Firms' governance and efficiency in the water service provision: empirical evidence from the Italian case
VERY PRELIMINARY VERSION

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MOTIVATION

ITALY, recent years, **relevant increase in water tariffs** perceived by consumers.
Given the actual regulation system, drivers for this increase can be:

- 1. (In)Efficiency in provision, given new governance at work
- 2. Planned investments
- 3. Tariffs' structure

Extended debate at national (and EU) level focussed on i) the firm's governance allowed in the provision of the service ii) the awarding procedures to be adopted to select the firm (i.e., Environmental Code, 152/2006; Decreto Ronchi 135/2009, Referendum in June 2010).
In particular, the entry of private firms as providers has been often identified as the main determinant of tariffs' increase.

WHAT WE DO:

- Collect a **new dataset on Italian water services, 2005-2010,** with
  i) technical data on provision;
  ii) budgetary data on about 80 operators over a total of 114;
  iii) data on local regulators.
- Assess the **effect of firms' governance on efficiency** in the provision of the water service in Italy as a first step in the analysis on tariffs' level.

Very preliminary stage of the analysis:

- 47 operators, 2008-2009

LITERATURE ON EFFICIENCY in the PROVISION

- - **of public utilities:** prior 1990, USA, empirical investigations measuring the efficiency and productivity performance of various utilities; bulk on rail and electricity industry.
- - **of water services:** debate during the 1970s in USA about the optimal size of water utilities, the existence of possible economies of scale, the effects of mergers and the relative performance of public *vs* private operators and wastewater businesses.

Measures: - Partial and total factor productivity measures; - *Econometric measures*; - Data envelopment analysis (DEA); - Stochastic frontier measures.

Issues investigated: - economies of scale; - economies of scope; - *public vs private ownership*; - effects of regulation.

MAIN RESULTS on public vs private ownership in provision

- No discernable difference between government- and privately owned companies (Feigenbaum and Teeples, 1983; Byrnes et al., 1986; Teeples and Glyer, 1987; see further Houtsma, 2003; Garcia-Sanchez, 2006; da Silva et al., 2007).
- Private operators more efficient (Crain and Zardkoohi, 1978; Morgan, 1977; Raffiee et al., 1992)
- Public providers more efficient (Mann and Mikesell, 1976; Bruggink, 1982; Fox and Hofler, 1985; Lambert et al., 1993; Bhattacharyya et al., 1994; Shih et al., 2006).

- Bhattacharyya et al. (1995): government owned firms were more efficient at high levels of output, while privately owned ones more efficient at low levels of output.
- Wallsten and Koser (2005): in driving efficiency, ownership is not important as other factors, such as scale or the level of competition in the industry.

ITALIAN REGULATORY SETTING - National Law 36/1996

- Integration at two levels: i) **vertical**, in the supply of services, *Integrated water service, IWS* (supplying of water - fetching, transporting and distributing - sewage and water treatment/purification, i.e.scope economies). ii) **horizontal**, in the IWS coverage, *Optimal Territorial Basins, OPT,* (i.e. scale economies).
- Regulatory design:

  1. at local level, OPT Authority, maintaining the property of infrastructures, contracting out the service to a single operator,designing regulation, programming and monitoring the IWS;

  2. at national level, a national authority - the actual CONVIRI - protecting consumers' general interests, pursuing efficiency and productivity, monitoring the tariffs' design.

  3. at intermediate level: Basin Authorities and Regions
- Introduction of a new tariff system (full-cost recovery approach, investment included).

Tariff Regulation

Limit Tariff (LT):

$$LT_n = (C + A + R)_{n-1} * \frac{(1 + \pi + K)}{m^3}$$

$LT_n =$ current tariff
$C =$ operation costs
$A =$ amortization costs
$R =$ capital remuneration component
$\pi =$ inflation rate expected for the current year
$K =$ price cap, i.e. max rate of increase over planned inflation
$m^3 =$ volume of water provided

Average Real Tariff (ART):

$$ART = (C + A + R)/m^3$$

(C) Operation Costs

- Cost of raw materials and merchandise,
- Cost of services;
- Cost of personnel;
- Taxes;
- Other operating expenses (any costs not included in the previous categories or which have not tax or financial nature).

(A) Amortization

- Amortization and Depreciation charges on assets

(R) Invested capital remuneration

- remuneration of the operator's invested capital, it is applied to the average value between the *assets amortization* and *depreciation* values at the beginning and the ending of the year, and fixed to the 7% value (abolished by Referendum, June 2011).

