HEALTH NEEDS AND RESOURCES:
ALLOCATION and MEASUREMENT ISSUES
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Health expenditure in Italy: a comprehensive intergovernmental model

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Aim of the paper

- Develope a **standard expenditure needs model** of the healthcare sector in line with: local demand factors, production efficiency and constitutional mandates.
- Introduction of new factors in the assessment of standard needs (Socio-economic context, Efficiency in the provision of the service, Degree of satisfaction of potential demand), evaluation of two gaps:
  - **output gap** (lack in satisfaction of local demand)
  - **efficiency gap** (potential spending review target)
- Analysis based on the **Italian health care system (pre-covid period)**, decentralization of service provision at regional level, fiscal equalization not fully in line with constitutional principles.

Background information on Italy: tiers of government

- **Regions (20, five of which with special statutes)**, 20% of total current public expenditure (150 billion euros). Main expenditure responsibilities: **Protection of health (125 billion euros)**; Public transport; Complementary social welfare; Higher education and vocational training.
- **Provinces (93, 17 of which in special regions) and Metropolitan districts (14, four of which in special regions)**, 1% of total current public expenditure (6 billion euros).
- **Municipalities (7.901, 1.351 of which in special regions)**, 7% of total current public expenditure (53 billion euros).

Motivation

- The current structure of the Italian National Health System assigns to regional governments the provision of health care services.
- The duality of Italian economy assigns to intergovernmental grants a important role to reduce fiscal imbalances in the provision of health care services.
- According to the Italian Consititutions (art. 117, 119) and the Law 68/2011, health expenditure should be fully equalized among Regions
  - equalization grants distributed according to the difference between standard expenditure and fiscal capacity of each region
  - standard expenditure needs must comply with national constitutional mandates (uniform national minimum levels of services)
- However, health expenditure is standardized on per capita base and Constitutional mandateds are only used as a performance indicators

Fiscal equalization of health expenditure: international context

- Allocation of healthcare resources is a crucial issue in decentralised institutional arrangements *(Rice & Smith (2002); Schokkaert & van de Voorde (2011); Asthana & Gibson (2011); Buck & Dixon (2013))*.
- In many countries allocation according to per capita quota (capitation).
- In some countries (UK, Netherlands, Germany, Sweden) more advanced formulas: adjusted per capita quotas (risk adjustment system) based on all the factors influencing health needs: age, morbidity, socio-cultural factors (family status, employment, disposable income), environmental factors.
- In countries that have adopted advanced formulas, continuous developments in relation to the increasing availability of increasingly detailed data (e.g. Resource Allocation Working Party-RAWP in UK).

Fiscal equalization of health expenditure: Italian context

- In recent decades, there have been frequent changes in the regional allocation criteria:
  - 1980-1981: 70-85% health risk indicators
  - 1982-1984: 68-78% historical expenditure
  - 1985-1991: 85-97% health consumption by age group
  - 1992-1996: 96-98% per capita quota
  - L. 662/1996: Expansion of the set of variables relevant to the allocation: population, frequency of consumption by age and gender, mortality rates, territorial epidemiological indicators, etc.
  - D.lgs. 68/2011: 'false reform' of standard expenditure needs and Constitutional mandates
- Pact for Health 2014-16: new the determinants of standard expenditure that take more adequately into account health needs and efficiecy.
- However, equalization system is still firmly anchored to a top-down logic, without direct connection with constitutional mandates.

Italian NHS: Allocation criteria of standard expenditure

- Breakdown by macro areas (Prevention, District, Hospital).
- 35% of the expenditure is allocated based on age-weighted population, and the remaining 65% is allocated based on a uniform per capita share.
- top-down approach, macrobudget of 125,98 billion euros of which 119,72 non-earmarcked and 4,7 earmarked.

