ASSESSING THE IMPACT OF SERVICE QUALITY ON THE PRODUCTIVITY OF WATER INDUSTRY: A MALMQUIST-LUENBERGER PRODUCTIVITY INDEX FOR ENGLAND AND WALES

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Performance of water companies:

Efficiency: A firm is compared with respect to its main competitors. Static assessment.

Productivity change: Evaluates how firms are doing over time. Dynamic assessment.

Productivity change assessment is essential to set water prices in regulated industries which follow Price Cap Regime.







Service quality issues are becoming relevant in the performance assessment of water companies:

Ignoring service quality favors "low-cost" but low-quality companies while companies providing high-quality at expense of larger costs are penalized.

Service quality?

- <u>Developing countries:</u> service coverage, percentage of water receiving treatment, service continuity.
- <u>Developed countries:</u> water losses, unaccounted-forwater, water quality







INTRODUCTION

Service quality?

<u>CUSTOMERS PERSPECTIVE</u>: Written complaints, Unplanned interruptions and Properties below the reference level.

OBJECTIVE:

EVALUATE THE IMPACT OF INTRODUCING THE QUALITY OF THE SERVICE TO CUSTOMERS IN THE ASSESSMENT OF THE PRODUCTIVITY CHANGE OF WATER COMPANIES.







Compare two productivity indexes:

- Traditional assessment without considering service quality variables: Luenberger Productivity Indicator (LPI)
- Alternative assessment introducing the lack of service quality as undesirable outputs: Malmquist-Luenberger Productivity index (MLPI)

Empirical application: English and Welsh water industry for the period 2001-2008.







Luenberger productivity indicator (LPI): Directional distance function. Minimize the use of inputs and maximize the generation of outputs.

 $D_t(x_t, y_t; g) = \begin{cases} \sup[\delta: (x_t - \delta h; y_t + \delta k) \in T_t] & \text{if } (x_t - \delta h; y_t + \delta k) \in T_t, \delta \in \Re \\ -\infty & \text{otherwise} \end{cases}$

$$LPI(x_{t_{i}} y_{t_{i}} x_{t+1_{i}} y_{t+1}) = [D_{t}(x_{t_{i}} y_{t}; g) - D_{t+1}(x_{t+1_{i}} y_{t+1}; g)] \\ + \frac{1}{2} [D_{t+1}(x_{t+1_{i}} y_{t+1}; g) - D_{t}(x_{t+1_{i}} y_{t+1}; g) + D_{t+1}(x_{t_{i}} y_{t}; g) \\ - D_{t}(x_{t_{i}} y_{t}; g)]$$







LPI = *Efficiency change* (*LECH*) + *Technical change* (*LTCH*)

LPI > 0 productivity has increased; LPI < 0 productivity has decreased; LPI = 0 productivity has not changed







Malmquist-Luenberger Productivity Index: Directional distance function.

 $\overrightarrow{D_o}(x, y, b; g) = sup\{\beta: (y, b) + \beta g \in P(x)\}$

 $x \in \mathfrak{N}^{M}_{+}$ is a set of inputs $y \in \mathfrak{N}^{M}_{+}$ is a set of desirable outputs $b \in \mathfrak{N}^{I}_{+}$ is a set of undesirable outputs







Malmquist-Luenberger Productivity Index:

$$MLPI_{t}^{t+1} = \left[\frac{\left(1+\overline{D}_{0}^{t}(x^{t},y^{t},b^{t};g^{t})\right)}{\left(1+\overline{D}_{0}^{t}(x^{t+1},y^{t+1},b^{t+1};g^{t+1})\right)} * \frac{\left(1+\overline{D}_{0}^{t+1}(x^{t},y^{t},b^{t};g^{t})\right)}{\left(1+\overline{D}_{0}^{t+1}(x^{t+1},y^{t+1},b^{t+1};g^{t+1})\right)}\right]^{1/2}$$

MLPI = *Efficiency change* (*MLECH*) * *Technical change* (*MLTCH*)

MLPI > 1 productivity has increased; MLPI < 1 productivity has decreased; MLPI = 1 productivity has not changed















EMPIRICAL APPLICATION: SAMPLE

- 22 English and Welsh water companies (10 WaSCs and 12 WoCs).
- Period: 2001-2008
- Drinking water services
- Inputs: Operational costs and Capital Stock.
- Desirable outputs: Water distributed and Number of connected properties.
- Undesirable outputs: Total number of written complaints, total number of unplanned interruptions and properties below the reference level.