Final Tariff

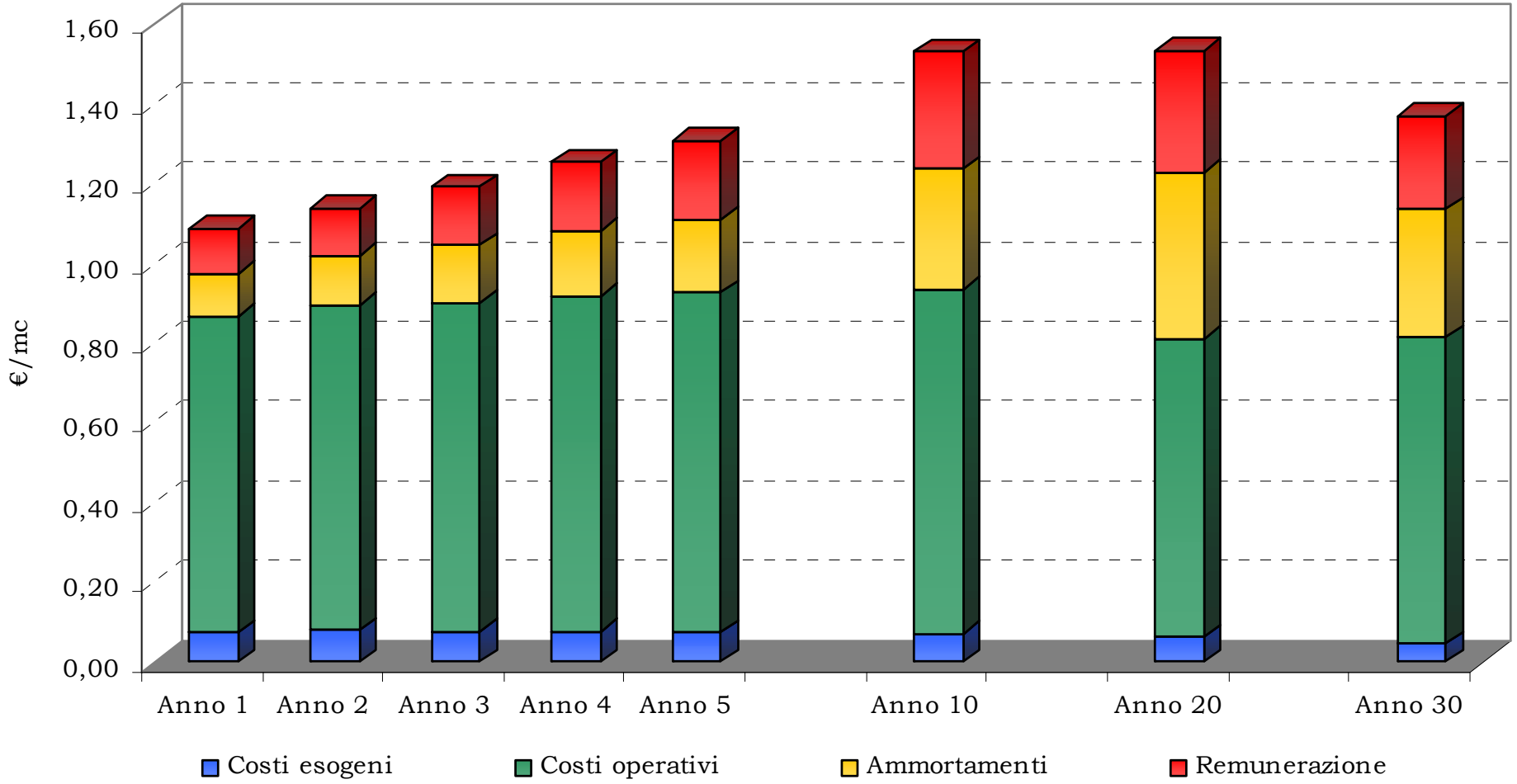
The Final Tariff, namely the one payed by consumers, is the smaller between the LT and the ART, so that:

$$\text{if ART} \leq \text{Limit Tariff} \longrightarrow \text{ART} \equiv \text{Final Tariff}$$

$$\text{if ART} \geq \text{Limit Tariff} \longrightarrow \text{Limit Tariff} \equiv \text{Final Tariff}$$

ART is the main reference in this regulatory design

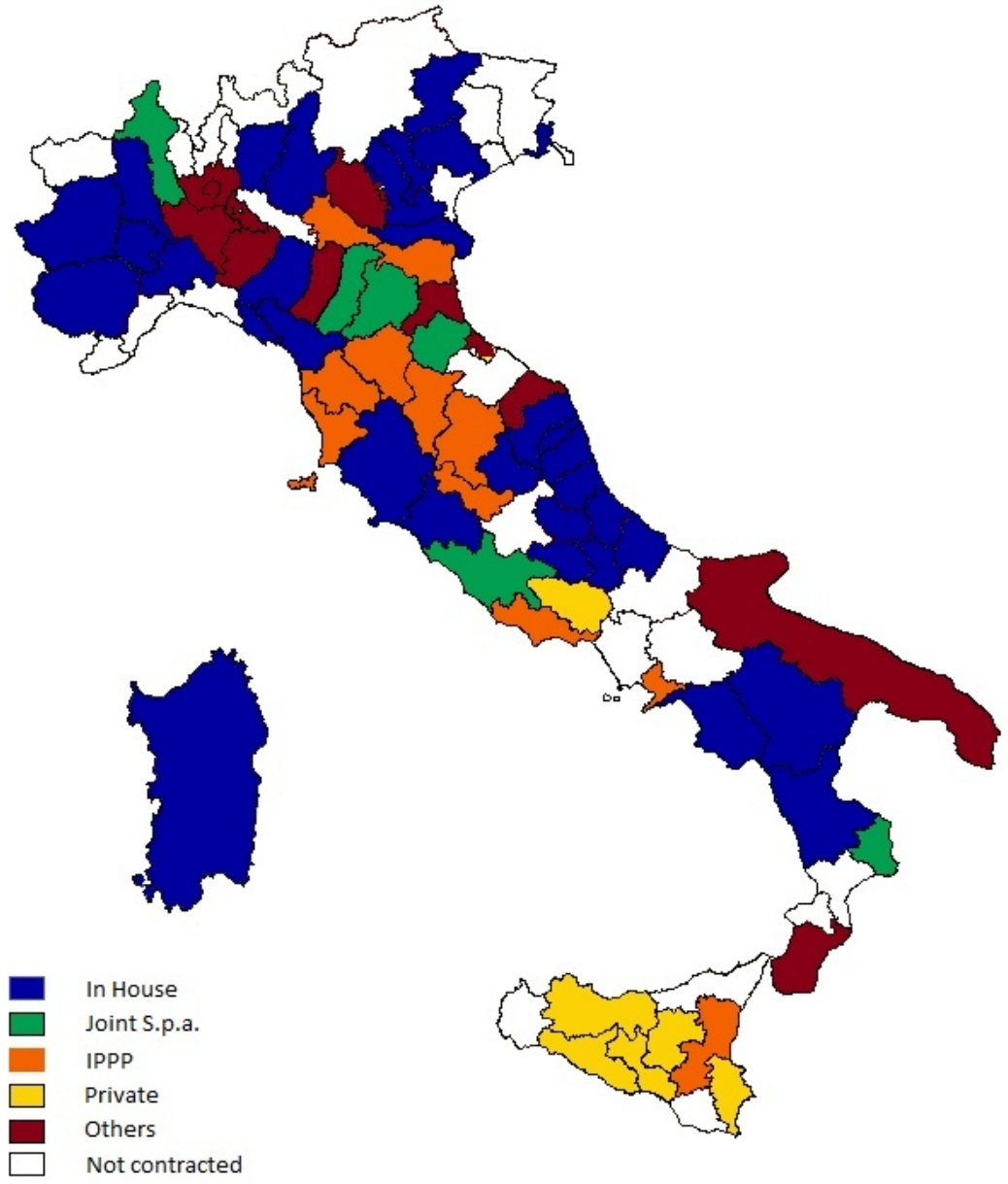
Figure 1: ART: the relevance of operation costs on tariffs' level (in green), 12 operators having different governance and operating in the three Italian macro regions *Source: CNEL - 2010*



