Is a little sunshine all we need?

On the impact of sunshine regulation on profits, productivity and prices in the Dutch drinking water sector.

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October 9, 2010

Introduction

- To analyze the consequences of regulatory instability, we decompose the change in economic profits into seven profit drivers:

  - Changes in: A. Price effects

    (1) output price (domestic and non-domestic)

    (2) input price (for labor, capital and other inputs)

    B. Quantity effects

    (3) technical progress and regress

    (4) catching-up effect of inefficient observations

    (5) scale economies

    (6) improved resource mix

    (7) improved product mix

↓

Relate the profit change and the change in its drivers to the regulatory framework

Introduction

➡ The profit decomposition is implemented for the Dutch drinking water sector

⬇

This sector is a nice experiment to analyze the consequences of regulatory instability

→ Many regulatory models have been proposed and dismissed during the period 1992-2007

→ Eventually, the sector opted for a soft regulatory model: sunshine regulation

➡ Interesting to examine whether the light-handed sunshine regulation is an effective regulatory tool.

Introduction

➡ Research questions:

1. What are the consequences in terms of price and quantity effects from regulatory uncertainty?

2. Is soft regulation of public utilities effective?
Hence, does it provide sufficient incentives to the utilities?

Outline

1. Decomposing profit change into its drivers
   i.e. decompose the change into price and quantity effects

2. Non-parametrically estimating unobserved efficient quantities
   i.e. deduce unobserved quantities by a non-parametric DEA model

3. The input and output variables

4. Regulatory swings in the Dutch drinking water sector

5. Conclusion

Decomposing profit change

- Decompose the economic profit change between *t* and *t+1*:

(cfr. Grifell-Tatjé and Lovell, 1999, 2008)

profit in *t* = sum of total revenues – sum of total costs

$$\pi^t = \sum_{m=1}^{q} p_m^t y_m^t - \sum_{l=1}^{p} w_l^t x_l^t$$

by adding and rearranging terms: profit change

$$\pi^{t+1} - \pi^t = \left[(y^{t+1} - y^t) p^t - (x^{t+1} - x^t) w^t \right] + \left[(p^{t+1} - p^t) y^{t+1} - (w^{t+1} - w^t) x^{t+1} \right]$$

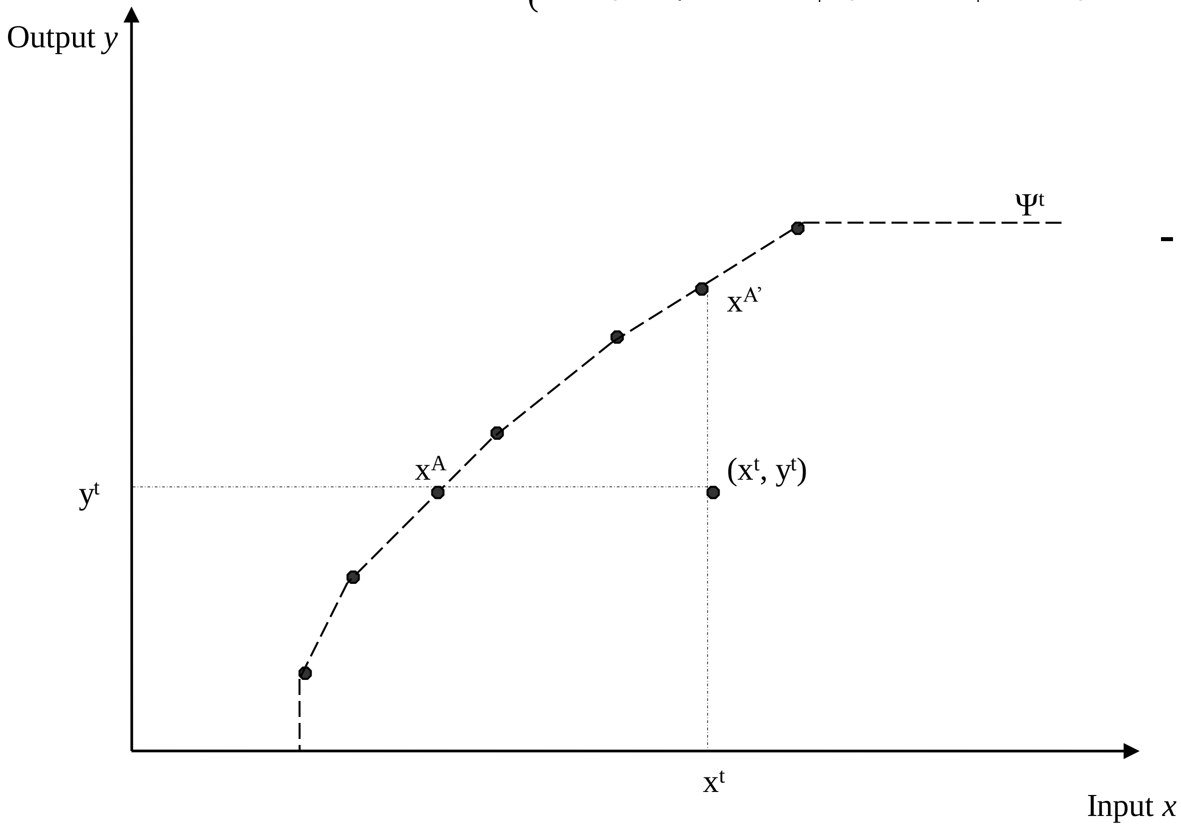
quantity effect for fixed prices
(= Laspeyres: units base period)

price effect for fixed quantities
(= Paasche: units comparison period)

Decomposing profit change

- To decompose the quantity effect further, we need to define the production frontier set:
  - Production set:

$$\Psi^t = \left\{(x^t, y^t) \mid x^t \in \mathbb{R}_+^p, y^t \in \mathbb{R}_+^q, (x^t, y^t) \text{ is feasible}\right\}$$



- input versus output efficiency

$$\theta^t(x^t, y^t) = \inf\left\{\theta^t \mid (\theta^t x^t, y^t) \in \Psi^t\right\}.$$

