ASSESSMENT OF THE TOTAL FACTOR PRODUCTIVITY CHANGE IN THE ENGLISH AND WELSH WATER INDUSTRY: A FÄRE-PRIMONT PRODUCTIVITY APPROACH

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INTRODUCTION

Improvement of the Total Factor Productivity (TFP) is a major policy objective of water companies and regulators

Increase the profitability of water companies

Reduce water tariff

Price Cap Regime RPI+K:

RPI: Retail Prices Index

K: Factor composed by:

X: Productivity as benchmarking.

Q: Cost of investments to improve quality.

INTRODUCTION

Indexes to compute TFP change

Prices are available: Törnqvist and Fisher indexes
They are inappropriate to make multi-lateral (across firms) and multi-temporal (over time) comparisons since they are not transitive and do not follow the identity axiom.

Prices are not available: Malmquist Productivity Index and Luenberger Productivity Indicator
They do not measure TFP change when variable returns to scale is assumed.

INTRODUCTION

Indexes to compute TFP change

Prices are not available: Hicks-Moorsteen index (Bjurek, 1996) and Färe-Primont index (O´Donnell, 2011)

Hicks-Moorsteen index fails the transitivity test and therefore only can be used to make a single binary comparison.

Färe-Primont index can be used to make reliable multi-lateral and multi-temporal comparisons.

OBJECTIVES

- Assess the TFP change of the English and Welsh water industry from 2001 to 2008 by using the Färe-Primont index.
- Explore the different components contributing to TFP change
- Provide some insight into the relationship between TFP change and the regulatory cycle.

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METHODOLOGY

N water companies over T time periods

$y_{it} = (y_{1it}, \dots, y_{Jit})$ and $x_{it} = (x_{1it}, \dots, x_{Jit})$ denote the output and input vectors of water company i in period t:

$$TFP_{it} = \frac{Y_{it}}{X_{it}} \quad \Rightarrow \quad TFP_{hs,it} = \frac{TFP_{it}}{TFP_{hs}} = \frac{Y_{it}/X_{it}}{Y_{hs}/X_{hs}} = \frac{Y_{it}/Y_{hs}}{X_{it}/X_{hs}} = \frac{Y_{hs,it}}{X_{hs,it}}$$

Shephard output and input distance functions:

$$TFP_{hs,it} = \frac{D_o(x_o, y_{it}, t_o)}{D_o(x_o, y_{hs}, t_o)} \cdot \frac{D_I(x_{it}, y_o, t_o)}{D_I(x_{hs}, y_o, t_o)}$$

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METHODOLOGY

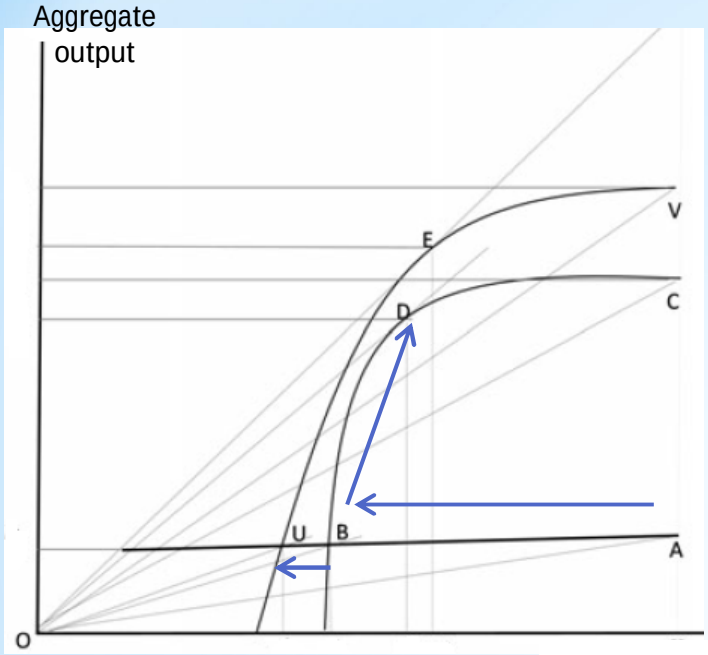
Färe-Primont index:

Technical change: Movements in the production frontier.

Efficiency change: Movements of the units towards or away from the production frontier.