TYPES OF MANAGEMENT ACTUALLY OPERATIVE

- In House (Local Public Firm)
- Joint Stock Company
- IPPP
- Private
- Others
- Non contracted

Figure 2: Italy splitted in *Optimal Territorial Basins*, coloured according to the Type of Management. Source: *Conviri Report 2009*



TYPE OF MANAGEMENT (Percentage)

	In house	Joint	IPPP	Private	Others	TOT
North	51,7	9,5	17,6	1,4	18,9	100
Center	60,0	4,0	28,0	4,0	4,0	100
South	26,7	6,7	13,3	33,5	20,0	100

POPULATION SERVED (Percentage)

	In house	Joint	IPPP	Private	Others	TOT
North	32.5	11.3	7.2	0.8	43.5	100
Center	26.1	32.0	34.0	4.4	3.6	100
South	22.3	1.2	17.9	8.6	47.5	100

THE REGULATORY DATA

FROM: CONVIRI, Annual Reports; UTILITATIS, Blue Book: 2009, 2010, 2011; CNEL, Report 2010

- *Info on Optimal Territorial Basins*
- *Info on Average Tariffs and Tariffs' Structure*

THE BUDGETARY DATA

FROM: AIDA 2005-2010; direct interview to operators

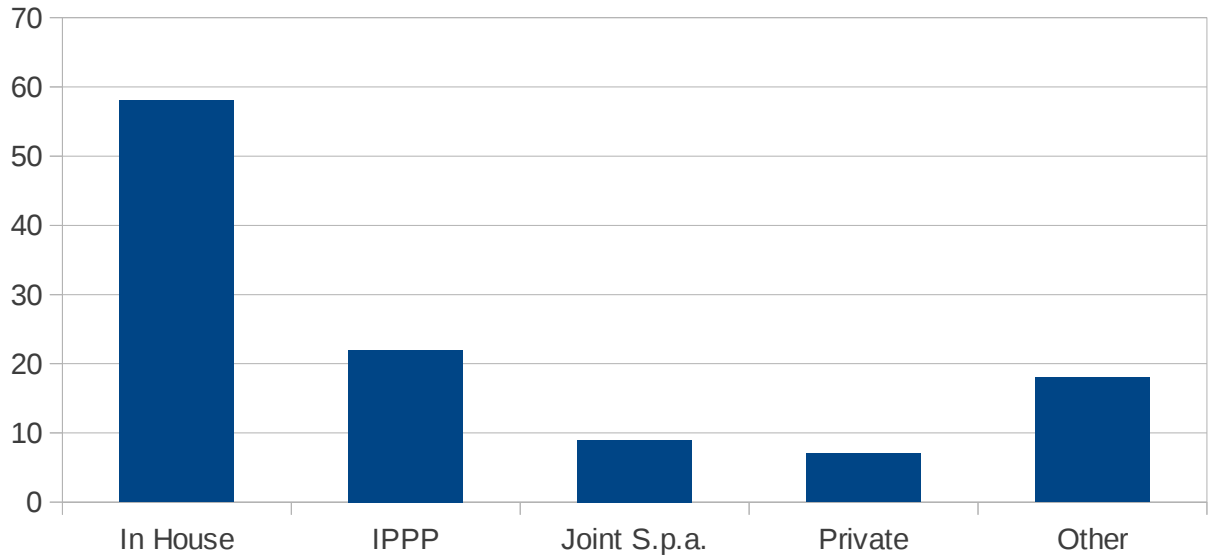
- *Production cost*
- *Personnel cost*
- *Number of employees*
- *Raw materials, furniture and merchandise*
- *Services*
- *Fixed assets internally generated*

THE TECHNICAL DATA

FROM: UTILITATIS, 2005-2010; direct interview to operators

- *Population served*
- *Clients* (i.e. number of contracts)
- *Annual volume of water sold* (m^3)
- *Annual volume of water sold by type of source* (m^3)
- *Served territory area* (m^2)
- *Annual revenues and employees*
- *Water pipelines length* (Km)
- *Annual electric energy consumptions* (kW)
- *Services*
- *Leaks*

CONVIRI REPORT 2009 Operators (114)



DATA SAMPLE Operators (47)

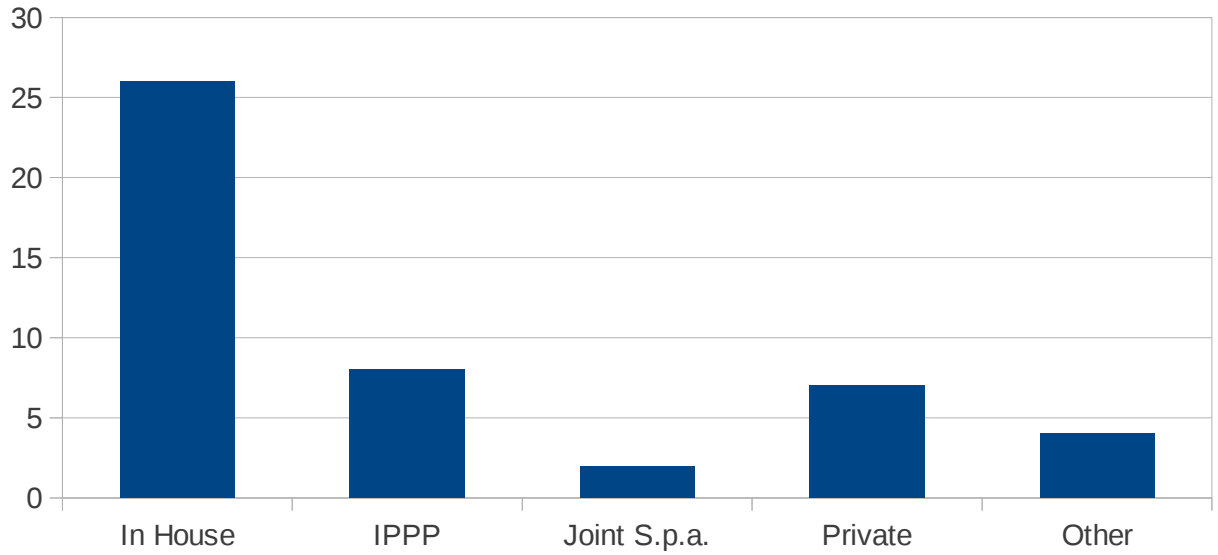


Table 1: *Population*, *Clients*, *Volume of water sold*, *Conducts*, *Employees* and *Employees expenditure* for 47 operators in 2009, grouped by management

