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DESP
DIPARTIMENTO DI
ECONOMIA,
SOCIETÀ, POLITICA

HEALTH NEEDS AND RESOURCES: ALLOCATION and MEASUREMENT ISSUES

Regional devolution and efficiency of the Italian hospital sector: Catching up or falling behind?

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Motivation

- A paper on the efficiency of healthcare provision in a decentralized system
- A traditional view of decentralization considers that it may foster **more accountability of governments and thus more efficiency**, under certain conditions (so called first-generation fiscal federalism)
  - *but decentralization is far from simple … paid little attention to the specific institutional pathways …* (Costa-Font and Greer, 2013)
  - Empirical analysis does not provide such clear-cut results
- More recent models (so called second-generation fiscal federalism) stress the relevance of incentives as arising from the specific context and from the institutional design of decentralization
  - As far as Italy is concerned, misalignment of incentives have been called on to explain inefficiency in healthcare (expenditure) or, better, across-regions inefficiency – Ferrario *et al.* (2023) argue that the underperformance of southern regions may be due to vertical fiscal imbalances (local financing of healthcare heavily relies on central government grants)

- However:
  - Main focus on efficiency as related to the level of healthcare expenditure and, therefore, on the cost-saving capacity of decentralization, while little attention devoted to consider **production efficiency**
    - potential trade-off between short-term cost savings and long-run efficiency (reduction of volumes arising from economic unviability of activities, originated by excessive cuts)
    - It depends on how decentralized governments manage the principal-agent relationship with providers
  - Need to measure the **long-term performance of healthcare provision** – relevant information
    - to capture how the potential trade-off above is actually realized;
    - to assess the nature of the dynamics of the potential difference in efficiency across providers as well as the dynamics characterizing the best performers

Objectives

- Estimate **efficiency of the Italian hospitals** over the period 1999-2010 through nonparametric frontier approaches
- Assess **efficiency growth** over time
- Assess **convergence patterns** of efficiency, both at hospital and at a regional level:
  - Overall convergence
  - Similarity of time paths of efficiency between regions (club convergence)

Methods

- We use nonparametric estimators to examine not only the **level of inefficiency** in each year of our data, but how this varies over time
  - It's crucial avoiding the typical biases of nonparametric estimators, particularly the ones related to the *ad hoc* choice of estimators and to the curse of dimensionality – may lead to overestimation of efficiency for some units and, therefore, to overstate the differences across providers
- We use an efficiency estimation protocol recently proposed by O'Loughlin *et al.* (*Empirical Economics*, 2021), which has been applied to an unbalanced sample of US municipalities over the period 1997-2012

- The protocol is essentially **data-driven,** minimizing discretion in the choice of the model and the estimator to be used
  - Use of the diagnostics developed by Wilson (2018) to indicate whether reducing dimensionality (of the input-output space) might be advantageous
  - Check for the convexity of the production set and for the nature of the returns to scale (Kneip et al., 2016), for the choice of the best efficiency estimator
  - Assess the time unconditional and conditional efficiency through the algorithm developed by Daraio et al. (2018)
- In addition, we carry out an **analysis of the convergence** of the efficiency time paths, using the Phillips and Sul (2007) approach

Data and empirical strategy (1/2)

- All the data used in this analysis were provided by the Italian Ministry of Health and refer to a sample of public and private accredited Italian hospitals.
- Our variable specifications are similar to the one usually considered in the nonparametric literature on efficiency of hospital care
  - Among the **input variables**, we include the number of **beds** as a proxy of capital and the number of the different categories of personnel (**physicians**, **nurses**, and **other personnel**).
  - Regarding **output measurement**, we restrict our analysis to **acute patients only** and employ the number of **case-mix adjusted discharged** patients.
- Data were examined for errors, outliers, and missing values. The final sample is made up of an unbalanced panel of **11,393** observations over the **12 years** between 1999 and 2010.
- For each year, hospital observations ranged from a minimum of 885 to a maximum of 1,044, depending on the year.

Variables	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Whole sample
	Obs.	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*	*Obs.*
	1,044.00	1,020.00	1,012.00	1,004.00	981.00	901.00	904.00	896.00	930.00	914.00	902.00	885.00	11,393.00
						Inputs							
	Mean	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*
BED	233.57	229.02	226.47	216.81	213.99	223.40	222.79	199.38	213.21	212.33	209.57	210.89	217.99
MED	100.79	102.38	106.91	111.36	115.10	124.07	127.38	116.09	128.77	131.65	133.84	137.18	119.00
NURS	236.50	239.44	248.74	249.62	254.53	270.05	266.52	245.93	280.07	286.42	289.92	296.18	262.76
PERS	218.63	222.32	227.08	229.67	235.51	250.17	256.89	210.64	243.55	245.75	249.51	253.32	236.39
						Outputs							
	Mean	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*	*Mean*
W_DISCHARGES	8,309.50	8,193.10	8,135.28	7,844.61	7,557.59	7,947.12	7,906.61	7,130.02	7,647.84	7,654.26	7,584.50	7,496.25	7,797.36

Data and empirical strategy (2/2)