Support Level	**Percentage of expenditure**			**Available from NSIS**	**Population weighting criteria**
Prevention	5%			No	Unweighed
District	51%	Primary Care Medicine	7.00%	No	Unweighed
		Pharmaceutics	11.84% of the indistinct needs	Yes	Ceiling imposed on the total requirements of the sums tied up
		Specialist	13.30%	Yes (Health Card)	Weighing
		Territorial	18,947%	No	Unweighed
Hospital	44%			Yes (SDO Registry)	50% weighted population 50% unweighted population

Empirical model

Analysis in four logically distinct steps

- 1st step: **Composite indicators of output and input** using *BoD* method
  $\Longrightarrow$ production function components
- 2nd step: **Efficiency analysis** using *DEA* method
  $\Longrightarrow$ technical efficiency index
- 3rd step: **Demand function** using *Linear Panel Data Models*
  $\Longrightarrow$ output gap (lack of demand satisfaction)
- 4th step: **Cost function** using *Linear Panel Data Models* including among the regressors technical efficiency and output gap
  $\Longrightarrow$ efficient standard expenditure needs to finance the output gap

Data

- Construction of a regional panel Years 1999 – 2018
- 20 regional systems
- Data source $\Longrightarrow$ ISTAT, Health for All
  - Expenditure
  - Output variables (hospitalization and mobility)
  - Input variables (technical staff, medical staff, beds, machinery)
  - Context variables (population structure, lifestyles, private spending)

Method

1 step: Aggregate level of the output and input

The *aggregate level* of performance (output) and input employed in the healthcare system are estimated for each region and each year, the aggregate level of input and output was calculated using a specific composite indicators (CI) technique named "*Benefit of the Doubt*" (BoD) by *Melyn & Moesen* (1991).

Table 1: Principal component analysis - output factors (per capita)

Variables	Factor 1		Factor 2		Factor 3	
Hospitalization_total	96	*	.		.	
Hospitalization_acute	96	*	.		.	
Hospitalization_private	95	*	.		.	
Days_hospital_acute	94	*	.		.	
Days_hospital	94	*	.		.	
Hospitalization_public_acute	94	*	.		.	
Hospitalization_public	94	*	.		.	
Hospitalization_private_acute	94	*	.		.	
Days_hospital_acute_private	93	*	.		.	
Days_hospital_acute_public	91	*	.		.	
Days_hospital_public	91	*	.		.	
Days_hospital_private	88	*	.		.	
Hospitalization_rehabilitation_private	82	*	.		.	
Hospitalization_rehabilitation	80	*	50		.	
Days_hospital_rehabilitation	80	*	41		.	
Days_hospital_rehabilitation_public	72	*	58		.	
Days_hospital_rehabilitation_private	70	*	.		40	
Hospitalization_rehabilitation_public	70	*	58		.	
Interregional_mobility_PRC	.		73	*	.	
Interregional_mobility2_PRC	.		73	*	.	
Assisted_per_doctor	.		48		.	
Hospital_beds_rate	.		48		.	
Assisted_per_pediatrician	.		48		.	
Hospitalization_mean_rehabilitation	.		.		91	*
Hospitalization_mean_rehabilitation_private	.		.		83	*
Hospitalization_mean_rehabilitation_public	.		.		74	*
Hospitalization_mean_private	.		52		64	*
Hospitalization_mean_acute_private	.		48		59	