Scale and mix efficiency change: Movements around the production frontier to capture economies of scope and scale.

METHODOLOGY



$$ITE_{it} = \frac{slope\ OA}{slope\ OB}$$

$$ISE_{it} = \frac{slope\ OB}{slope\ OD}$$

$$IME_{it} = \frac{slope\ OB}{slope\ OU}$$

Input-oriented technical efficiency (ITE):
Difference between observed TFP and the maximum TFP holding the input mix, output mix and output level fixed (A-B)

Input-oriented scale efficiency (ISE):
Difference between observed TFP at a technically-efficient point and the maximum TFP holding the input and output mixes fixed but levels vary (B-D)

Input-oriented mix efficiency (IME):
Difference between observed TFP at a technically-efficient point and the maximum TFP holding the output level fixed (B-U).

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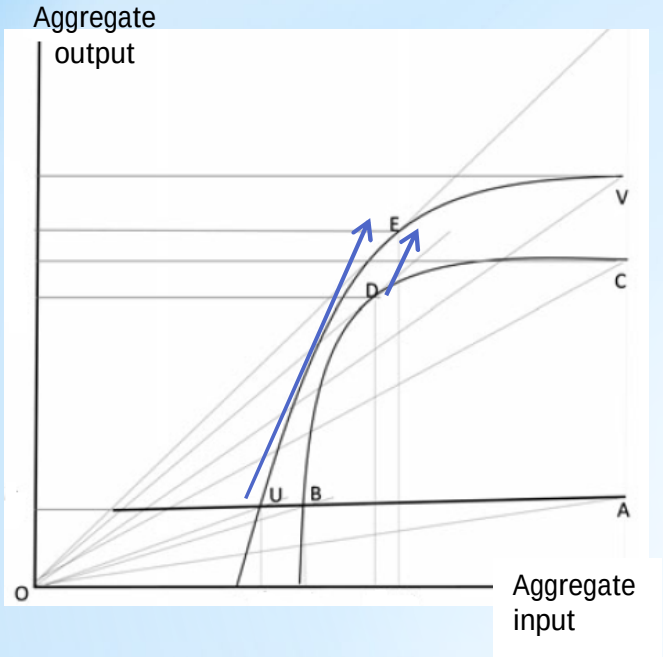

Residual Input-oriented scale efficiency (RISE): **Difference between observed TFP at a technically-efficient point and TFP at te point of maximum productivity (U-E)**

Residual mix efficiency (RME): **Difference between observed TFP and the maximum TFP when input and output mixes and levels vary (D-E)**

$$RISE_{it} = \frac{slope\ OU}{slope\ OE}$$

$$RME_{it} = \frac{Slope\ OD}{Slope\ OE}$$

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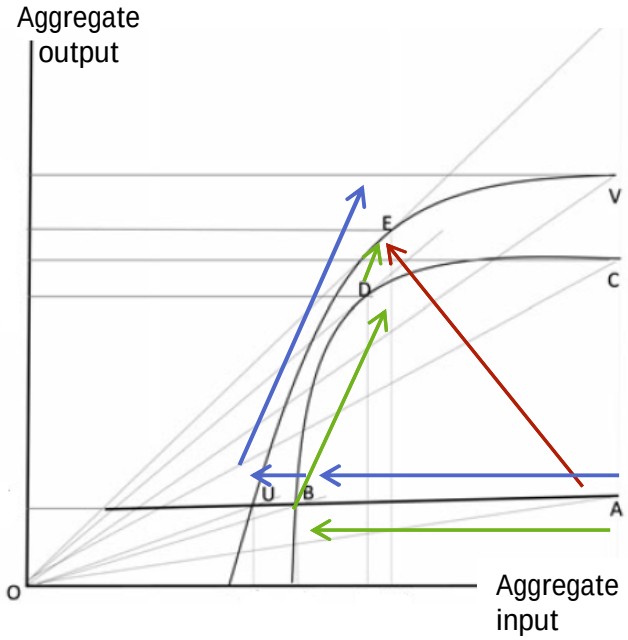
Total Factor Productivity Efficiency (TFPE): Ratio of observed TFP and the maximum TFP

$$TFPE_{it} = \frac{TFP_{it}}{TFP_t^*}$$

$$TFPE_{it} = ITE_{it} \cdot IME_{it} \cdot RISE_{it}$$

$$TFPE_{it} = ITE_{it} \cdot ISE_{it} \cdot RME_{it}$$



$$TFP_{it} = TFP_t^* \cdot (ITE_{it} \cdot IME_{it} \cdot RISE_{it}) = TFP_t^* \cdot (ITE_{it} \cdot ISE_{it} \cdot RME_{it})$$