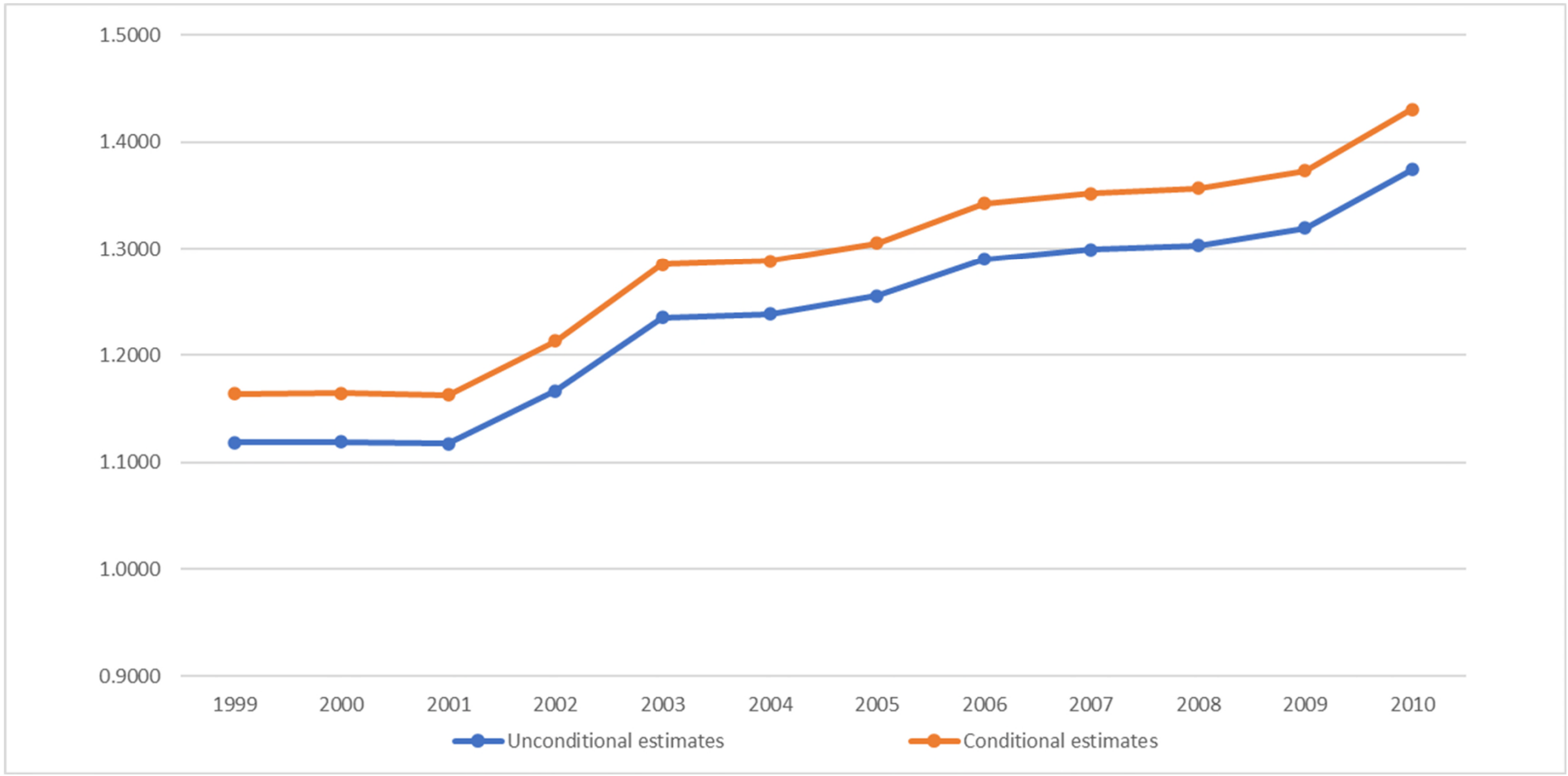
- We first test for the reduction of the dimension of the input-output space for each year and for the pooled sample. The tests proposed by Wilson (2018) suggest in all cases to use only **the first principal component** corresponding to the largest eigenvalue of the moment matrix of inputs **X´X**.
  - In what follows, we work in the two-dimension space of the variables **X*** and **Y** using an output-oriented o*rder-m* estimator.
  - As pointed out by O'Loughlin et al, (2021), with a minimum cost, the dimension reduction **shrinks estimation error, ensures a more efficient convergence in the estimates**
- As a further step, we test for **convexity assumption**. The convexity test (Kneip et al., 2016) suggests to use an FHD estimator.
  - However, as the FDH estimator does not allow inference on the distribution of efficiency scores and it is particularly sensitive to the presence of outliers we opted for an ***order-m* estimator** (Cazals et al., 2002), which is derived from an FDH but it is robust to potential outliers. Furthermore, the *order-m* estimator allows us to control for time effects (Mastomarco and Simar, 2014).

- Note that, with output-oriented assumption *order-m*, **the efficiency scores** are **not bounded by 1** as it is the case under DEA or traditional FDH.
  - With *order-m* output-oriented assumption, **values equal to 1 correspond to efficient DMUs**, whereas **values higher than 1 correspond to inefficient** DMUs. A DMU that performs **better than the average observations set in its reference sample *m*** may obtain a **score below 1**, thus being **super-efficient**.