Figure 1: Output Composite Indicator by Region

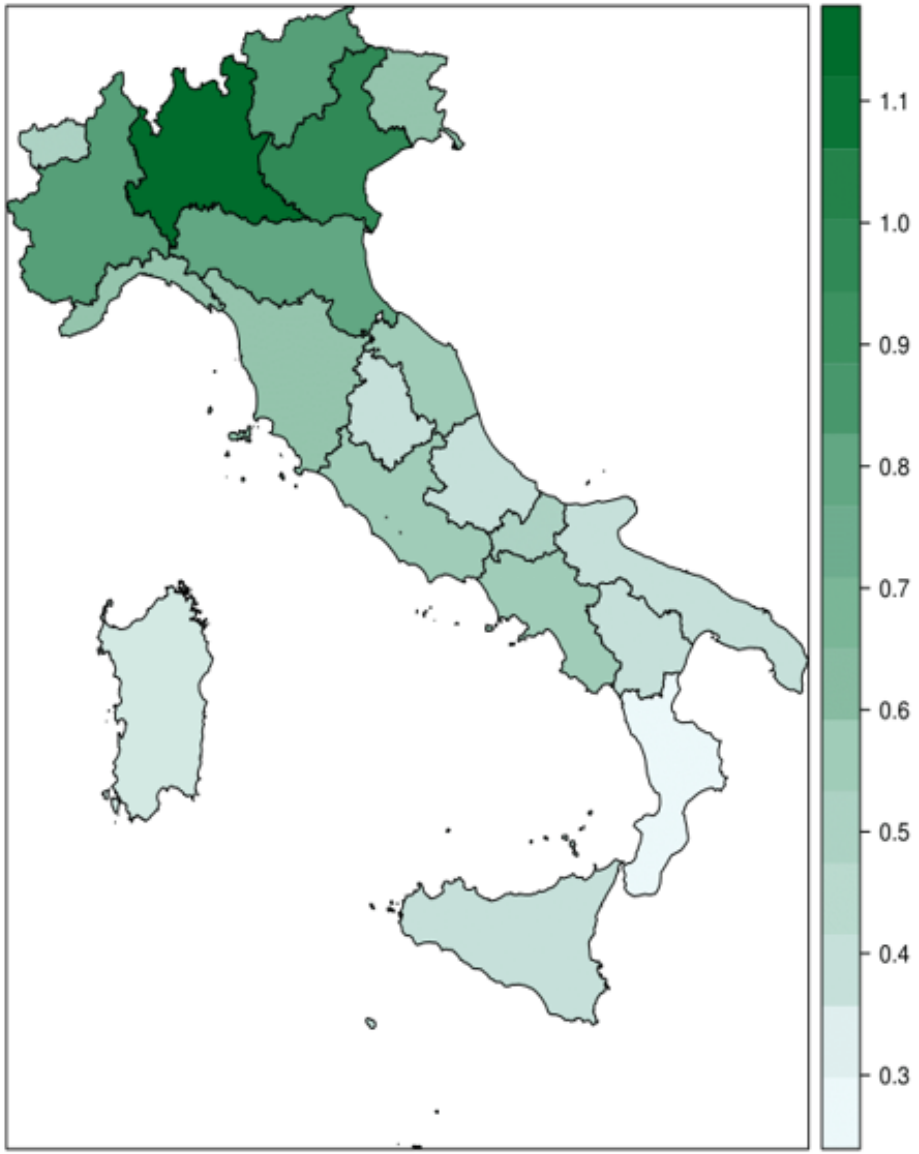


Figure 2: Constitutinal mandates (LEA score) and Composite output Indicator.