EMPIRICAL APPLICATION: SAMPLE

- 22 English and Welsh water companies:
  - 10 Water and Sewerage companies (WaSCs)
  - 12 Water only companies (WoCs)
- Period: 2001-2008
- Drinking water services

- **Inputs:** Operating costs and Capital stock (thousand of pounds at constant prices).

- **Outputs:** Volume of water distributed (megalitres per day) and number of properties connected to the water network

EMPIRICAL APPLICATION: SAMPLE

		2001	2002	2003	2004	2005	2006	2007	2008
Operating cost (£000´s)	Mean	68.24	68.34	69.58	72.44	73.92	80.06	86.83	87.63
	Std. Dev.	67.45	67.52	69.09	72.18	73.36	83.82	92.65	90.6
Capital Stock (£000´s)	Mean	3,869.00	3,891.05	3,922.40	3,955.60	3,984.79	4,007.87	4,035.13	4,070.46
	Std. Dev.	3,919.12	3,938.85	3,972.93	4,017.08	4,060.14	4,090.35	4,117.38	4,152.84
Water distributed (10^6 l/d)	Mean	681.41	696.62	699.71	711.71	699.00	697.39	681.55	670.76
	Std. Dev.	716.26	739.38	751.40	763.22	748.28	748.31	725.48	706.51
Connected properties (Nr)	Mean	1,067.51	1,075.20	1,081.95	1,089.15	1,095.98	1,103.93	1,110.40	1,110.07
	Std. Dev.	1,098.56	1,106.32	1,113.16	1,119.31	1,125.11	1,133.05	1,138.86	1,127.17

EMPIRICAL APPLICATION: RESULTS

Year	TFP	TCH	ECH	ITE	IME	RISE	ISE	RME
2001	**1.079**	1.000	1.078	1.141	0.956	0.988	1.000	0.945
2002	**1.010**	1.001	1.097	1.131	0.992	0.978	1.000	0.970
2003	**1.085**	1.001	1.082	1.124	0.985	0.977	1.000	0.967
2004	**1.056**	0.973	1.081	1.137	0.981	0.969	1.000	0.952
2005	**1.027**	0.989	1.037	1.115	0.988	0.941	1.000	0.929
2006	**0.950**	0.814	1.166	1.206	0.994	0.973	1.000	0.968
2007	**0.876**	0.848	1.031	1.108	0.977	0.952	1.000	0.931
2008	**0.845**	0.904	0.933	1.154	0.984	0.822	1.000	0.807

- **2001-2008: TFP decreased by 7.2%**
- **Molinos-Senante et al. (2014): MPI: 12.9% and LPI: 11.5%**