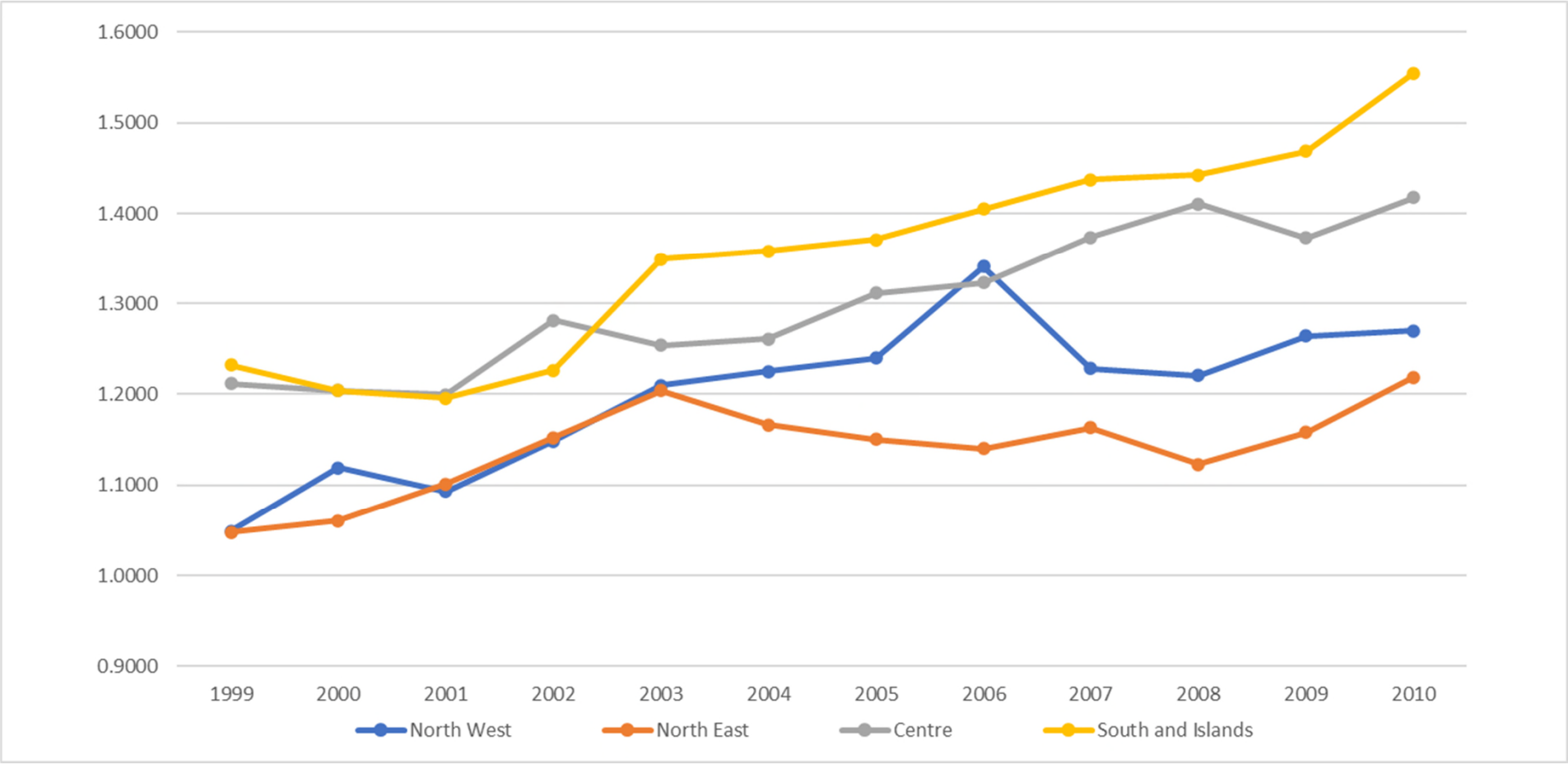
Results

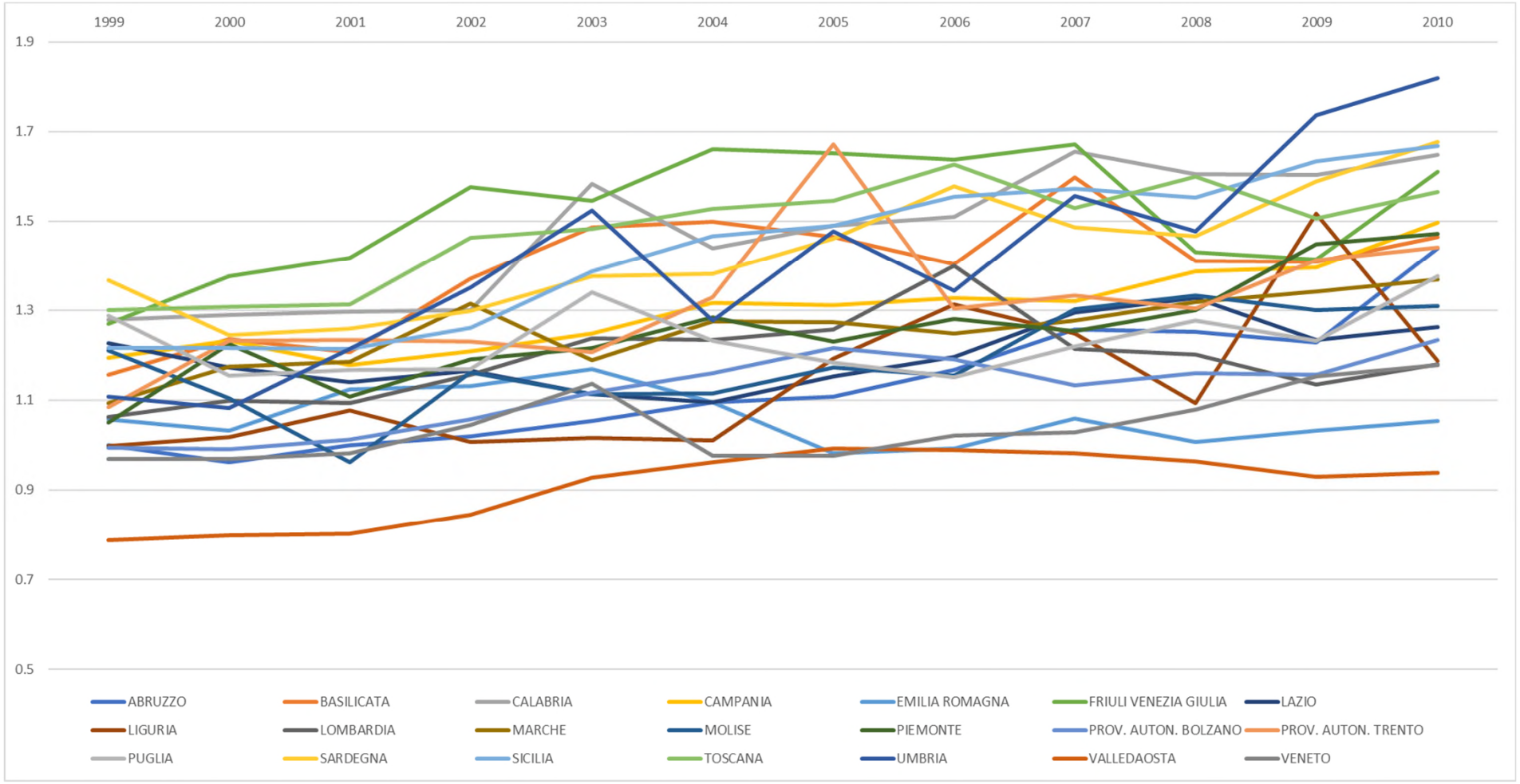
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Whole sample
Conditional estimates													
Obs	1,044.00	1,020.00	1,012.00	1,004.00	981.00	901.00	904.00	896.00	930.00	914.00	902.00	885.00	11,393.00
Mean	1.1641	1.1647	1.1626	1.2130	1.2850	1.2881	1.3052	1.3425	1.3517	1.3568	1.3736	1.4308	1.2816
St. Dev	0.5135	0.4858	0.4363	0.5070	0.6184	0.5941	0.6119	0.6902	0.6811	0.7036	0.7021	0.7533	0.6170
Min	0.4898	0.4086	0.5576	0.5454	0.5443	0.4140	0.2304	0.2613	0.5230	0.3861	0.5428	0.5553	0.2304
Max	5.1072	5.6821	4.3873	6.1749	7.7460	5.4873	5.7370	6.8093	6.4734	7.2990	5.8165	6.5882	7.7460
Unconditional estimates													
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Whole sample**
Obs.	1,044.00	1,020.00	1,012.00	1,004.00	981.00	901.00	904.00	896.00	930.00	914.00	902.00	885.00	11,393.00
Mean	1.1185	1.1191	1.1176	1.1665	1.2351	1.2383	1.2554	1.2898	1.2990	1.3033	1.3196	1.3742	1.2317
St. Dev	0.4926	0.4646	0.4163	0.4854	0.5810	0.5663	0.5842	0.6577	0.6478	0.6669	0.6712	0.7176	0.5877
Min	0.4437	0.3556	0.5115	0.5059	0.5076	0.3493	0.2091	0.2251	0.4784	0.3435	0.4747	0.4890	0.2091
Max	5.0208	5.5200	4.1608	5.8482	6.6515	5.2899	5.4606	6.5490	6.0389	6.6581	5.6322	6.0098	6.6581