			Population	**Clients**	**Volume sold (m^3)**	**Conduct (Km)**	**Employees**	**Emp.Ex. (€)**
In House (26)	Min.	:	12.644,0	5.013,0	1.065.000,0	240,0	8,0	226.735,0
	Mean	:	437.334,0	164.782,0	38.726.295,0	3.509,0	245,1	9.578.117,0
	sd	:	577.436,6	165.420,9	55.374.948,0	2.445,3	306,5	13.499.120,0
	Max.	:	2.194.759,0	780.000,0	250.000.000,0	10.267,0	1.417,0	53.824.351,0
Ippp (8)	Min.	:	39.543,0	13.727,0	6.000.000,0	600,0	13,0	583.984,0
	Mean	:	608.324,0	220.719,0	40.052.305,0	4.197,0	366,5	12.760.539,0
	sd	:	512.557,9	171.035,1	31.453.409,0	2.298,3	279,5	10.536.019,0
	Max.	:	1.448.715,0	460.000,0	85.605.678,0	7.000,0	780,0	30.353.235,0
Private (4)	Min.	:	160.645,0	78.170,0	8.637.827,0	1.019,0	30,0	748.661,0
	Mean	:	468.911,0	124.724,0	36.906.804,0	1.921,0	190,0	8.258.770,0
	sd	:	303.399,0	48.623,6	32.691.143,0	799,9	187,0	9.313.944,0
	Max.	:	880.000,0	186.205,0	72.706.000,0	2.544,0	428,0	20.975.969,0
Joint (2)	Min.	:	656.081,0	-	45.032.665,0	1.300,0	676,0	33.932.350,0
	Mean	:	2.106.140,0	-	245.966.332,0	6.026,0	1.186,5	58.642.655,0
	sd	:	2.050.693,0	-	284.163.118,0	6.684,3	722,0	34.945.647,0
	Max.	:	3.556.199,0	-	446.900.000,0	10.753,0	1.697,0	83.352.959,0
Others (7)	Min.	:	62.500,0	13.592,0	3.113.000,0	333,0	24,0	1.114.975,0
	Mean	:	1.127.552,0	348.648,0	90.713.392,0	5.498,0	459,0	18.374.568,0
	sd	:	1.405.275,0	449.804,4	103.671.016,0	7.064,6	707,3	26.738.646,0
	Max.	:	4.032.950,0	1.000.000,0	245.678.423,0	21.000,0	2.000,0	76.675.731,0

Table 2: *Population*, *Clients*, *Volume of water sold*, *Conducts*, *Employee* and *Employee Expenditure* for 47 operators in 2009, grouped by size

			Population	**Clients**	**Volume sold (m^3)**	**Conducts (Km)**	**Employees**	**Emp.Ex. (€)**
Small (11);75	Min.	:	12.644,0	5.013,0	1.065.000,0	240,0	8,0	253.661,0
	Mean	:	170.372,0	6.6234,0	12.695.110,0	1.127,6	34,1	1.093.288,0
	sd	:	151.709,0	61.201,1	12.620.486,0	1.272,5	19,1	583.309,8
	Max.	:	494.737,0	150.000,0	40.000.000,0	4.000,0	73,0	2.051.799,0
Med (22);	Min.	:	94.767,0	40.746,0	6.922.114,0	964,0	82,0	226.735,0
	Mean	:	323.745,8	152.345,0	27.526.732,0	3.195,0	177,7	6.665.416,0
	sd	:	185.579,4	63.448,8	16.366.407,0	1.520,8	78,4	3.922.825,0
	Max.	:	729.951,0	291.567,0	63.000.000,0	7.000,0	344,0	14.300.550,0
Big (14);350	Min.	:	656.081,0	122.933,0	45.032.665,0	1.300,0	353,0	9.282.218,0
	Mean	:	1.925.668,0	476.725,0	171.288.537,0	6.721,0	811,9	33.670.886,0
	sd	:	1.106.829,0	306.575,3	124.721.147,0	4.960,9	520,7	23.397.222,0
	Max.	:	4.032.950,0	1.000.000,0	446.900.000,0	21.000,0	2.000,0	83.352.959,0
(Top) (3); 1400	Min.	:	1.576.328,0	780.000,0	141.750.437,0	4.000,0	1.417,0	53.824.351,0
	Mean	:	3.055.159,0	890.000,0	278.109.620,0	11.918,0	1.705,0	71.284.347,0
	sd	:	1.302.701,0	155563,5	155.138.328,0	8.559,6	291,6	15.484.991,0
	Max.	:	4.032.950,0	1.000.000,0	446.900.000,0	21.000,0	2.000,0	83.352.959,0

EFFICIENCY INDICATORS

INTERNAL PRODUCTION EFFICIENCY: the operator, given its productions function, chooses among all the possible combinations of production factors that one leading to the cost minimization.

- *Average Cost/ Volume of water sold*
- *Average Cost/ Length of conducts*
- *Average Cost/ Inhabitants*
- *Average Cost/ Employees*

- *Cost of Personnel/ Production Cost*

- we calculate these indicators, clustering operators by size and by management

Table 3: *EFFICIENCY INDICATORS - Average Cost per Unit of Water Sold,* for 47 operators in 2009 grouped by size

AVC PER A UNIT OF WATER SOLD (€/m^3)

	Small	**Medium**	**Big**	**(Top)**
Min. :	0,3553	0,5832	0,4712	0,4715
Mean :	1,2798	1,4870	1,4010	1,2820
sd :	0,5483	0,6541	0,4715	0,4360
Max. :	2,0574	3.5630	1,9500	1.6320

Table 4: *EFFICIENCY INDICATORS - Average Cost per Employee,* for 47 operators in 2009 grouped by size

AVC PER EMPLOYEE (€/Person)

	Small	**Medium**	**Big**	**(Top)**
Min. :	133.400,0	114.000,0	115.400,0	163.300,0
Mean :	280.800,0	203.200,0	182.700,0	182.200,0
sd :	183.856,6	65.641,3	41.827,7	23.836,1
Max. :	668.700,0	368.600,0	264.000,0	209.000,0