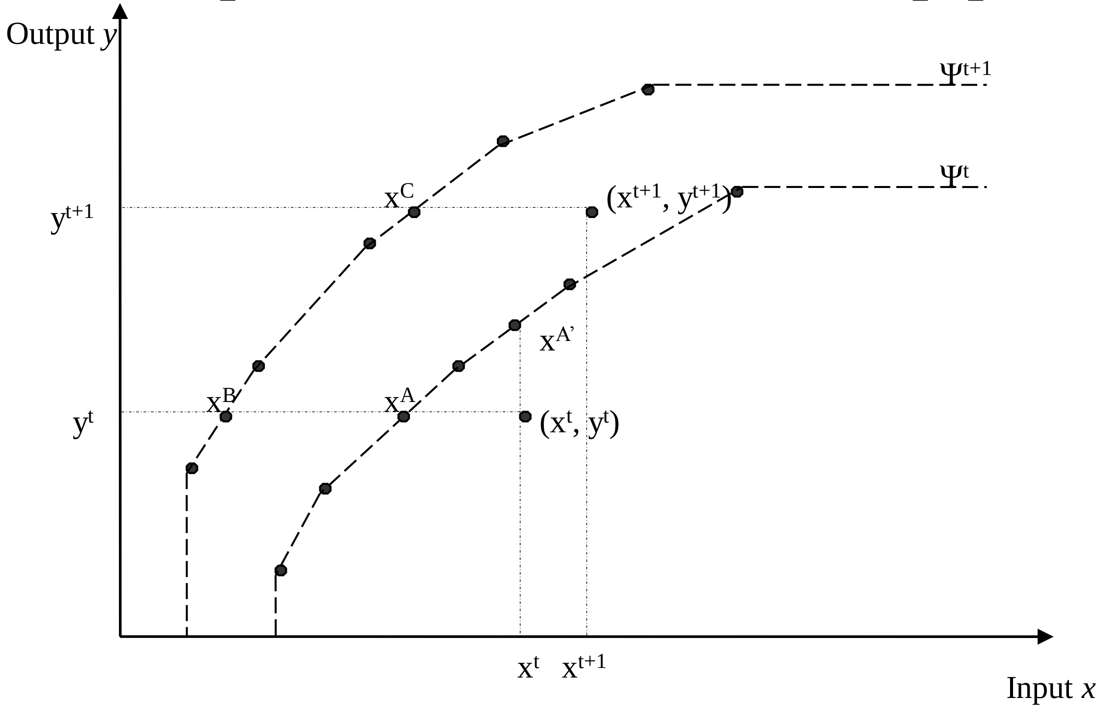
$$\lambda^t(x^t, y^t) = \sup\left\{\lambda^t \mid (x^t, \lambda^t y^t) \in \Psi^t\right\}.$$

Decomposing profit change

- Decompose quantity effect by adding and rearranging terms

quantity effect = [productivity effect] + [activity effect]
= [improvement relatively to best practice + technical progress] + [act]
= [operating efficiency (catching-up) + technical change] + [activ. eff]

$$(y^{t+1}-y^t)p^t-(x^{t+1}-x^t)w^t = \left[(x^t-x^A)w^t-(x^{t+1}-x^C)w^t+(x^A-x^B)w^t\right]+\left[(y^{t+1}-y^t)p^t-(x^C-x^B)w^t\right]$$



Decomposing profit change

➡ Decompose activity effect

activity effect = [resource mix] + [product mix] + [input scale] + [output scale]

= [resource mix] + [product mix] + [scale effect]

$$(y^{t+1}-y^{t})p^{t}-(x^{C}-x^{B})w^{t} = (x^{D}-x^{C})w^{t}-(y^{E}-y^{t+1})p^{t}+(x^{B}-x^{D})w^{t}-(y^{t}-y^{E})p^{t}$$

- $(x^{B}-x^{D})$: input scale effect (since the output mix is similar to y^{t}) (obtained from input isoquants)

- For same output level y^t, shift in resources: x^D-x^C (obtained from input isoquants)

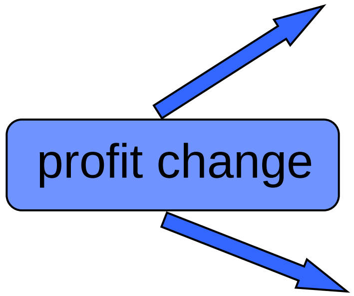
- $(y^{t}-y^{E})$: output scale effect (since the input mix is similar to x^{t})

- For same input level x^t, shift in resources: y^E-y^{t+1} (from output isoquants)

Decomposing profit change

- To analyze the consequences of regulatory instability, we decompose the change in economic profits into seven profit drivers:

  - Changes in:



A. Price effects

(1) output price (domestic and non-domestic)

(2) input price (for labor, capital and other inputs)