Time conditional and unconditional estimates



Catching up or falling behind? Hospitals by geographical areas

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MOLISE
PIEMONTE
PROV. AUTON. BOLZANO
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VENETO

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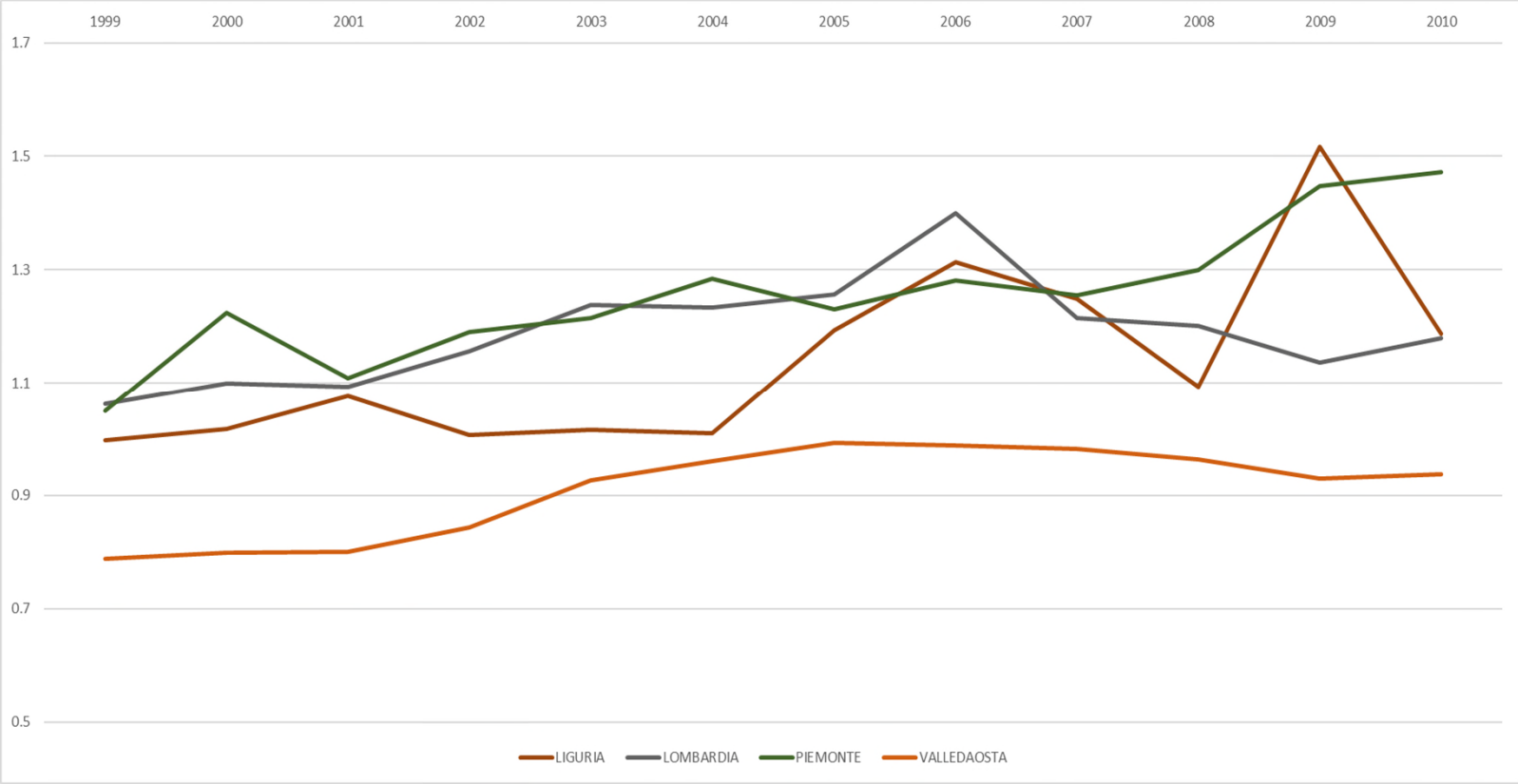
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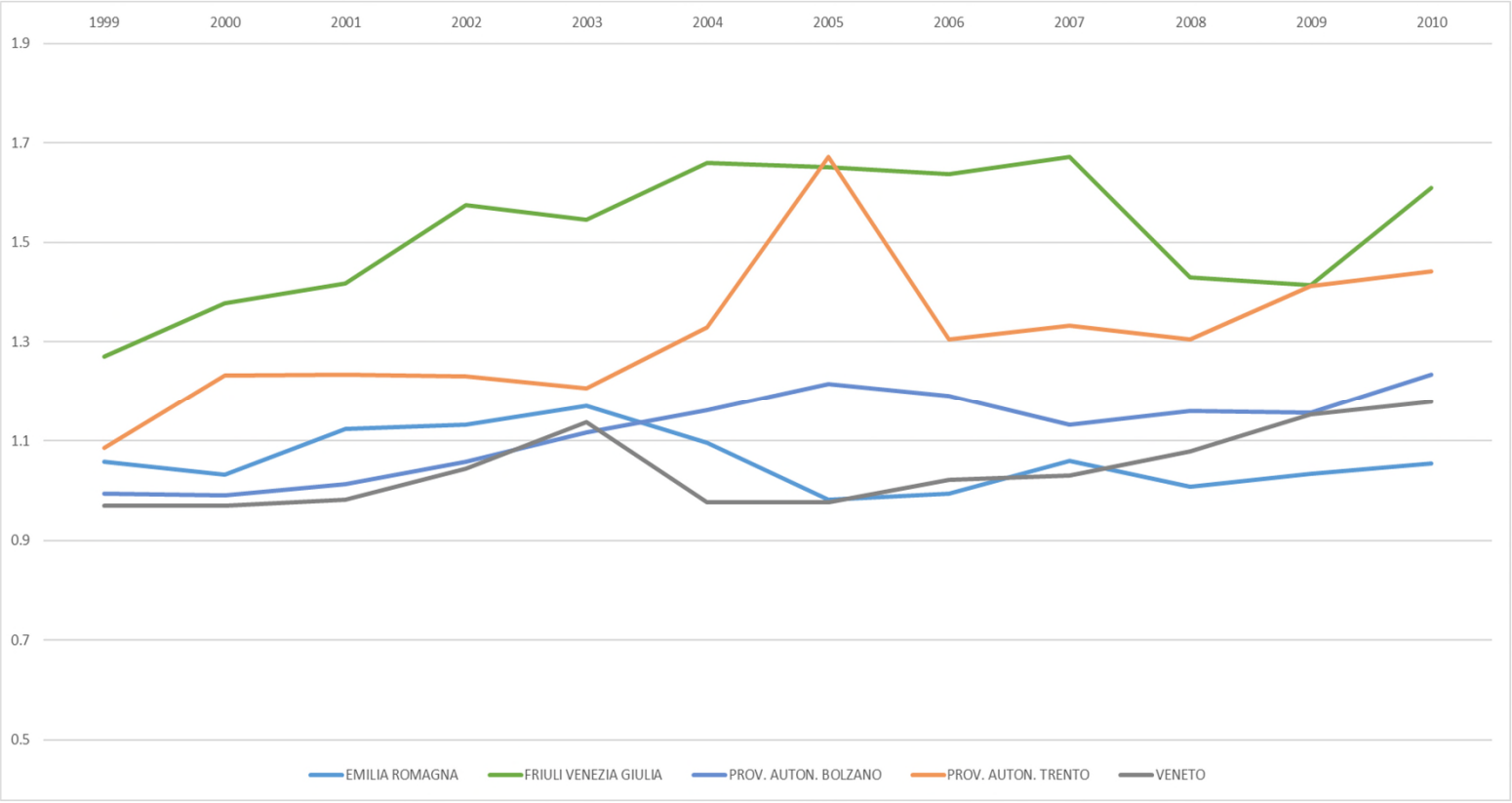
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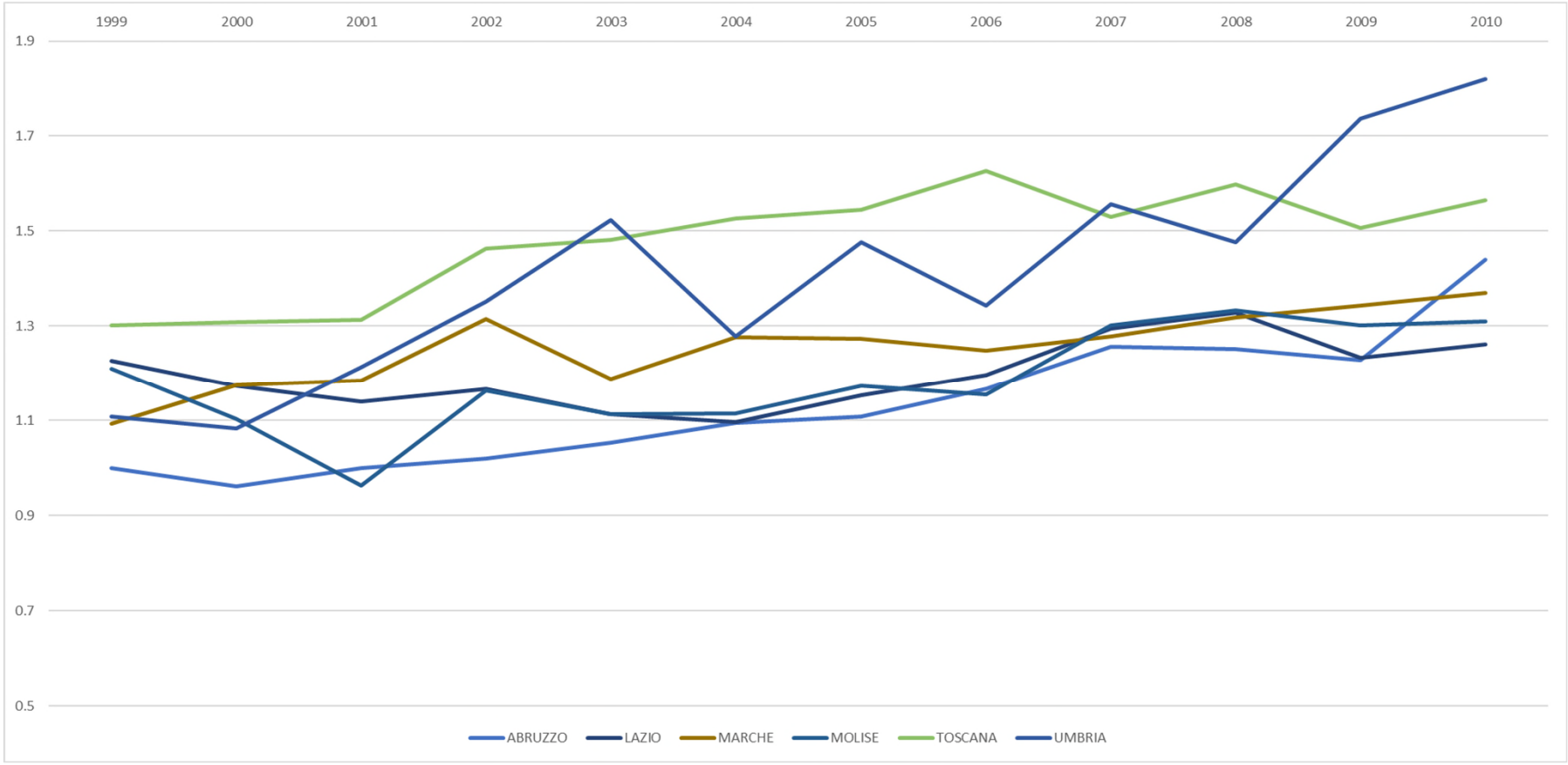
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TOSCANA
UMBRIA