Table 5: *EFFICIENCY INDICATORS - Average Cost per Unit of Water Sold* for 47 operators in 2009 grouped by management

AVC PER VOLUME OF WATER SOLD (€/m^3)

	In House	**Ippp**	**Joint S.p.a.**	**Private**	**Others**
Min. :	0,5832	0,4979	0,7935	1,554	0,355
Mean :	1,4462	1,5040	1,2630	1,919	1,030
sd :	0,5981	0,4713	0,6633	0,404	0,528
Max. :	3,5629	1,9830	1,7320	2,354	1,652

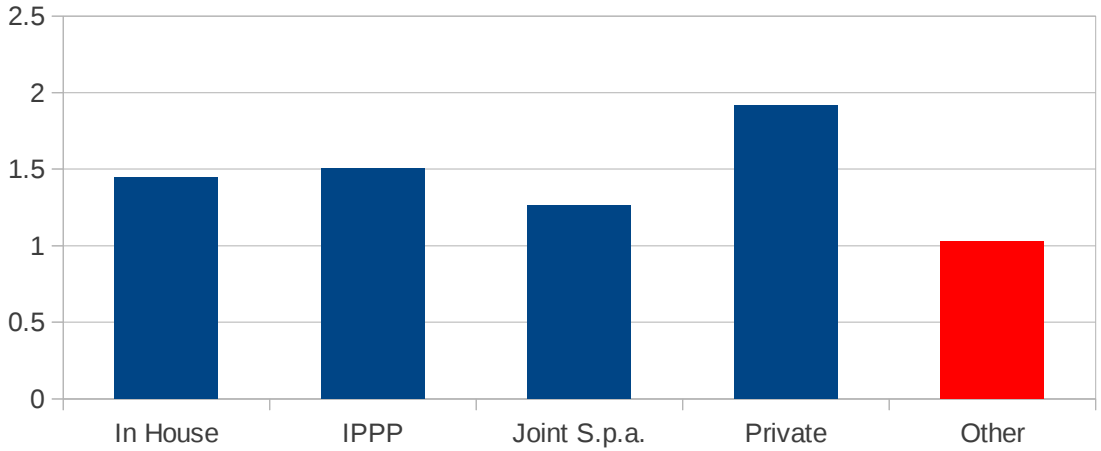
Table 6: *EFFICIENCY INDICATORS - Average Cost per Employee,* for 47 operators in 2009 grouped by management

AVC PER EMPLOYEE (€/Person)

	In House	**Ippp**	**Joint S.p.a.**	**Private**	**Others**
Min. :	114.000,0	145.000,0	115.400,0	264.000,0	116.700,0
Mean :	192.400,0	190.500,0	162.200,0	435.400,0	217.700,0
sd :	59.226,9	52.988,8	66.197,5	198.677,9	106.787,3
Max. :	368.600,0	310.700,0	209.000,0	668.700,0	434.200,0

Data Sample 2009 AVC per Unit of Water Sold (Euro/mc3)

operators grouped by type of management (red bar means statistical significance)



Data Sample 2009 AVC per Employee (Euro/person)

operators grouped by type of management (red bar means statisticall significance)

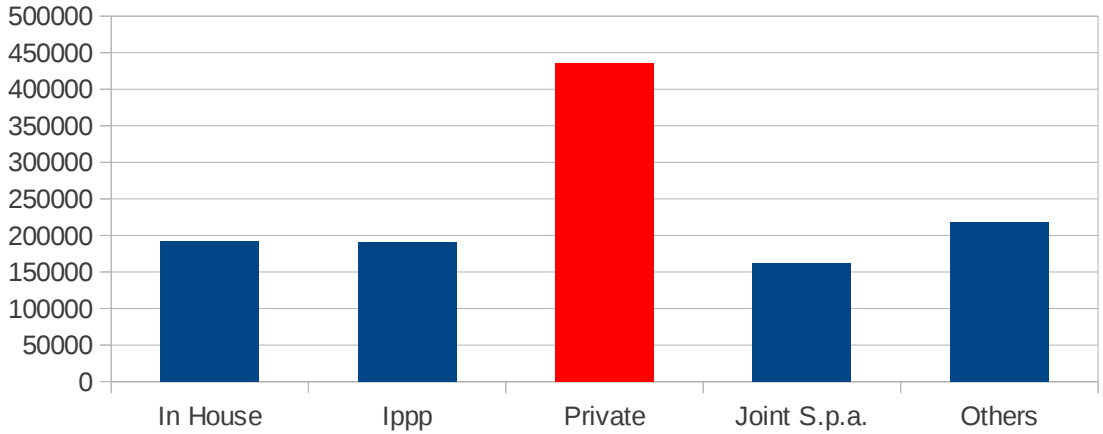


Table 7: *EFFICIENCY INDICATORS - Ratio of Personnel Cost over Production Cost*, for 47 operators in 2009 grouped by size

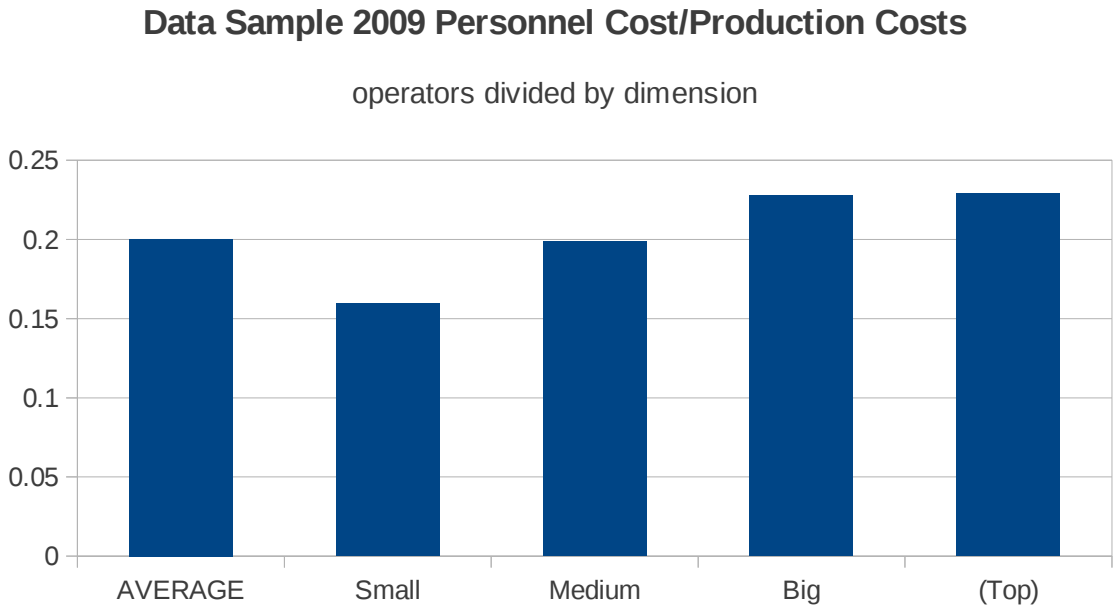
PERSONNEL COST OVER PRODUCTION COST by size (€/Person)

