots,M$$

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot VCPY_n^{obs\ v} \leq VCPY_n^{v'} \qquad n = 1,\ldots,\tilde{N}$$

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot FCPY_n^{obs\ v} \leq FCPY_n^{obs\ v'} \qquad n = \tilde{N}+1,\ldots,N$$

$$\sum_{v=1}^{V} \lambda^{v'v} = 1, \lambda^{v'v} \geq 0 \qquad v = 1,\ldots,V$$

(individual)

$$\sum_{v=1}^{V} CPY_m^{v} \leq \sum_{v=1}^{V} CPY_m^{obs\ v}$$

(industry)

Model EF-MF

$$\Pi = \max_{(\beta^{v}, \lambda^{vv}, VCPY^{v})} \sum_{v=1}^{V} \left(\sum_{m=1}^{M} P_m \cdot \beta^{v} \cdot \frac{CPY_m^{obs\ v}}{F^{obs\ v}} - \sum_{n=1}^{\tilde{N}} VCPY_n^{v} \right)$$

s.t.

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot CPY_m^{obs\ v} \geq \beta^{v'} \cdot CPY_m^{obs\ v'} \qquad m = 1,\ldots,M$$

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot VCPY_n^{obs\ v} \leq VCPY_n^{v'} \qquad n = 1,\ldots,\tilde{N}$$

$$\sum_{v=1}^{V} \lambda^{v'v} \cdot FCPY_n^{obs\ v} \leq FCPY_n^{obs\ v'} \qquad n = \tilde{N}+1,\ldots,N$$

$$\sum_{v=1}^{V} \lambda^{v'v} = 1, \lambda^{v'v} \geq 0 \qquad v = 1,\ldots,V$$

(individual)

$$\sum_{v=1}^{V} \beta^{v} \cdot \frac{CPY_m^{obs\ v}}{F^{obs\ v}} \leq \sum_{v=1}^{V} CPY_m^{obs\ v}$$

(industry)

Aggregated trade gains

	Gross profit (1,000 DKK)	Change (%)	Catch value (1,000 DKK)	Variable cost (1,000 DKK)
Initial	260,270		1,246,760	752,313
Model EF–MF	394,404	51.54	1,233,210	604,629
Model EC–MF	451,386	73.43	1,241,803	556,240
Model EF–MC	448,888	72.47	1,246,760	563,695
Model EC–MC	486,338	86.86	1,246,760	526,225

288 vessels

Trade effects

	Efficiency effects	Scale effects	Scope effects
Model EF–MF	x	x	
Model EC–MF		x	
Model EF–MC	x	x	x
Model EC–MC		x	x

	Buying vessels	Selling vessels	Status quo vessels	Traded amounts (tonnes)	Number of vessels with zero catch
Model EF–MF	124	124	40	112,520	24
Model EC–MF	146	111	31	116,250	14
Model EF–MC	119	169	0	729,066	25
Model EC–MC	98	190	0	841,178	0

CFEM applications

Interesting insight

Equally profitable to

- Reallocate resources and tasks
- Learn best practice

CFEM

- Market maker
- Resource broker
- Equity funds support
- SMC based Dantzig-Wolfe algorithm ?
- Restructuring of waterworks ?

Conclusions

Benchmarking and markets

Merger analyses	Reallocation studies	Sector analyses Scale & allocative eff
Complex, local exchange	Missing markets	Imperfect markets
Some resources and services transferable	Some resources and services transferable	All resources and services transferable SE, AE,…
Corporate dating and broker functions	Market making, auctions and broker functions	Lower transaction costs, secret decision support, support learning of best practices.