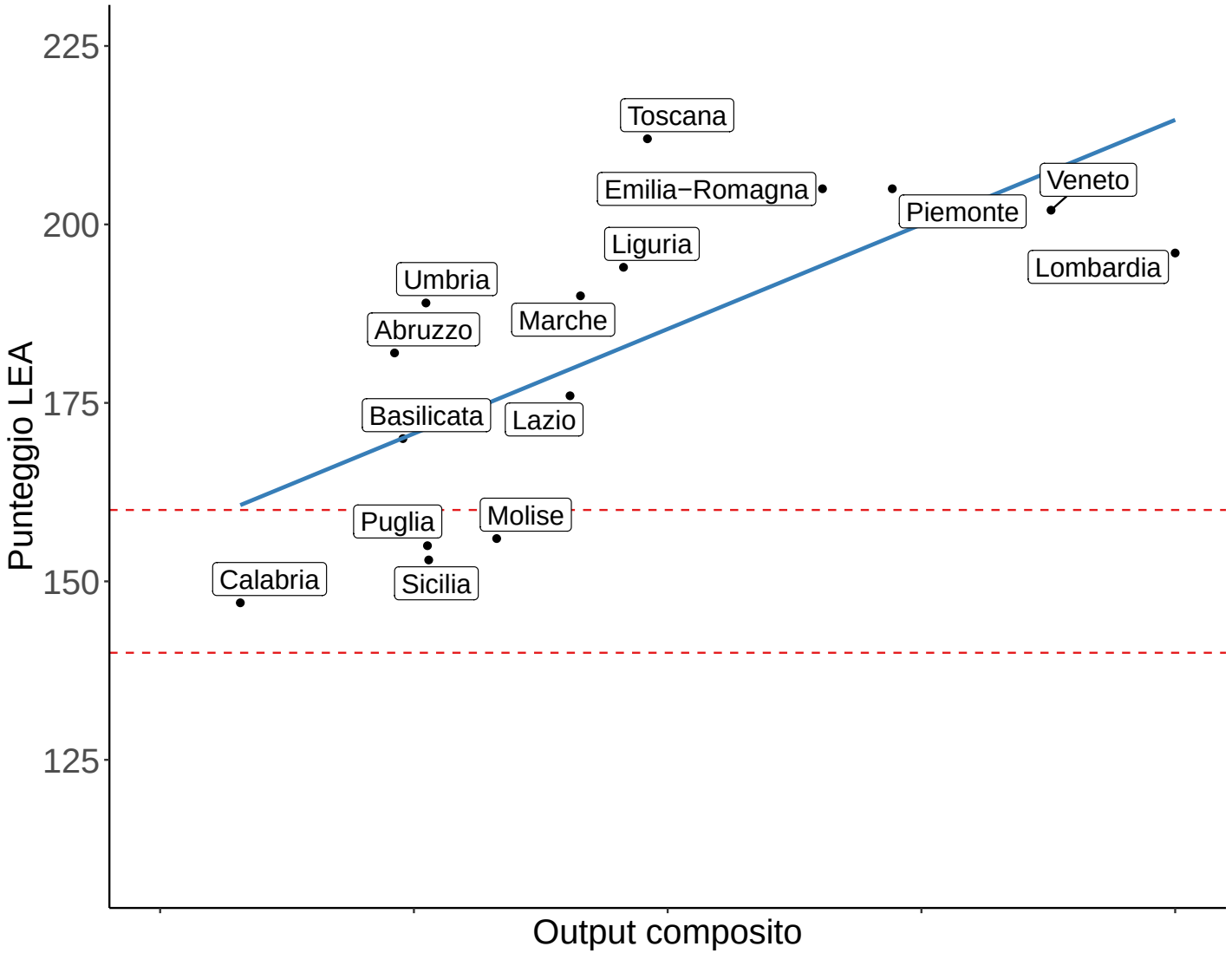
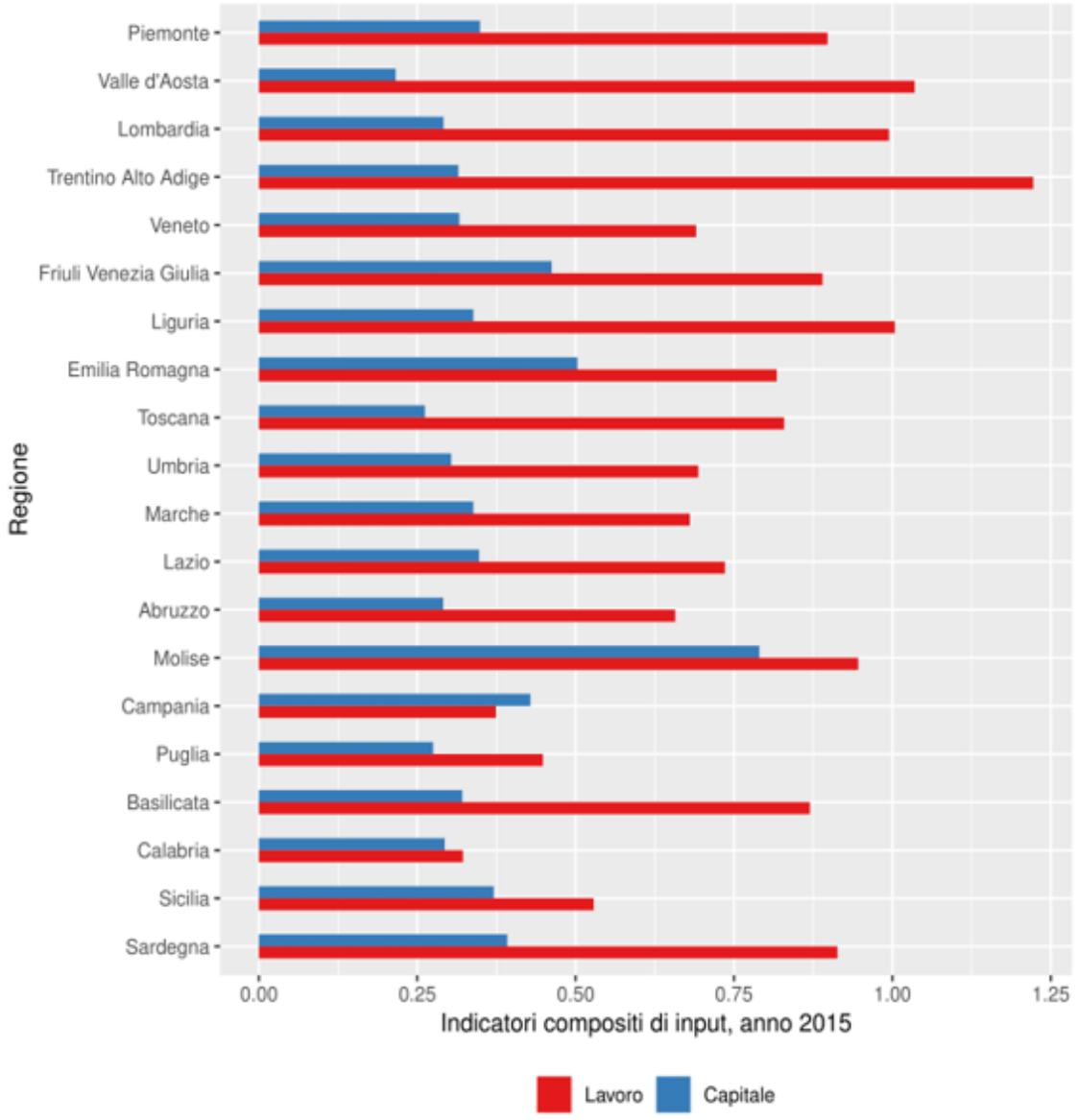