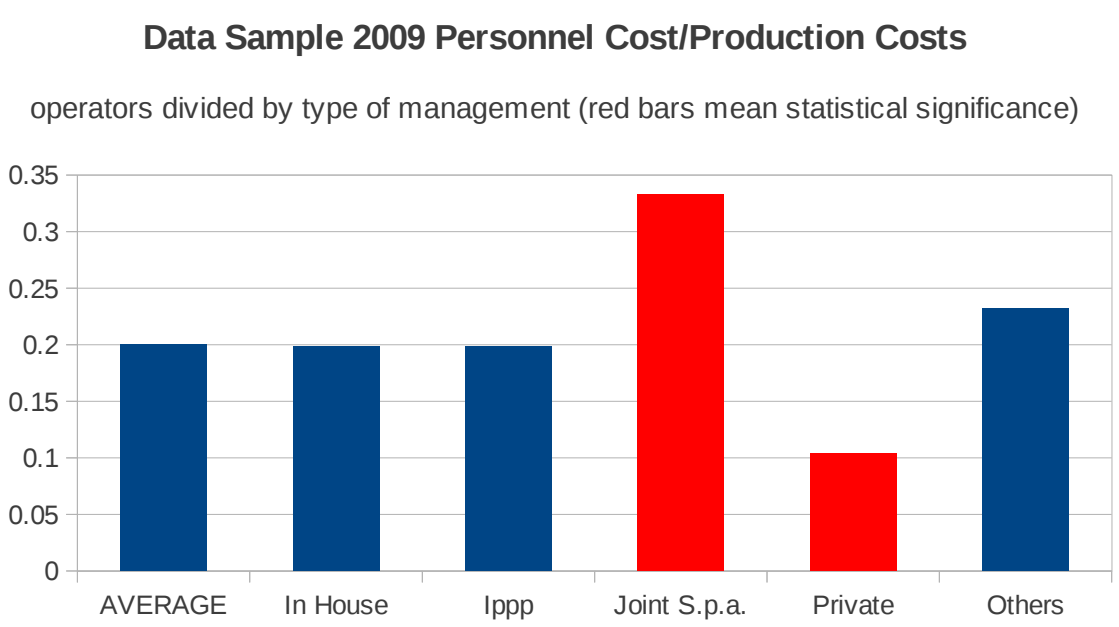
	Operators	Small	Medium	Big	(Top)
Min. :	0,0047	0,0468	0,0047	0,1033	0,2199
Mean :	0,2003	0,1593	0,1984	0,2277	0,2291
sd :	0,0845	0,0816	0,0867	0,0735	0,0081
Max. :	0,4351	0,2724	0,3966	0,4351	0,2350

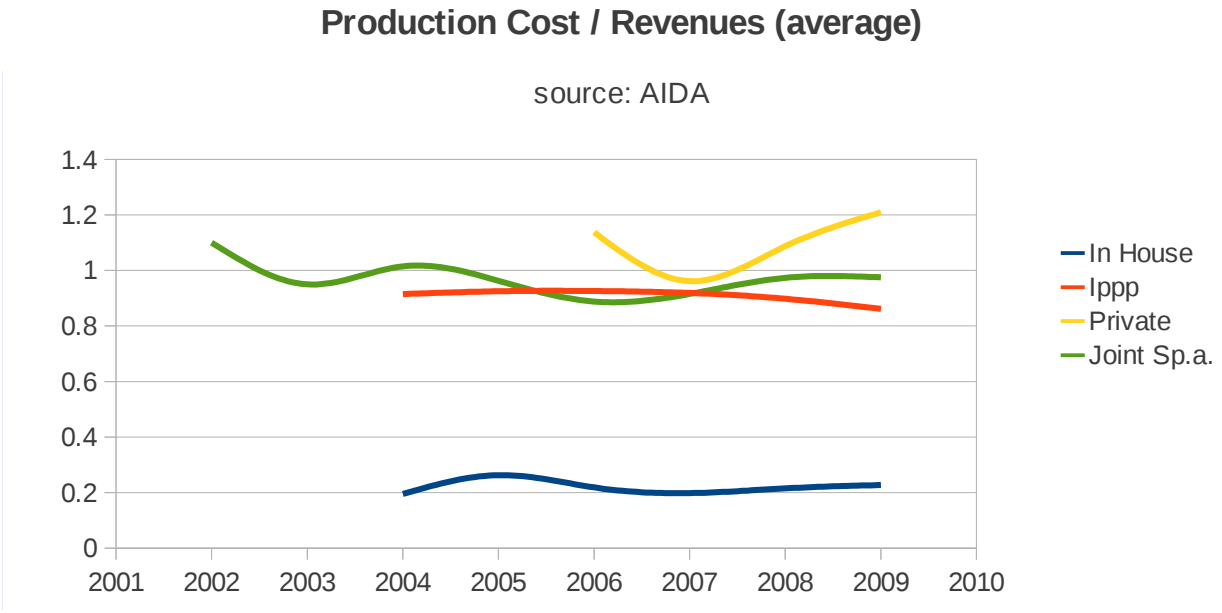
Table 8: *EFFICIENCY INDICATORS - Ratio of Personnel Cost over Production Cost*, for 47 operators in 2009 grouped by management