B. Quantity effects

(3) technical progress and regress

(4) catching-up effect of inefficient observations

(5) scale economies

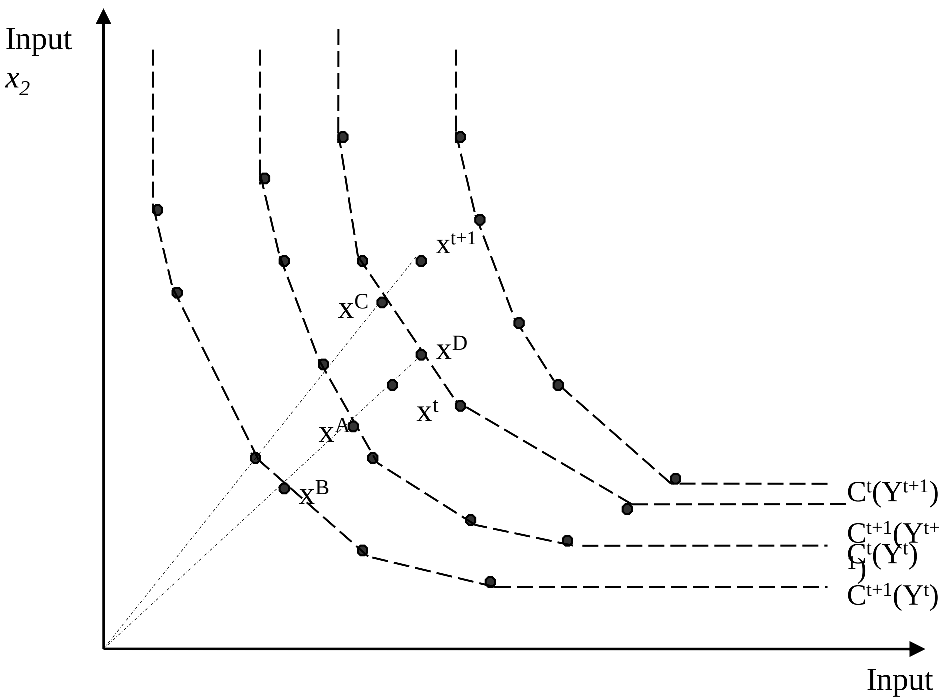
(6) improved resource mix

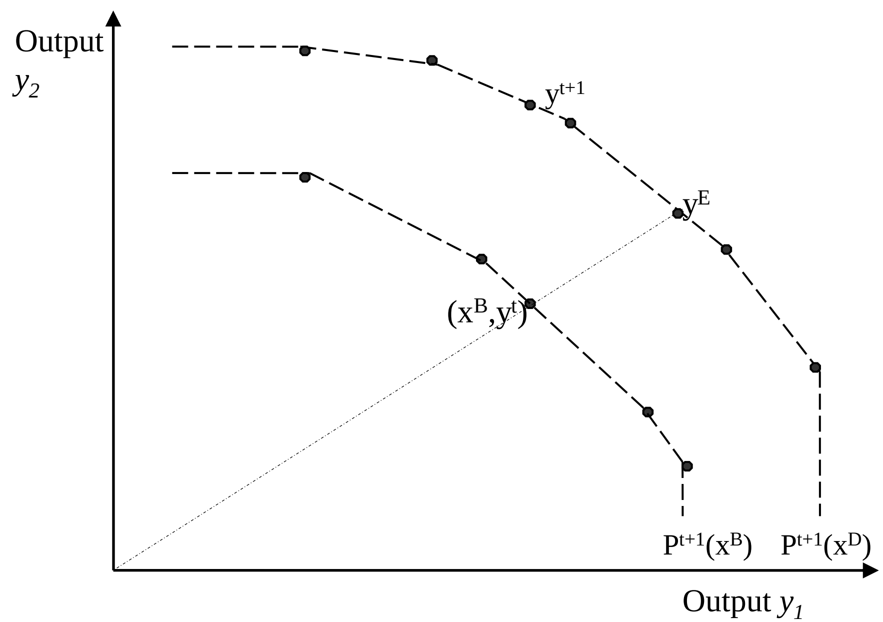
(7) improved product mix

Non-parametrically estimating efficient quantities

Deduce unobserved quantities x^A, x^B, x^C, x^D and y^E

$$\begin{cases} x^A = \theta^t(x^t, y^t) * x^t \\ x^B = \theta^{t+1}(x^t, y^t) * x^t \\ x^C = \theta^{t+1}(x^{t+1}, y^{t+1}) * x^{t+1} \\ x^D = \theta^{t+1}(x^t, y^{t+1}) * x^t \\ y^E = \lambda^{t+1}(x^D, y^t) * y^t \end{cases}$$





Outline

1. Decomposing profit change

2. Non-parametrically estimating efficient quantities
   i.e. how to deduce unobserved quantities x^A, x^B, x^C, x^D and y^E ?

3. The input and output variables

4. Regulatory swings in the Dutch drinking water sector

5. Conclusion

Non-parametrically estimating efficient quantities

- Deduce unobserved quantities x^A, x^B, x^C, x^D and y^E

  By a Data Envelopment Analysis (DEA) model which allows for uncertainty (i.e. a *robust* DEA model) and for heterogeneity in the data (i.e. a *robust* and *conditional* DEA model).

- The model is constructed in three steps:

  1: a deterministic DEA model

  1 + 2: add the uncertainty assumption: a robust DEA model

  1 + 2 + 3: add the heterogeneity assumption: a robust and conditional DEA

Non-parametrically estimating efficient quantities

➡ Deduce unobserved quantities x^A, x^B, x^C, x^D and y^E

Step 1: a deterministic DEA model

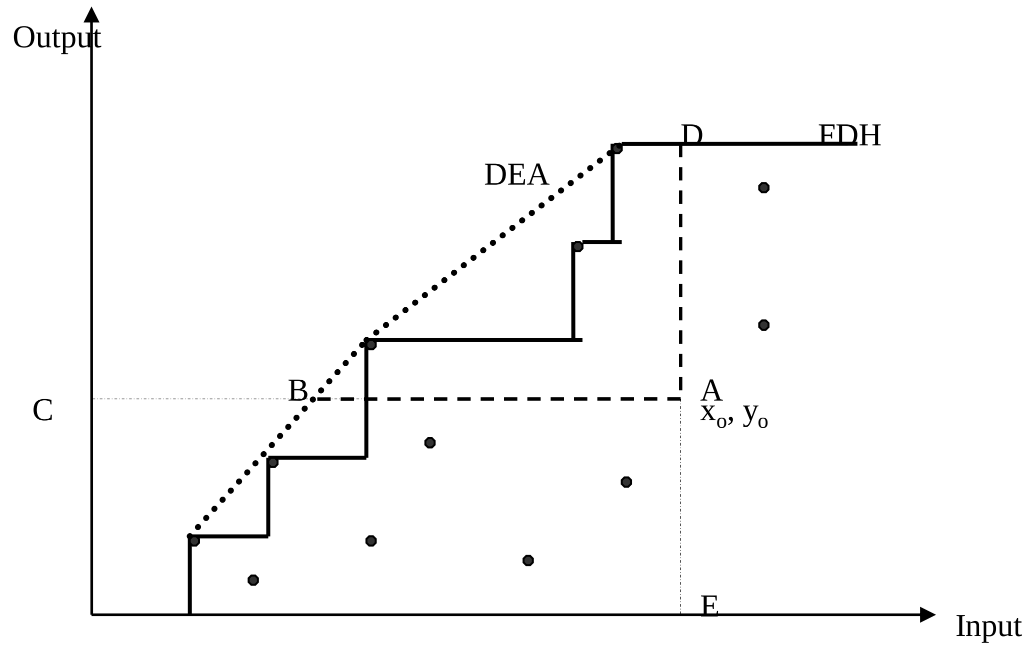
We make two assumptions:

➡ 1. Free disposability of inputs and outputs

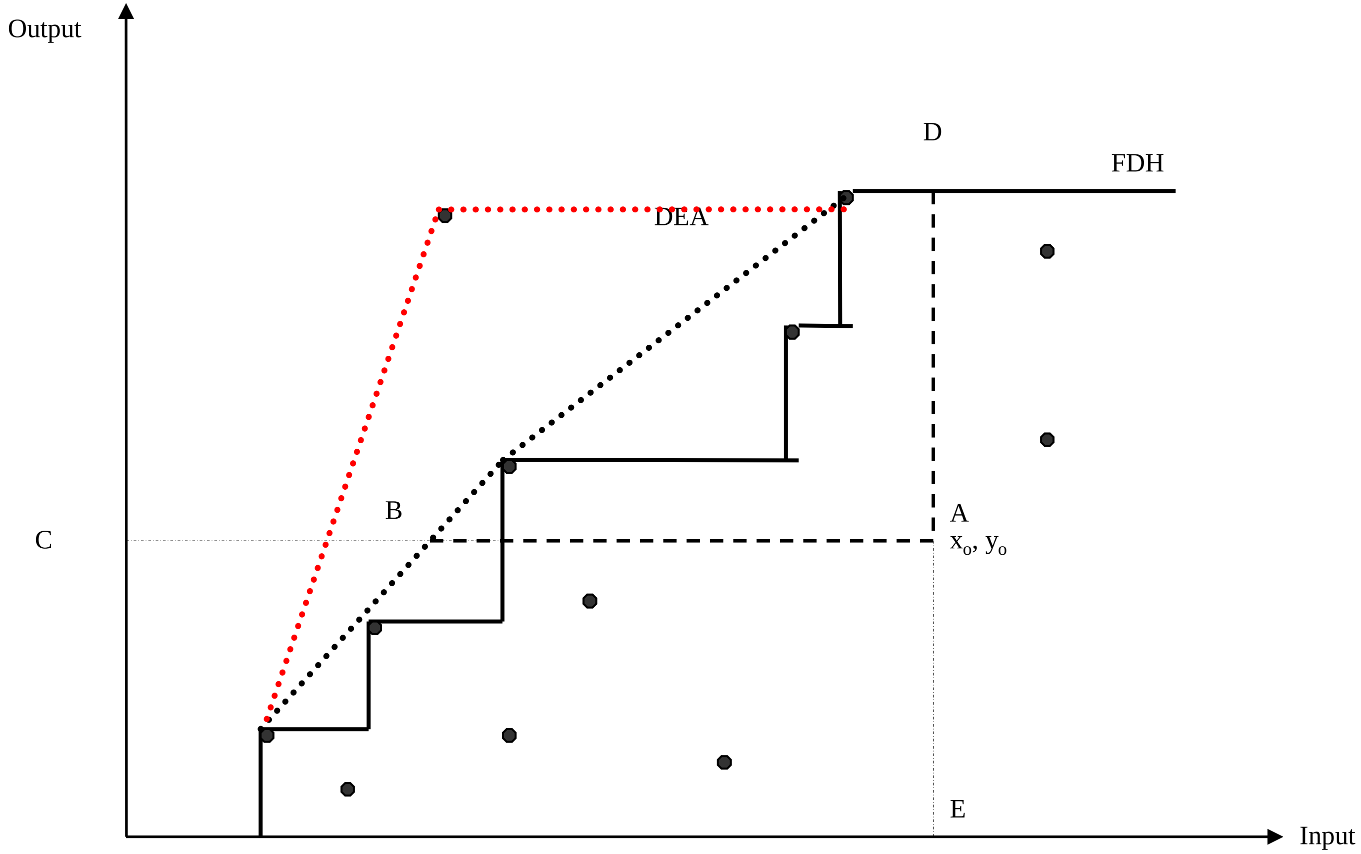
$\rightarrow \forall (x^t, y^t) \in \Psi^t$, if $x^t \geq x^t$ and $y^t \leq y^t$ then $(x^t, y^t) \in \Psi^t$

2. Convexity in inputs and outputs

$\rightarrow$ This convexifies the FDH model and brings the DEA model.



Non-parametrically estimating efficient quantities



Non-parametrically estimating efficient quantities

- Step 2: add the uncertainty assumption: a robust DEA model

→ Robust order-*m* approach of Cazals *et al.* (2002):

Instead of using a full frontier (with all undominated observations), we construct a partial frontier

→ Reason: - measurement errors

- mergers in the water sector (atypical observations)
- use of accounting data

→ procedure:

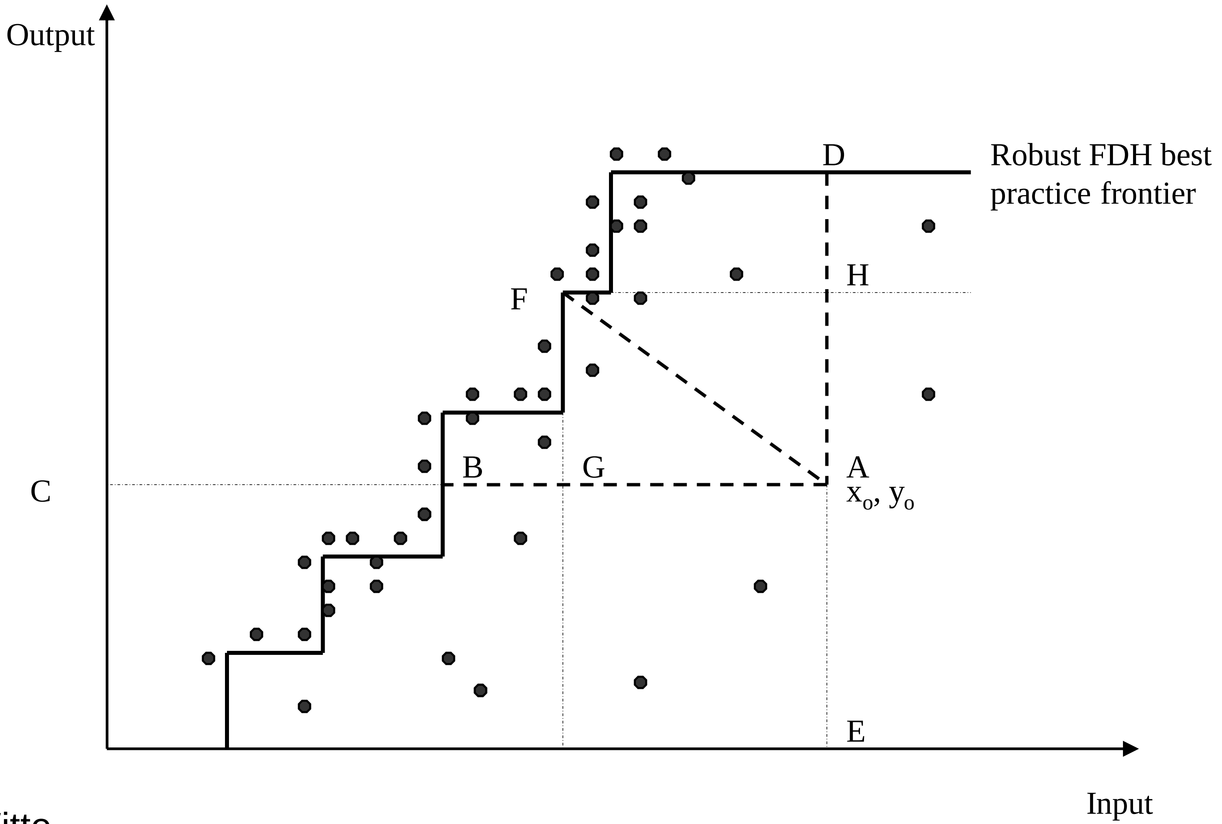
1. draw *R* times with replacement a subsample of size *m* from the original sample among those x_i such that $y_i \geq y$
2. estimate for each draw the linear FDH program
3. average the *R* obtained efficiency estimates
4. convexify the FDH efficient frontier and calculate DEA model