Extra

Natural monopoly regulation

Natural monopoly regulation

Regulatory instruments

Natural monopolies

- Markets do not work
- Pseudo market via regulation

Instruments

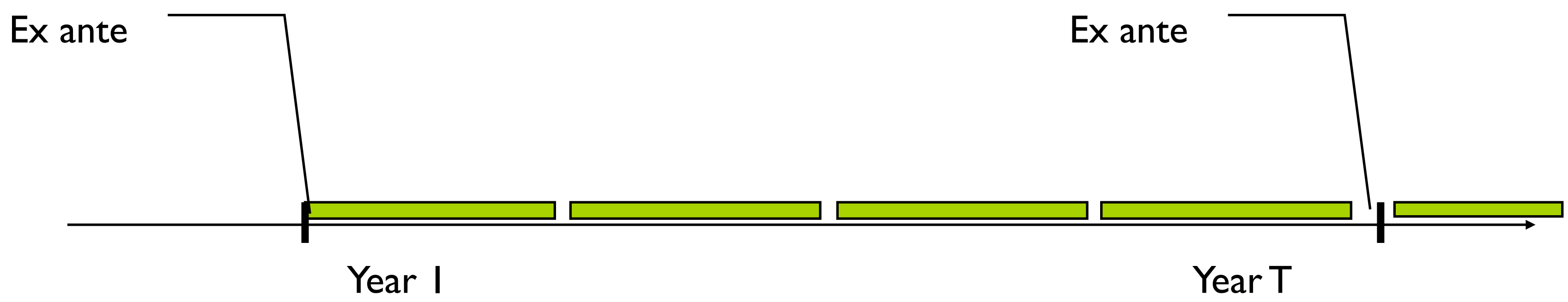
- *Cost recovery regimes (cost plus, rate of return etc)*
- *CPI-X*
- *Yardstick*
- *Concession auctions*
- *Menu*
- *Technical norm models*

Ex ante CPI–X Scheme

Predicted future costs sets allowed future revenue

Historical costs lowered according to ax ante plan

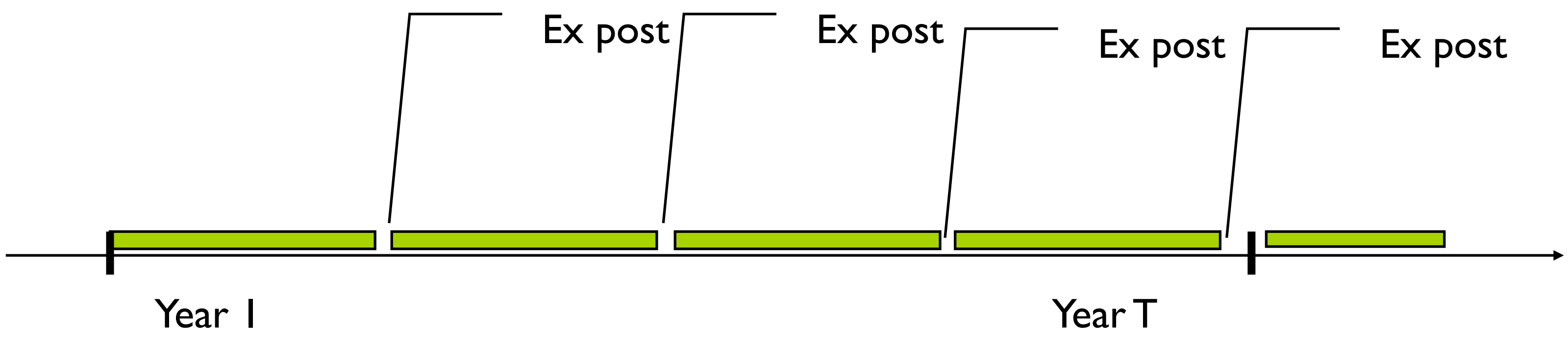
E.g.: $R(t)=C(0)(1-x-x_i)^t$ for $t=1,\ldots,T$



Ex post Yardstick scheme

Actual future costs of ”competitors” sets allowed future revenue

$$R_i(t) = \frac{1}{n-1}\sum_{j \neq i} C_i(t) \text{ for } t = 1,2,\ldots..$$



Role of benchmarking

Cost norms and yardstick must reflects

- Multiple dimensional outputs
- Controllable and non-controllable cost elements
- Contextual differences
- Use flexible frontier model like DEA
- More on this in benchmarking