Table 2: Principal component analysis - input factors (per capita)

Variables	Factor 1		Factor 2		Factor 3		Factor 4	
Technicians_employees_private	88	*	.		.		.	
Nurses_employees_public	86	*	.		.		.	
Technicians_employees_public	86	*	.		.		.	
Nurses_employees_private	84	*	.		.		.	
Rehabilitation_employees_public	81	*	.		-42		.	
Rehabilitation_employees_private	74	*	.		-39		.	
Nurses_employees_SSN	72	*	.		.		.	
Computed_tomography	.		77	*	.		.	
Blood_cell_counter	.		75	*	.		.	
Anesthesia_machine	.		70	*	.		.	
Tables_Fixed_Radiological_Systems	.		69	*	.		.	
Operating_tables	.		69	*	.		.	
Hyperbaric_chambers	-38		50	*	.		.	
Doctors_employees_public	44		.		76	*	.	
Doctors_employees_SSN	.		.		74	*	.	
Doctors_employees_private	.		36		64	*	.	
Outpatient_surgery_beds	.		.		53	*	38	
Outpatient_surgery	.		.		.		92	*

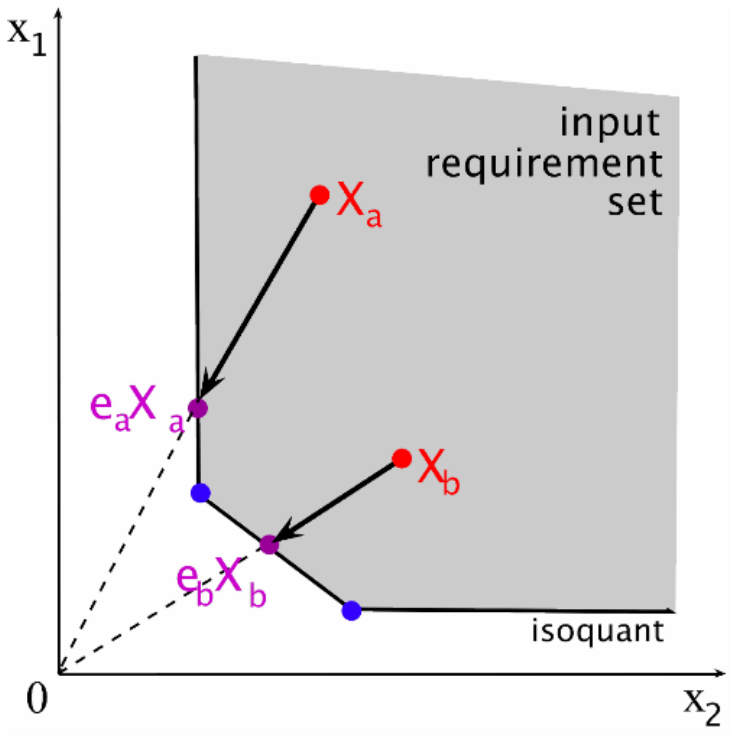
Figure 3: Input Composite indicators, labour and capital by Regions



Method

2 step: Technical efficiency

The level of *technical efficiency* is calculated on the basis of the input and output composite indicator using DEA and Order-m robust estimators (excellent correlation between the two scores).



Method

3 step: Demand function

Estimation of demand in reduced form (named *output function*)

- evaluate the *output gap* for each region comparing estimated standard service with the historical service level, measure of how each regional system meets its demand
- Regions producing more services $\Rightarrow$ positive *output gap*
- Regions with negative *output gap* $\Rightarrow$ performance lower than the potential demand from their territories.