→ Remark: the higher *m*, (1) the closer the approximation to the full sample, and (2) the higher the probability an influential observation constitutes the frontier.

Non-parametrically estimating efficient quantities

Step 2: add the uncertainty assumption: a robust DEA model

→ robust order-*m* approach of Cazals *et al.* (2002):



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Non-parametrically estimating efficient quantities

- Step 3: add the heterogeneity assumption: a robust and conditional DEA

→ conditional estimates of Daraio and Simar (2005, 2007)

→ Idea: compare like with likes (similar exogenous characteristics)

→ Procedure: Condition on the value of z_E such that it selects only input-output vectors with z in the neighbourhood of z_E by a nonparametric Kernel function

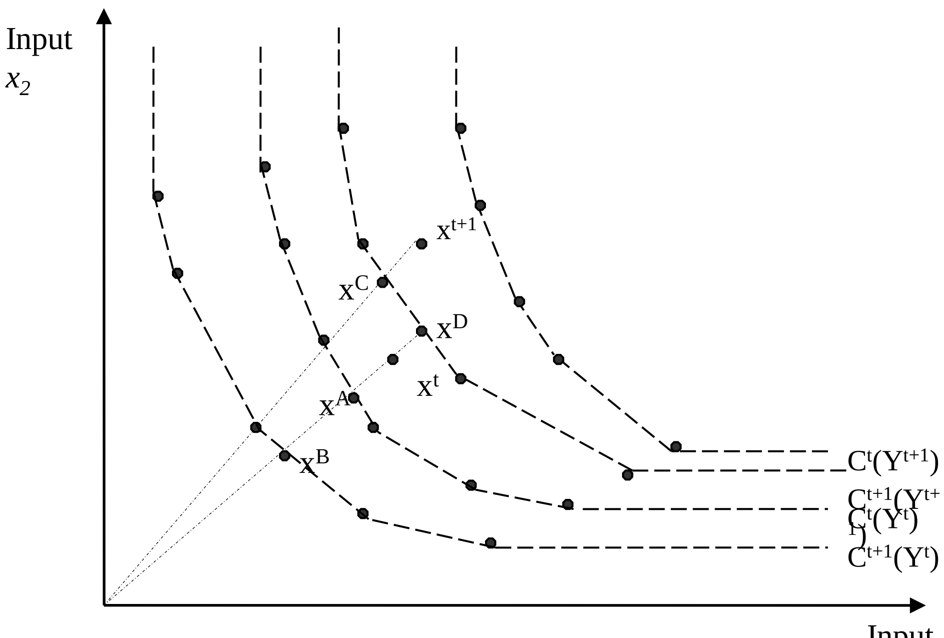
↓

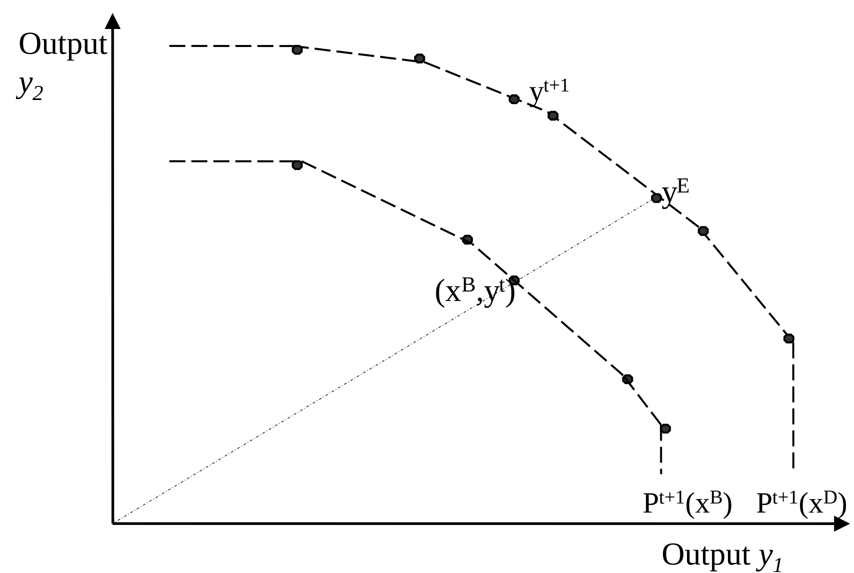
For a given x, draw a sample of size m with replacement and with a probability $K((z-z_i)/h) / \Sigma (K((z-z_j)/h)$, among those x_i such that $y_i \geq y$

Where are we?