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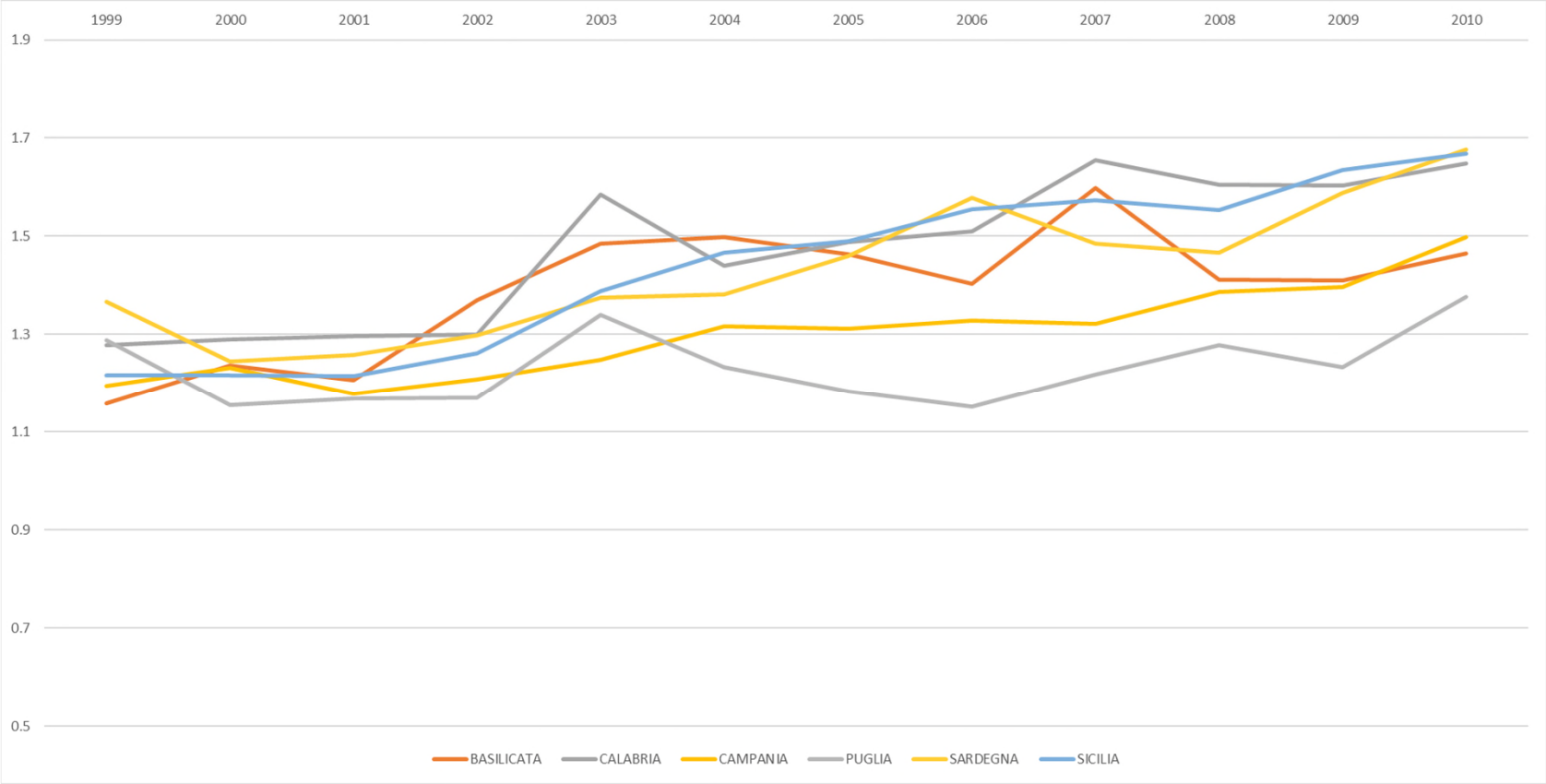
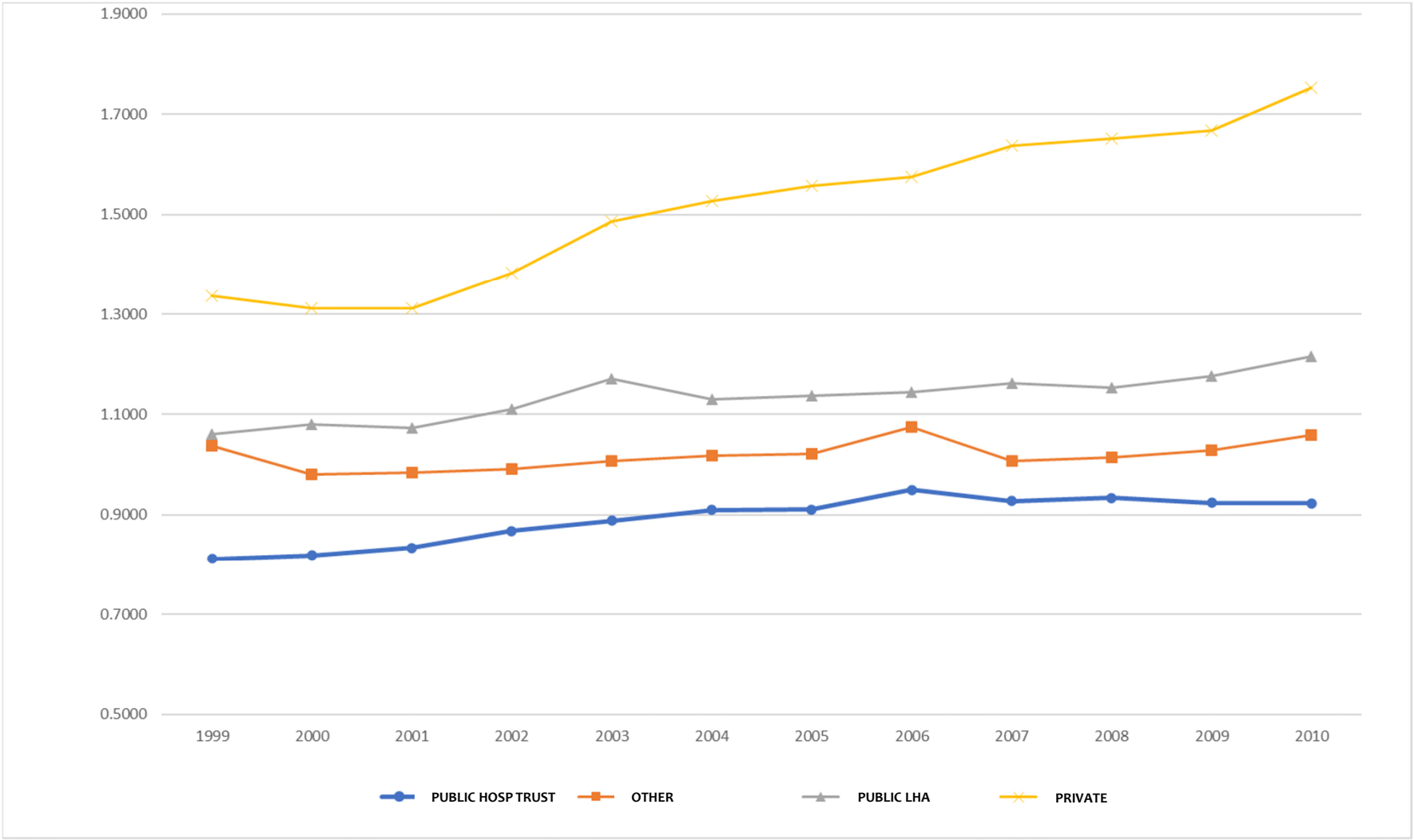