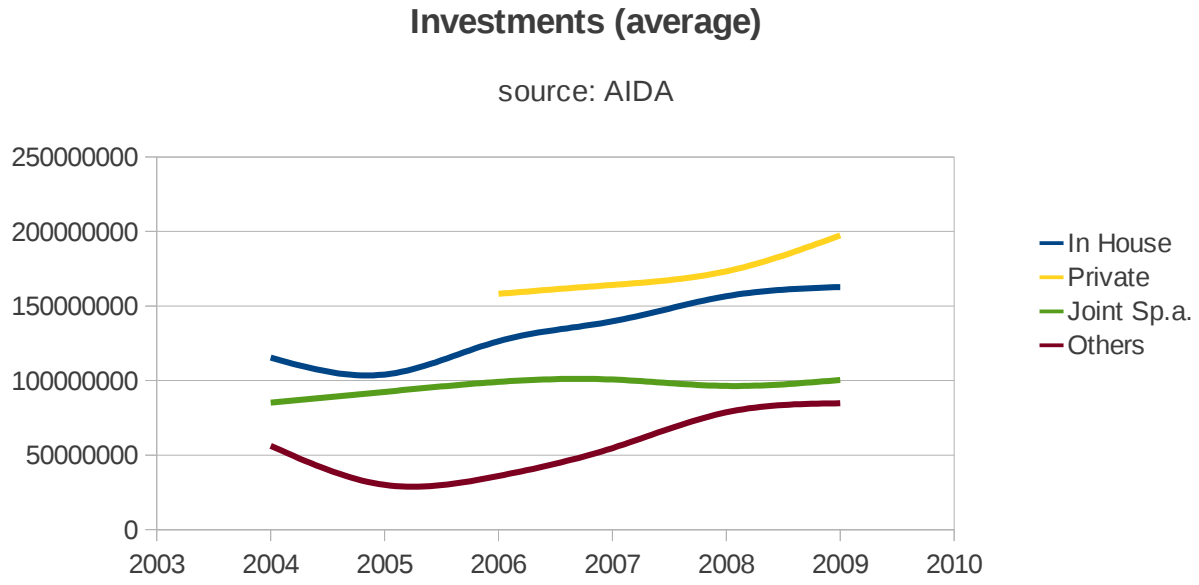
PERSONNEL COST OVER PRODUCTION COST* by management (€/Person)

	Operators	In House	Ippp	Joint S.p.a.	Private	Others
Min. :	0,0047	0,0047	0,1033	0,2350	0,0468	0,1070
Mean:	0,2003	0,1989	0,1978	0,3330	0,1040	0,2325
sd :	0,0845	0,0758	0,0575	0,1414	0,0670	0,0890
Max. :	0,4351	0,2955	0,2685	0,4351	0,1856	0,3967


Data Sample 2009 Personnel Cost/Production Costs
operators divided by dimension
0.25
0.2
0.15
0.1
0.05
0
AVERAGE
Small
Medium
Big
(Top)


Data Sample 2009 Personnel Cost/Production Costs
operators divided by type of management (red bars mean statistical significance)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
AVERAGE
In House
Ippp
Joint S.p.a.
Private
Others


Production Cost / Revenues (average)
source: AIDA
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
In House
Ippp
Private
Joint Sp.a.


Investments (average)
source: AIDA
250000000
200000000
150000000
100000000
50000000
0
2003
2004
2005
2006
2007
2008
2009
2010
In House
Private
Joint Sp.a.
Others

LINEAR MODEL SPECIFICATION

$$Y = \alpha_0 + \beta_1 Q + \beta_2 D + U$$

$\alpha \longrightarrow$	In House, Medium-size operator
$\beta_1 \longrightarrow$	Volume of water sold; Employees; Km of Conduct; Raw Materials; Services.
$\beta_2 \longrightarrow$	Dipp; Djoint; Dprivate; Dothers. Dbig; Dsmall.

OLS MODEL RESULTS: AVC PER UNIT OF WATER SOLD (€/m^3)

Coefficients First 4 coeff. in per capita terms	Estimate		sd
Intercept	-0.969	(0.000)***	0,195
Raw materials	0,011	(0.001)**	0.004
Services	0.013	(0.000)***	0.002
Volume sold (inverse)	96.708	(0.000)***	12.093
Conducts	0.773	(0.898)	5.974
Employees	657.502	(0.000)***	159.360
Djoint	0.176	(0.284)	0.161
Dippp	0.144	(0.122)	0.091
Dprivate	0.520	(0.001)**	0.144
Dothers	-0,004	(0.965)	0.092
Dsmall	-0.199	(0.037)*	0.092
Dbig	-0.045	(0.524)	0.070
Adjusted R-squared:	0.902		
F-statistic:	36.1	(0.000)***	

DISCUSSION

- - This preliminary investigation (on 47 firms) highlights that there is larger heterogeneity in technical data when firms are clustered by size than by management
- - Average cost per unit of water sold: no large heterogeneity in size and in management
- - Average cost per employee: very high for Private compared to others management formats
- - Ratio of Personnel Cost over Production cost: higher heterogeneity in management than in size. Lower ratio for private than for public.

FURTHER STEPS IN THE EMPIRICAL ANALYSIS

- New indicators to be investigated: -Volume of water sold over i) number of employees; ii) conduct length; -Indicator of "energy efficiency" in production; -Leakages: different measures.
- Run the regression analysis for efficiency indicators on the enlarged dataset (5 years, about 80 operators)
- Investigate further: - Tariff structure; - Planned investments.
- Disentangle between multiunit and monounit operators
- Focus on leakages
- Focus on industrial use
- Focus on how trends in water demand affect tariff

BACKGROUND MATERIALS

Table 9: *EFFICIENCY INDICATORS - Average Cost per unit of Water Sold, Conduct, Population and Employee*, for 47 operators in 2009

	$\frac{\textbf{Prod.Cost}}{\textbf{Volume Sold}}$ (€/m^3)	$\frac{\textbf{Prod.Cost}}{\textbf{Conducts}}$ (€/km)	$\frac{\textbf{Prod.Cost}}{\textbf{Inhabitant}}$ (€/Inh.)	$\frac{\textbf{Prod.Cost}}{\textbf{Employees}}$ (€/Empl.)
Min. :	0,36	2.605,0	21,1	114.046,0
Mean :	1,42	18.079,0	120,6	215.256,0
sd :	0,58	14.097,8	52,1	105.972,8
Max. :	3,56	59.984,0	381,8	668.685,0