EMPIRICAL APPLICATION: SAMPLE

			2001	2002	2003	2004	2005	2006	2007	2008
INPUTS	Operating cost (£000 ´s)	Mean	68.2	68.3	69.6	72.4	73.9	80.0	86.8	87.6
		S.D.	67.4	67.5	69.1	72.2	73.3	83.8	92.6	90.6
	Capital Stock (£000 ´s)	Mean	3,869.0	3,891.0	3,922.4	3,955.6	3,984.8	4,007.8	4,035.1	4,070.4
		S.D.	3,919.1	3,938.8	3,972.9	4,017.1	4,060.1	4,090.3	4,117.3	4,152.8
DESIRABLE OUTPUTS	Water distributed (10 ⁶ l/d)	Mean	681.4	696.6	699.7	711.7	699.0	697.3	681.5	670.7
		S.D.	716.2	739.3	751.4	763.2	748.3	748.3	725.4	706.5
	Connected properties (Nr)	Mean	1,067.5	1,075.2	1,081.9	1,089.1	1,095.9	1,103.9	1,110.4	1,110.0
		S.D.	1,098.6	1,106.3	1,113.1	1,119.3	1,125.1	1,133.0	1,138.6	1,127.1
UNDESIRABLE OUTPUTS	Written	Mean	6,054.6	6,379.9	6,335.5	6,471.7	6,498.1	8,446.9	11,200.7	12,408.9
	complaints (Nr)	S.D.	8,310.5	8,822.2	8,701.4	8,424.3	9,242.4	13,199.5	18,123.4	16,932.0
	Unplanned interruptions (Nr)	Mean	659.2	1,473.0	511.9	2,065.0	1,489.8	1,027.8	2,239.5	2,037.0
		S.D.	1,690.5	4,851.0	1,016.4	8,790.6	3,841.4	1,944.9	5,538.0	19,378.2
	Properties below reference level	Mean	1,199.4	1,084.7	717.8	457.1	337.5	278.5	248.2	219.3
		S.D.	1,654.8	1,604.0	1,169.9	574.2	497.8	344.9	310.7	344.5







Average Annual Growth Rates (%)							
	LPI	MLPI	LECH	MLECH	LTCH	MLTCH	
2001/2002	-0.16	2.46	-1.34	1.77	1.17	0.75	
2002/2003	-0.68	1.07	-0.45	-1.37	-0.23	2.40	
2003/2004	-0.76	0.60	0.54	0.40	-1.30	0.24	
2004/2005	-1.76	-1.52	-1.16	0.90	-0.60	-2.36	
2005/2006	-2.46	-7.88	7.45	-0.07	-9.91	-7.52	
2006/2007	-4.69	-5.60	-7.13	-1.54	2.44	-3.63	
2007/2008	-0.94	-1.96	3.19	-3.53	-4.13	-3.53	

- Excluding service quality: productivity decreased during all periods analyzed.
- Including service quality: productivity increased in the period 2001/2004 (Price review 1999) and decreased in the period 2004/2008 (Price review 2004)







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- Excluding service quality: There is not a clear trend for any of the two factors.
- Including service quality: MLECH does not show any trend while for the period 2001/2004 there was a positive shift of the frontier while for the period 2004/2008 it was negative.







Null hypothesis	Mann-Whit	tney U test	Kolmogorov-Smirnov Z test			
	p-value	Result	p-value	Result		
LPI = MLPI	<0.001	Rejected	<0.001	Rejected		
LECH = MLECH	<0.001	Rejected	<0.001	Rejected		
LTCH = MLTCH	<0.001	Rejected	<0.001	Rejected		









- LPI: 5 companies improved their productivity
- MLPI: 3 companies improved their productivity (not the same)





LECH: 11 companies moved away from the efficient frontier
MLECH: 9 companies decreased their efficiency (7 are the same)





- LTCH: 19 companies experienced retardation
- MLTCH: 11 companies had negative shift of the frontier.



CONCLUSIONS

- Assessing productivity change over time and identifying its determinants in regulated water industry is a valuable tool for setting tariffs.
- Quality issues should be introduced in the assessment otherwise low-cost but low-quality companies are favored.
- To assess the impact of the service quality to customers we computed the LPI and MLPI for the 22 English and Welsh water companies from 2001 to 2008.
- LPI productivity decreased for all periods evaluated.
- MLPI productivity improved from 2001 to 2004. During this period, water companies made a great effort to improve the quality of the service provided to customers.







CONCLUSIONS

- From a policy perspective water regulators need to pay attention to service quality issues when assessing companies performance under comparative yardstick regimes.
- It was proved that the omission of service quality penalizes water companies that provide better service quality at the expense of larger operational costs.







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THANK YOU FOR YOUR ATTENTION!

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