1. We decomposed profit change into its drivers
2. We developed a model to deduce the unobserved quantities

$$
\begin{cases}
x^A = \theta^t(x^t, y^t) * x^t \\
x^B = \theta^{t+1}(x^t, y^t) * x^t \\
x^C = \theta^{t+1}(x^{t+1}, y^{t+1}) * x^{t+1} \\
x^D = \theta^{t+1}(x^t, y^{t+1}) * x^t \\
y^E = \lambda^{t+1}(x^D, y^t) * y^t
\end{cases}
$$





Outline

1. Decomposing profit change

2. Non-parametrically estimating efficient quantities

3. Selection of the input and output variables
   i.e. apply the DEA model

4. Regulatory swings in the Dutch drinking water sector

5. Conclusion

The model

- The data set:
  - → Panel data set for all Dutch drinking water companies in period 1992 – 2006
  - → Data from the annual accounts and sector publications (expressed in real 1995 euro)
  - → From 20 utilities in 1992 to 10 utilities in 2006

The model

- The data set:

Economic profits = [total revenues] – [total costs]

= [turnover] – [operating costs (Opex) + economic cost of capital]

output variables

input variables: labor, capital and other

The model

- The model: Input-variables
  - Labor → number of employees
  - Capital → length of mains
  - Other → physical proxy

such that:

Opex = [wage costs] + [other costs]
= [number of employees * *price proxy*] + [*physical proxy* * construction price]

Capital costs = [depreciation] + [opportunity cost of capital]
= [depreciation] + [book value of assets * (10 year bond rate + 4% risk premium)]
= length mains*[(depreciation + book value*(bond rate+4%))/length mains]
= length of mains * *price proxy*

The model

- The model: Output-variables

  1. Production for domestic customers * average price
  2. Production for non-domestic customers * average price

  such that:

  turnover = domestic + non-domestic revenues

- The model: Exogenous environmental variable

  Population density (i.e. number of connections per squared kilometer).

- Robust to alternative model specifications:

  Output: domestic and non-domestic number of connections

  Environment: soil stability, quality measures, age infrastructure

Outline

1. Decomposing profit change

2. Non-parametrically estimating efficient quantities

3. The input and output variables

➡ 4. Regulatory swings in the Dutch drinking water sector
   i.e. apply the profit decomposition

5. Conclusion

Regulatory swings in the Dutch drinking water sector

- We analyze the several sector publications, the annual accounts and opinion articles published in financial and academic media

Four periods of relative instability:

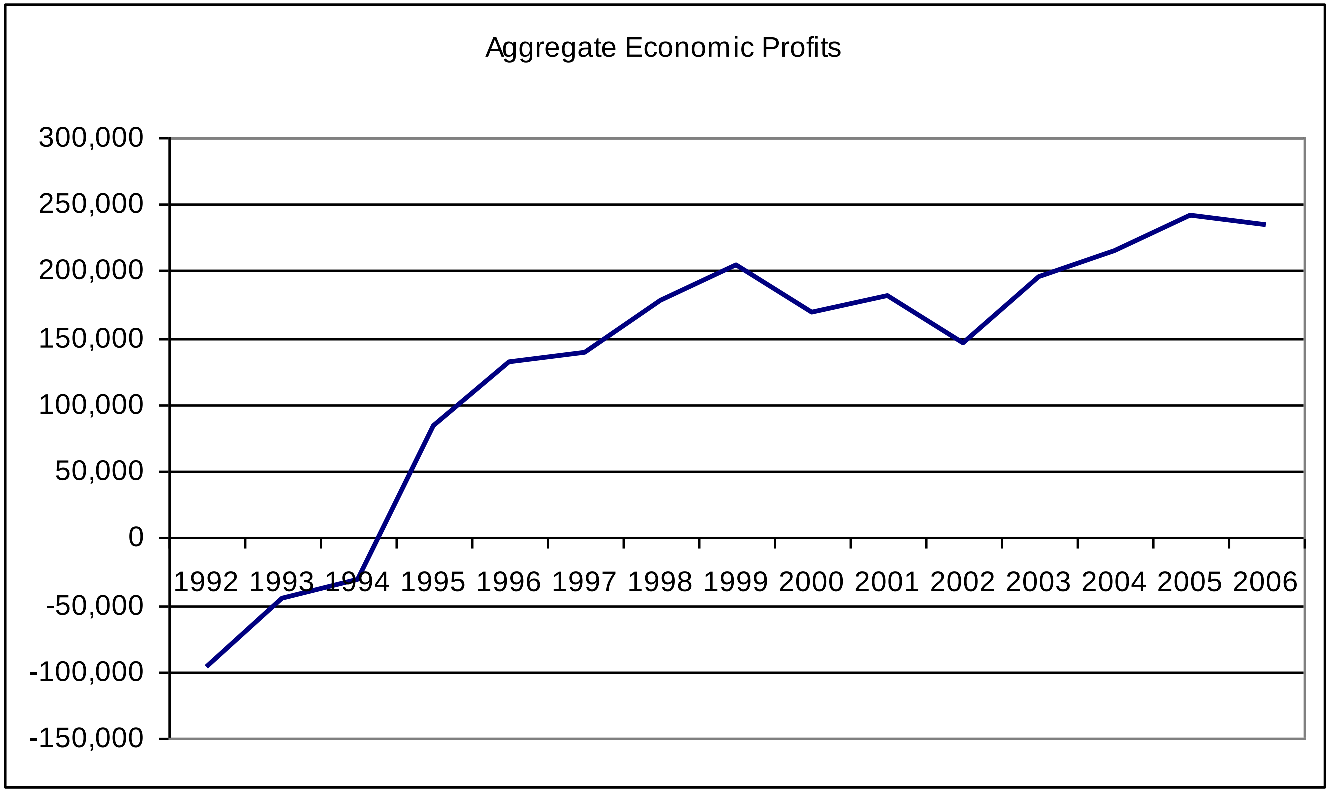
- 1992 – 1997
- 1997 – 2000
- 2000 – 2004
- 2004 – 2007

Regulatory swings in the Dutch drinking water sector

1. Period 1992 – 1997

➡ By the beginning of the 1990 → privatization and liberalization in several network sectors (e.g. telecommunication and energy)

Water sector: alert for privatization → increase attractiveness to draw investments



Regulatory swings in the Dutch drinking water sector

- Late 1990s: Ministry of Economic Affaires launched a program to deregulate monopolistic markets

  → Drinking water sector → owned by municipal and provincial governments

  → legal monopoly

  → managed by technocrats who preferred quality increases even with unsure benefits and prohibitive costs

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- Quiet life (Hicks, 1935)
- X-inefficiency (Leibenstein, 1966)
- Excess profits

Regulatory swings in the Dutch drinking water sector

2. Period 1997 – 2000

➡ The sector organization (Vewin) was strongly opposed to the idea of strict regulation

However, to avoid a privatization (as in E&W) and due to pressures for increased transparency:

➡ 1997: start of a voluntary benchmarking used for sunshine regulation:

- *benchmarking* = comparison of utilities on one or several indicators

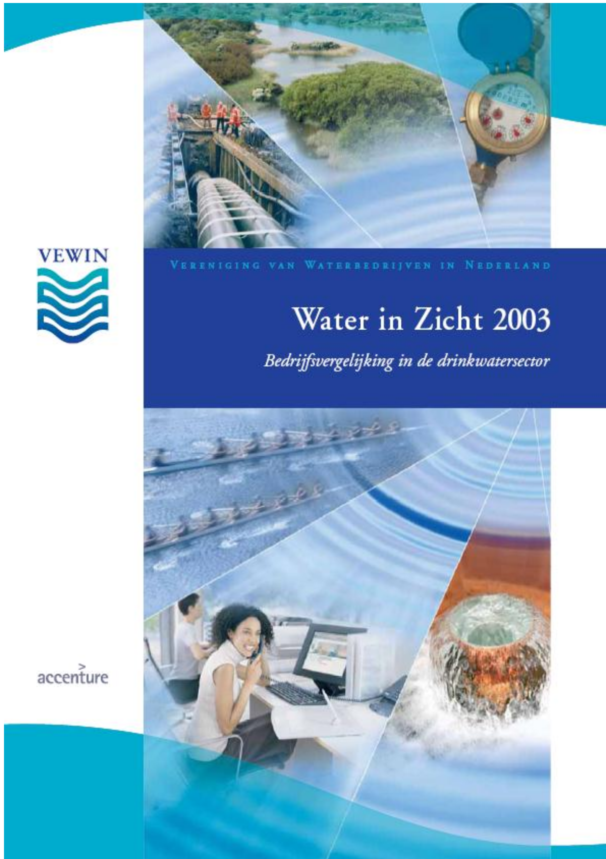
- *sunshine regulation* = use of benchmarking to ‘embarrass’ the least performing companies and put the best into the limelight

Regulatory swings in the Dutch drinking water sector

Bedrijfsniveau: kosten per m³ 2005

In de sector bedragen de totale kosten per afgeleverde m³ gemiddeld € 1,36, met een spreiding tussen waterbedrijven van € 0,72. In de rangorde op totale kosten per m³ bevindt Oasen zich met € 1,77 per m³ in het vierde kwadrant.

	Totale kosten (€ / m³)	Belastingen (€ / m³)	Vermogens-kosten (€ / m³)	Afschrijvingen (€ / m³)	Operationele kosten (€ / m³)
WBGR	1,05	0,18	0,11	0,12	0,64
Brabant Water	1,13	0,21	0,20	0,22	0,49
Hydron-MN	1,21	0,21	0,24	0,22	0,54
WMD	1,23	0,19	0,25	0,19	0,60
Vitens	1,31	0,20	0,31	0,21	0,58
Evides	1,31	0,04	0,39	0,32	0,56
Waternet	1,39	0,04	0,13	0,37	0,85
Hydron-FI	1,43	0,21	0,23	0,24	0,75
WML	1,52	0,17	0,34	0,28	0,73
PWN	1,58	0,03	0,27	0,37	0,91
DZH	1,72	0,13	0,18	0,50	0,91
Oasen	1,77	0,19	0,17	0,50	0,92
Sector	1,36	0,15	0,26	0,29	0,66



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Regulatory swings in the Dutch drinking water sector

3. Period 2000 – 2003

→ Discussion on the appropriate regulatory model: voluntary sunshine regulation or yardstick competition by an independent regulator?

Fear of the utilities: over-emphasize on output prices

(Settled in 2004: as a new Minister takes place)

Result of the uncertainty: undermined willingness to participate the voluntary benchmark

Reaction of government:

- provide an obligatory benchmark (since 2007)
- Dutch water sector is public domain (moratorium on private investments)

Regulatory swings in the Dutch drinking water sector

3. Period 2004 – 2006

Aggregate economic profits significantly increased

⇒ Result: Discussion on the prices and profits

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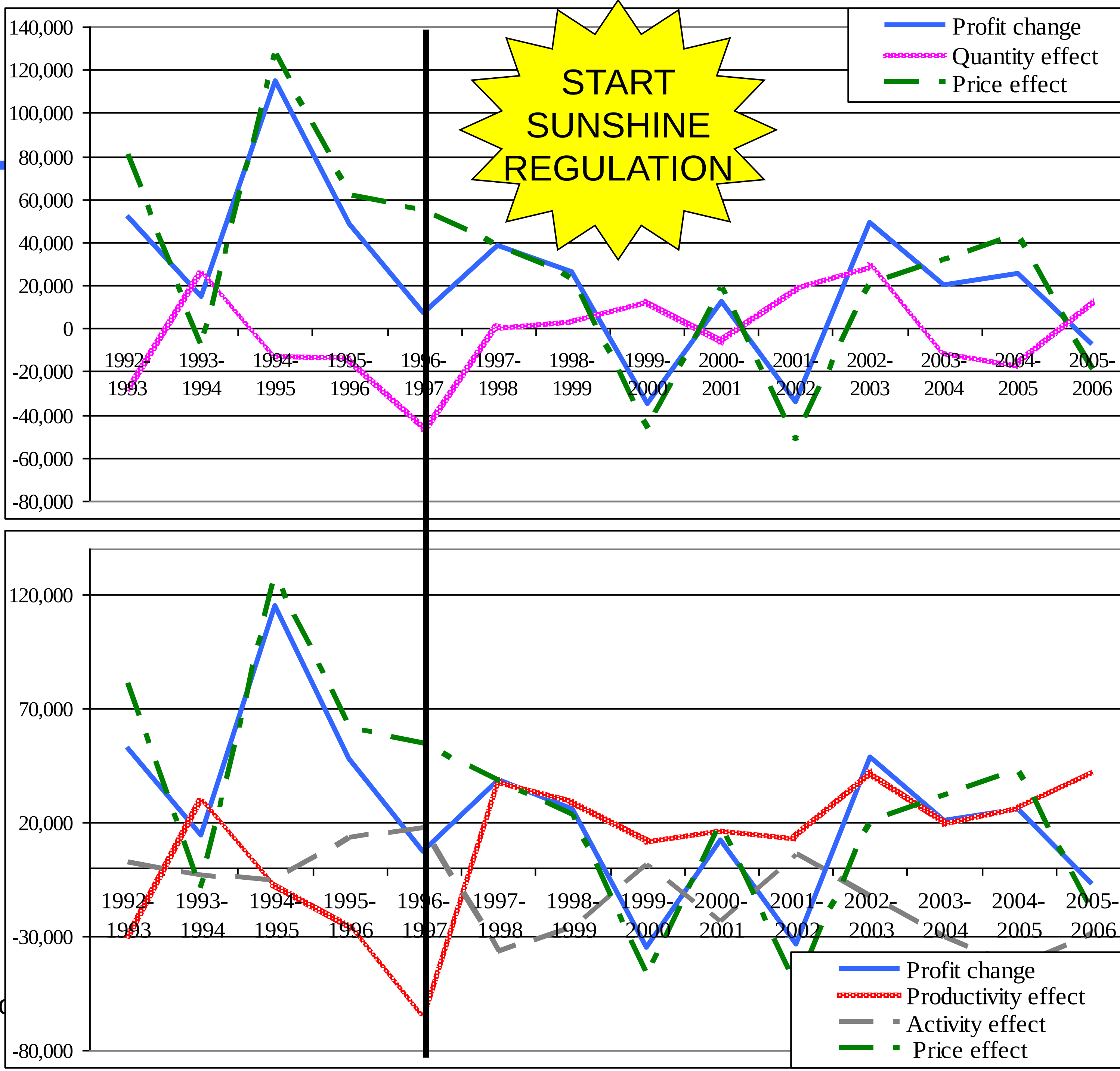
- ⇒ Settled by including in the 2003 benchmark profit figures
- ⇒ Not included in 2006 anymore, however, decrease in aggregate profits
- ⇒ Increased attention to the output prices in the sector publications