Table 10: *EFFICIENCY INDICATORS - Average Cost per Kilometer of Conduct* for 47 operators in 2009 grouped by management

PRODUCTION COSTS OVER KILOMETERS OF CONDUCT (€/km)

	In House	Ippp	Joint S.p.a.	Private	Others
Min. :	3.528,0	7.559,0	32.980,0	31.430,0	2.605,0
Mean :	14.890,0	17.300,0	46.480,0	36.660,0	14.190,0
sd :	13.664,2	6734,0	19.095,5	6.854,9	7.304,5
Max. :	57.850,0	26.310,0	59.980,0	44.420,0	22.630,0

Table 11: *EFFICIENCY INDICATORS - Average Cost per Inhabitant*, for 47 operators in 2009 grouped by management

AVC PER INHABITANT (€/Person)

	In House	Ippp	Joint S.p.a.	Private	Others
Min. :	53,0	78,1	99,7	96,9	21,1
Mean :	124,1	106,0	109,3	117,5	71,3
sd :	63,4	15,1	13,5	23,4	28,9
Max. :	381,8	123,1	118,9	145,3	102,5

Table 12: *EFFICIENCY INDICATORS - Average Cost per Kilometer of Conduct*, for 47 operators in 2009 grouped by size

AVC PER KILOMETER OF CONDUCT (€/km)

	Small	**Medium**	**Big**	**(Top)**
Min. :	2.605,0	3.528,0	6.288,0	16600
Mean :	13.360,0	13.340,0	28.220,0	35.810,0
sd :	11.253,6	8.785,3	17.379,4	20.768,7
Max. :	34.120,0	37.540,0	59.980,0	57.850,0

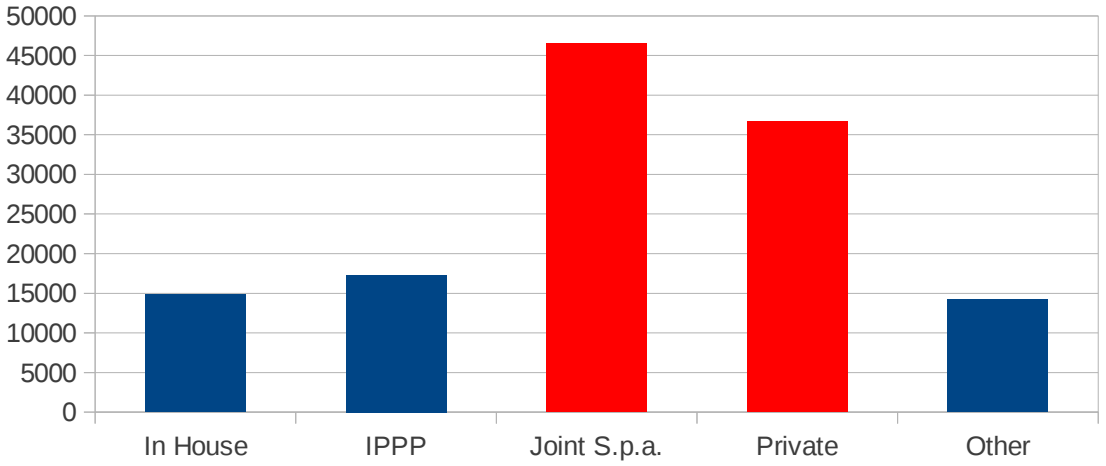
Table 13: *EFFICIENCY INDICATORS - Average Cost per Inhabitant*, for 47 operators in 2009 grouped by size

AVC PER INHABITANT (€/Inhabitant)

	Small	**Medium**	**Big**	**(Top)**
Min. :	21,1	54,4	53,0	86,4
Mean :	92,6	125,5	105,9	111,0
sd :	36,4	66,1	28,9	31,7
Max. :	163,1	381,8	152,1	146,8

Data Sample 2009 AVC per Kilometer of Conduct (Euro/Km)

operators grouped by type of management (red bars means statistical significance)



Data Sample 2009 AVC per Inhabitants (Euro/person)

operators grouped by type of management (red bar means statistical significance)

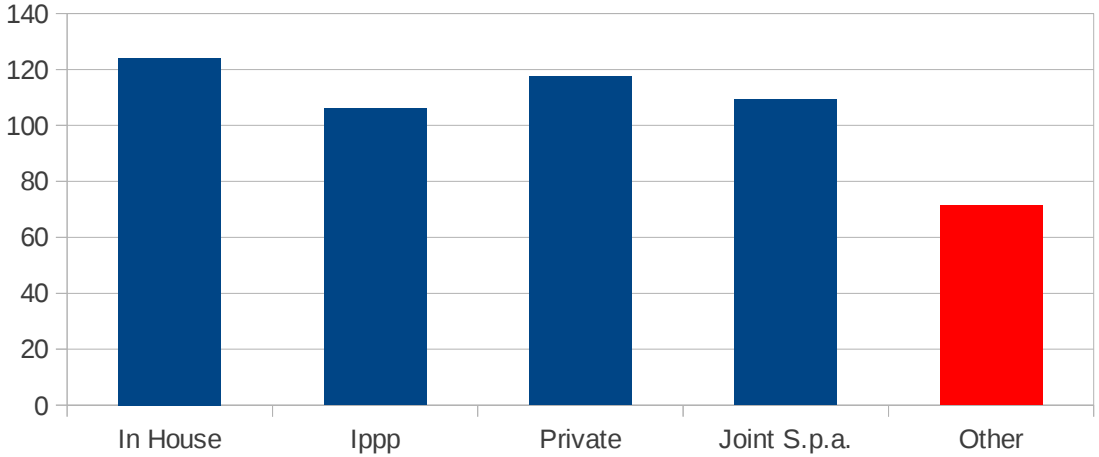


Table 14: *EFFICIENCY INDICATORS - Ratio of Personnel Cost over Operation Cost* for 47 operators in 2009 grouped by region

PERSONNEL COST OVER PRODUCTION COST by region (€/Person)				
	Operators	**North**	**Center**	**South**
Min. :	0,0047	0,0047	0,0842	0,0468
Mean:	0,2003	0,1840	0,2055	0,2386
sd :	0,0845	0,0718	0,0601	0,1332
Max. :	0,4351	0,2724	0,2955	0,4351