DEA based yardstick scheme

- Optimal revenue cap with verifiable costs:

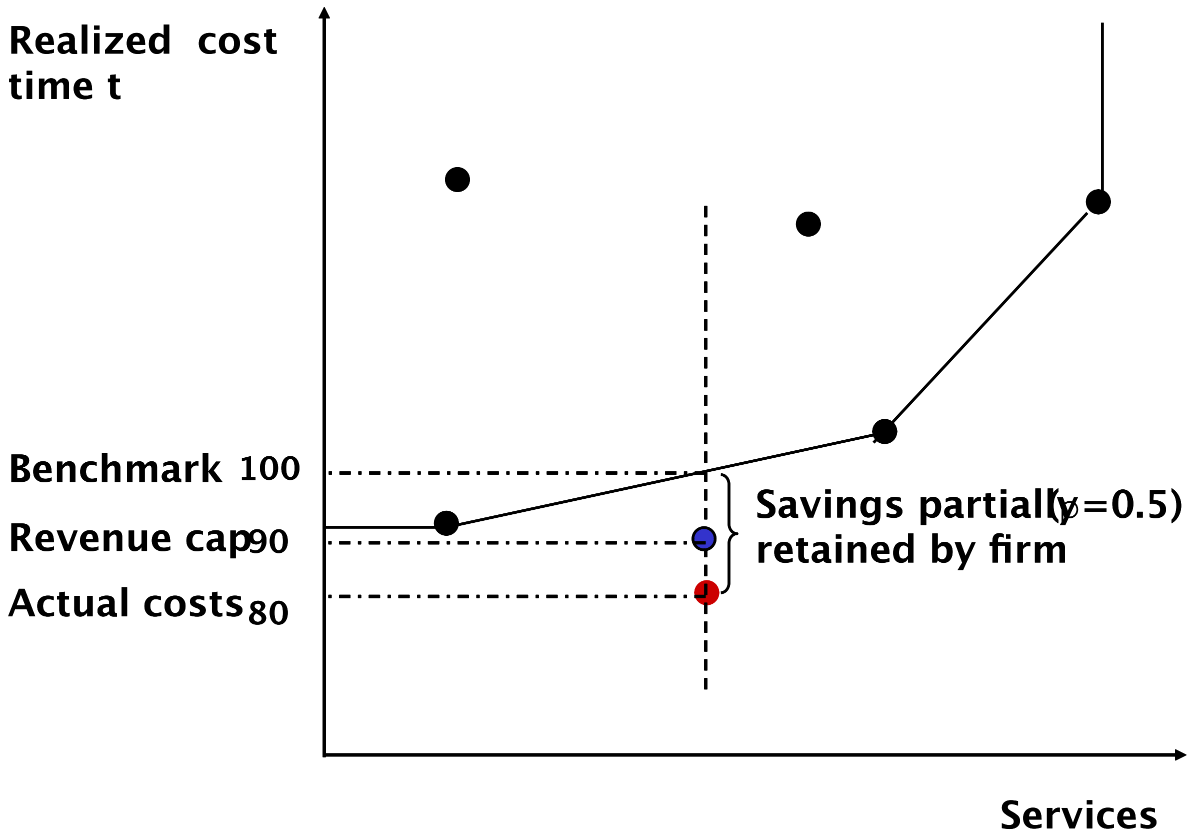
$$k + c + \rho \bullet (C^{DEA-i}(y) - c)$$

Constant + Actual Costs+ ρ of DEA-est. cost savings

Useful in general when

- Complex underlying technology / cost structure and good data

DEA based yardstick competition



CFEM

- Used in all EU countries
- Better benchmarking via SMC
- Benchmark past regulatory decisions
- All DSO to pre-screen investment proposals
- Coordinate smart grid investments across multiple players.