START SUNSHINE REGULATION
Profit change
Quantity effect
Price effect
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
1992-1993
1993-1994
1994-1995
1995-1996
1996-1997
1997-1998
1998-1999
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
120,000
70,000
20,000
-30,000
-80,000
Profit change
Productivity effect
Activity effect
Price effect

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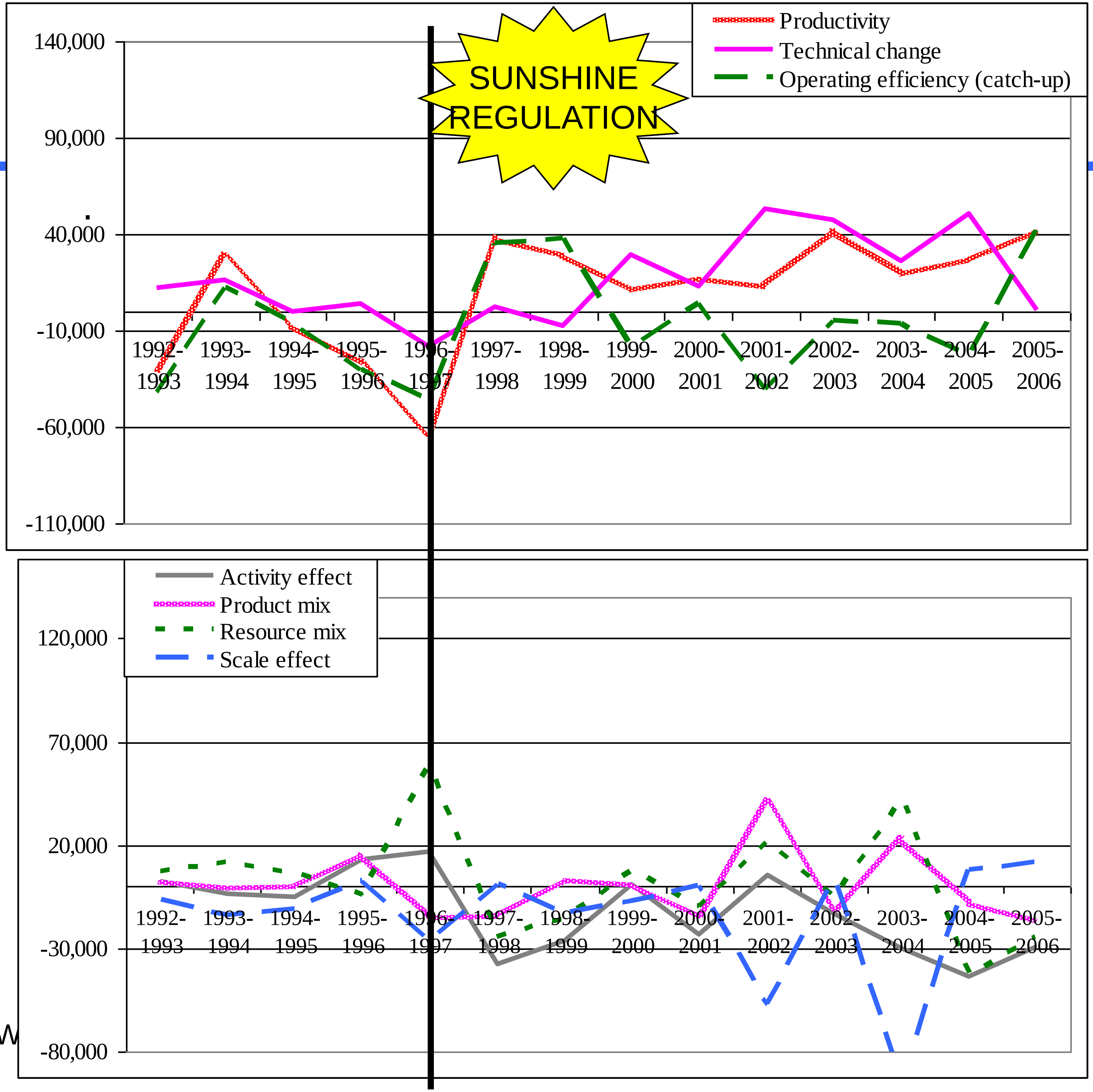
SUNSHINE REGULATION
Productivity
Technical change
Operating efficiency (catch-up)
140,000
90,000
40,000
-10,000
-60,000
-110,000
1992-1993
1993-1994
1994-1995
1995-1996
1996-1997
1997-1998
1998-1999
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
Activity effect
Product mix
Resource mix
Scale effect
120,000
70,000
20,000
-30,000
-80,000

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Outline

1. Decomposing profit change

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Conclusion

➡ The Dutch government launched several ideas for regulatory models (privatization, yardstick competition, profit regulation, self-regulation…)

→ Regulatory uncertainty influences the quantity and price effects

➡ The light-handed sunshine regulatory model incentivized the utilities

Given the specific situation in the Netherlands, public management can work

Is a little sunshine all we need?

On the impact of sunshine regulation on profits, productivity and prices in the Dutch drinking water sector.

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