- **TCH decreased by 45.2%**
- **ECH improved by 50.5%**

EMPIRICAL APPLICATION: RESULTS

Year	TFP	TCH	ECH	ITE	IME	RISE	ISE	RME
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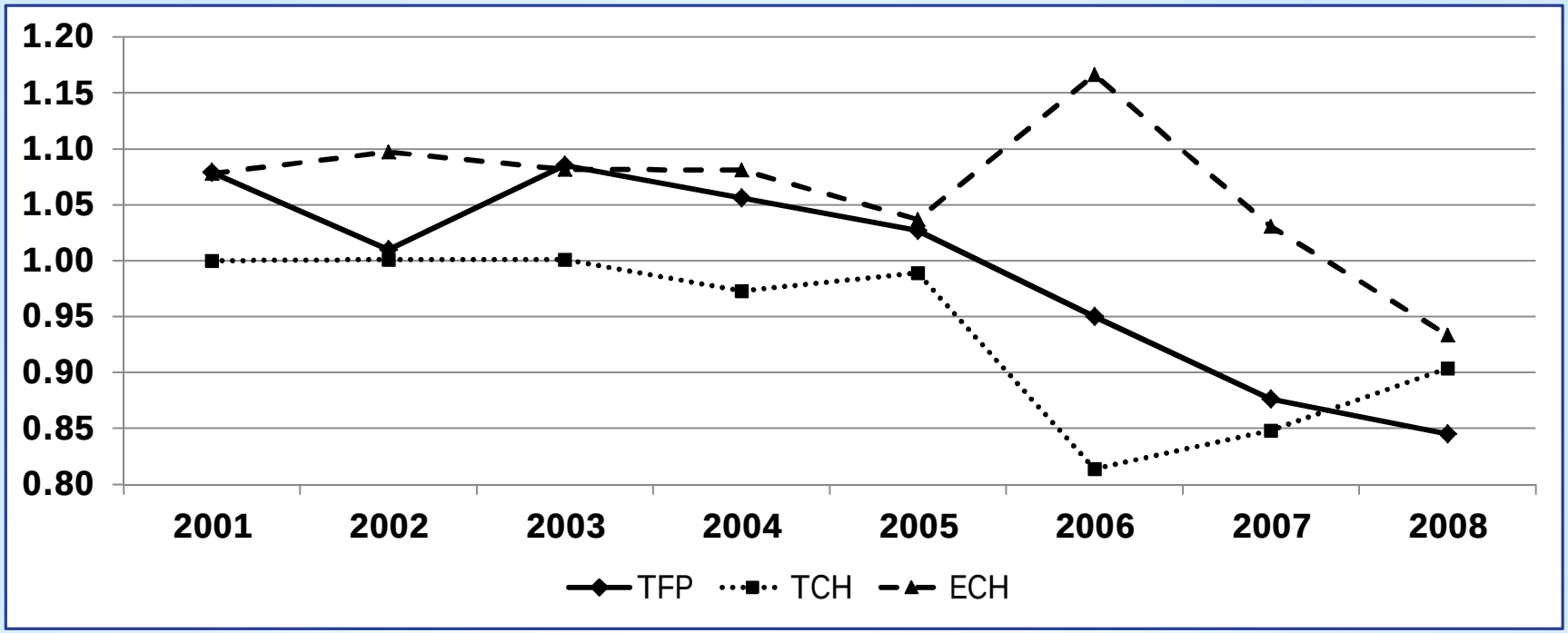
EMPIRICAL APPLICATION: RESULTS



- **2001-2005: Both drivers contributed to TFP change**
- **2006-2007: ECH and TCH moved in opposition (ECH: ↑19.7% and TCH: ↓ 33.8%)**
- **2008: Both drivers decreased**

EMPIRICAL APPLICATION: RESULTS

2001-2004: Price review 1999: RPI-2.1

- **Productivity increased by 25.7% and 16 out of 22 water companies improved their TFP.**
- **Technical change remained almost constant.**
- **Efficiency change contributed positively to TFP in 17 out of 22 water companies: They moved closer to the frontier after the price review in 1999.**
- **During 2001/2004 when price caps were tightened after the 1999 price cap review, productivity increased thanks to efficiency change.**

EMPIRICAL APPLICATION: RESULTS

2005-2008: Price review 2004: RPI+4.2

- **2 out of 22 water companies improved its TFP**
- **Technical change decreased as in the period 2001-2004: Price review did not stimulate technical change improvements.**
- **Efficiency change contributed positively to TFP in 13 out of 22 water companies.**
- **The 2004 price review did not have a positive impact on productivity.**

CONCLUSIONS

- **Several indexes can be used to estimate Total Factor Productivity (TFP) of water companies. However, the Färe-Primont index is the only index that can be used to make reliable multi-lateral and multi-temporal comparisons.**
- **Färe-Primont index is used to compute TFP of the 22 English and Welsh water companies from 2001 to 2008.**
- **2001-2004: TFP improved thanks to gains in efficiency change whereas technical change remained constant.**
- **2005-2008: TFP decreased and both drivers contributed to this retardation.**

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CONCLUSIONS

- **From a policy perspective, it is essential to compute TFP using reliable indexes otherwise conclusions may be incorrect which would affect to the process of setting water tariffs.**

- **The decomposition of productivity change into several drivers allows water utilities managers to identify the main factors on which they should act to improve productivity of the company.**

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