Catching up or falling behind? Hospitals by institutional nature



Efficiency results

- Hospitals in our sample have experienced a considerable **deterioration in efficiency** over the time period under observation
- However, the trend is **not homogeneous** both at the level of **geographical areas** and for providers with different **institutional characteristics** (*e.g.* Hospital Trusts, community hospitals, private hospitals, etc.)
  - In general, it appears that hospitals located in the **Center and South of the country have experienced a more pronounced decrease in efficiency** than those in the North of the country, even if **the latter have also experienced a deterioration of their efficiency**
  - Private providers showed the most significant decline in efficiency
    - One possible explanation for these findings may be related to the presence of volume caps in the private sector, which may have induced them to shift part of their activity to out-of-pocket.
    - A second related explanation is that private hospitals have changed their production mix by focusing on low-complexity DRGs.

Convergence of regional efficiency

- We conducted an **additional** empirical exercise, to assess convergence of efficiency of provision of hospital care at the regional level
  - We use the average eficiency of hospitals in each region, for the time period under observation
  - The Phillips and Sul's (2007) approach was used to check for the convergence-divergence patterns of **regional efficiency levels.**
  - We obtain a ***t-stat = –34.175 < –1.65*** indicating that we reject the null of convergence. This finding further confirms that regional hospital systems over the examined periods **do not converge**

log t test:

Variable	Coeff	SE	T-stat
log(t)	-0.2523	0.0074	-34.1750

The number of individuals is 21.
The number of time periods is 12.
The first 4 periods are discarded before regression.

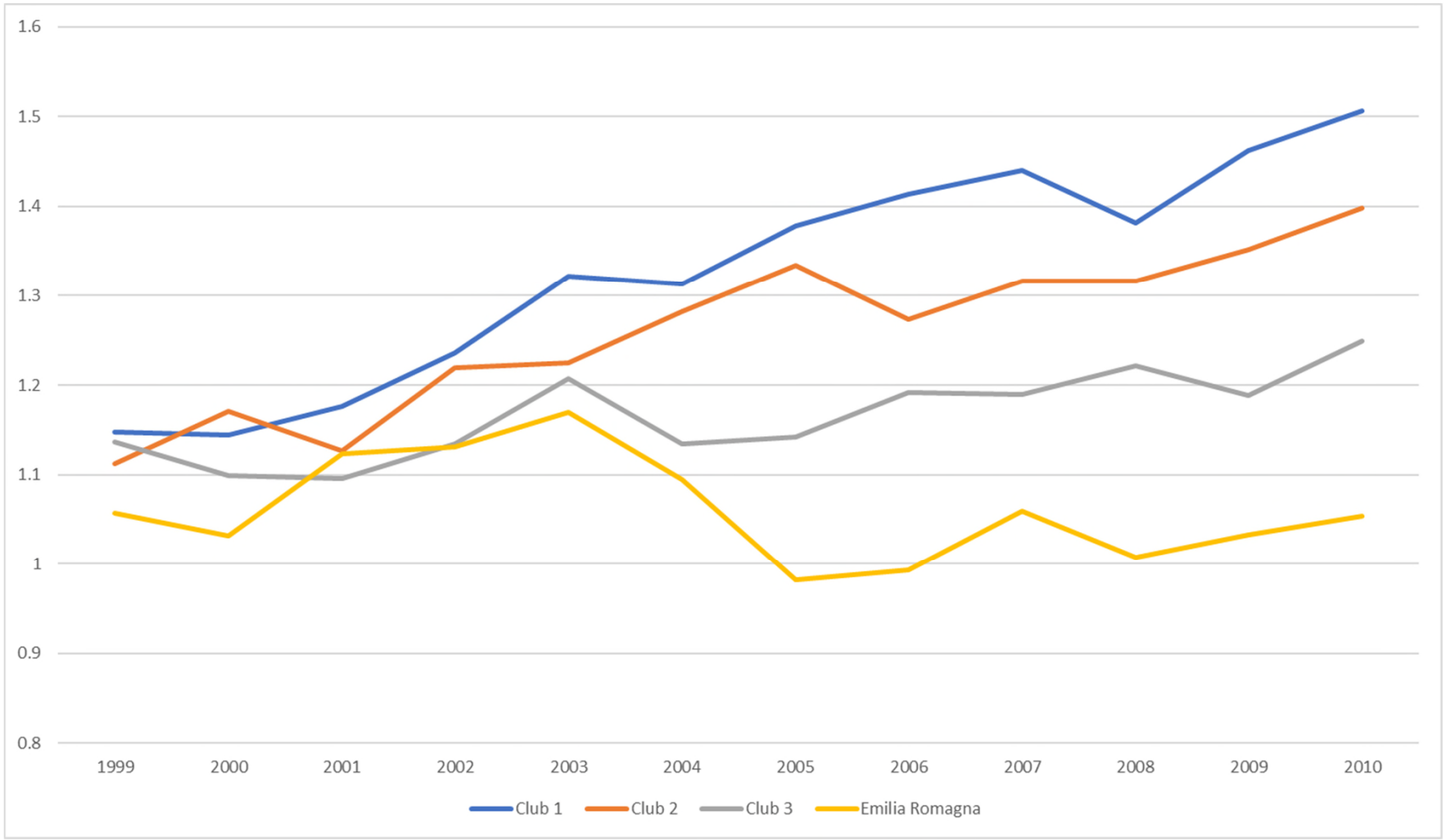
. psecta lnpgdp2, name(regione) kq(0.333) gen(club)

Convergence clubs of efficiency

Finally, we apply a four-step algorithm developed by Phillips and Sul (2007), which enables us to identify **different efficiency clubs among the regions**

Our results suggesting the existence of **three clubs** and one region (**Emilia Romagna**) that does not converge to any club.

```
xxxxxxxxxxxxxxxxxxxxxxxxxxxx Club classifications xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
------------------------------ Club 1 :(9)------------------------------
 | ABRUZZO | CALABRIA | FRIULI VENEZIA GIULIA | LIGURIA | SARDEGNA |
 | SICILIA | TOSCANA | UMBRIA | VALLEDAOSTA |
-------------------------------------------------------------------------

log t test:

------------------------------------------------------------
  Variable |      Coeff          SE        T-stat
------------------------------------------------------------
     log(t) |      0.2815        0.0230       12.2401
------------------------------------------------------------

The number of individuals is 9.
The number of time periods is 12.
The first 4 periods are discarded before regression.
------------------------------ Club 2 :(7)------------------------------
 | BASILICATA | CAMPANIA | MARCHE | MOLISE | PIEMONTE |
 | PROV. AUTON. BOLZANO | PROV. AUTON. TRENTO |
-------------------------------------------------------------------------

log t test:

------------------------------------------------------------
  Variable |      Coeff          SE        T-stat
------------------------------------------------------------
     log(t) |      0.1897        0.0556        3.4138
------------------------------------------------------------

The number of individuals is 7.
The number of time periods is 12.
The first 4 periods are discarded before regression.
------------------------------ Club 3 :(4)------------------------------
 | LAZIO | LOMBARDIA | PUGLIA | VENETO |
-------------------------------------------------------------------------

log t test:

------------------------------------------------------------
  Variable |      Coeff          SE        T-stat
------------------------------------------------------------
     log(t) |      0.7113        0.1254        5.6704
------------------------------------------------------------

The number of individuals is 4.
The number of time periods is 12.
The first 4 periods are discarded before regression.
---------------------- Not convergent Group 4 :(1) ----------------------
 | EMILIA ROMAGNA |
-------------------------------------------------------------------------
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```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Club 3
Emilia Romagna

Concluding remarks

- Even if **our results are not a test of the effects of decentralization**, they are related to information over hospital activities over a relatively long period of time following the two waves of reform in the nineties, that
  - Are in line with previous results that show that the Southern regions underperformed, relative to their Northern counterparts, not only in terms of expenditure, but also as far as production efficiency is concerned – they underperformed so badly that they not only did not fill the original gap, but they even enlarged it
  - Point out, at the same time, that for several Northern regions, efficiency was stagnant or even slightly decreasing – potential role for other drawbacks of decentralization related to misalignments of incentives? Limited effectiveness of competition because of "bad" performers? Limited ability of regional governance in controlling hospitals? Political capture due to the political appointment of hospitals' managers?