Output function

Linear panel data model (Within-the-Group estimator):

$$CI_{it} = \alpha_i + \eta_t + \beta_0 M_{it} + \beta_1 R_{it} + \beta_2 D_{it} + \beta_3 S_{it} + \epsilon_{it}$$

- where: M_{it} = patients mobility flows among regions (net balance); R_{it} = income; D_{it} = demand factors (eg. population by age); S_{it} = supply factors (eg. out-of-pochet exp.); η_t = year fixed effects; ϵ_{it} = idiosyncratic error term
- In the absence of information on input (labour and capital) prices, their impact on spending is only approximated by regional fixed effects (α_i)
- *output gap* $w_{it} = CI_{it} - \hat{CI}_{it}$
- *net output gap* $w_{it} = CI_{it} - \hat{CI}_{it} - \hat{\beta}_0 M_{it}$

Output Function

Table 3: Estimated demand function, output CI as dependent variable, year 1999-2018

Variable	**Output function**								**Demand function**
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
STRUCTURAL VARIABLES									
Interregional hospital mobility balances (active-passive) - 10,000 inhab.	0.903	0.992	0.978	1.008	0.835	1.320	0.855	1.018	1.370
	[0.001]***	[0.006]***	[0.008]***	[0.002]***	[0.003]***	[0.000]***	[0.018]**	[0.000]***	[0.000]***
Num. observations	383	384	384	384	384	383	384	383	383
R^2	0.761	0.343	0.347	0.352	0.656	0.546	0.440	0.708	
Adjusted R^2	0.722	0.307	0.304	0.315	0.629	0.505	0.396	0.669	
F test for excluded instruments (p-value)									6.06 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(7)$ (p-value)									15.250 (0.0329)

Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

Variable	Output function							Demand function	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
CONTEXTUAL DEMAND COVARIATES									
GDP at market prices - (€) real per capita (base 2005)	-0.00314			0.00143					
	[0.009]***			[0.566]					
Resident population 0-4 M+F - % total pop.	0.262				0.218			0.222	0.288
	[0.000]***				[0.000]***			[0.005]***	[0.000]***
Resident population 5-14 M+F - % total pop.	0.0780				0.0912			0.0948	0.0816
	[0.045]**				[0.100]*			[0.029]**	[0.003]***
Resident population 15-24 M+F - % total pop.	0.0492				0.0495			0.0482	0.0716
	[0.050]*				[0.087]*			[0.024]**	[0.000]***
Resident population 25-34 M+F - % total pop.	0.0268				0.0311			0.0373	0.0128
	[0.333]				[0.347]			[0.183]	[0.524]
Resident population 45-54 M+F - % total pop.	0.0696				0.0512			0.0375	0.00897
	[0.026]**				[0.064]*			[0.215]	[0.665]
Resident population 55-64 M+F - % total pop.	0.0842				0.110			0.0979	0.109
	[0.003]***				[0.015]**			[0.002]***	[0.000]***
Resident population 65-74 M+F - % total pop.	0.0461				0.0554			0.0489	0.0593
	[0.070]*				[0.078]*			[0.008]***	[0.001]***
Resident population 75+ M+F - % total pop.	0.107				0.100			0.112	0.132
	[0.000]***				[0.000]***			[0.001]***	[0.000]***
% Heavy smokers 15+ M+F	0.00106					0.00297		0.00159	0.00255
	[0.462]					[0.211]		[0.333]	[0.171]
Voluntary abortion rate 15-49	0.00540					0.0175		0.00525	0.00689
	[0.497]					[0.060]*		[0.541]	[0.185]
% People consuming vegetables once a day 3+ M+F	-0.00230					-0.00402		-0.00265	-0.00395
	[0.022]**					[0.012]**		[0.022]**	[0.000]***
% People consuming fish once a week 3+ M+F	-0.00245					-0.00186		-0.00224	-0.00344
	[0.020]**					[0.407]		[0.116]	[0.002]***
% People consuming beef occasionally once a week 3+ M+F	0.000445					-0.0000691		-0.0000710	0.000542
	[0.658]					[0.965]		[0.958]	[0.638]
% People consuming cheese at least once a day 3+ M+F	0.00150					0.000424		0.00138	0.00176
	[0.163]					[0.843]		[0.285]	[0.140]
% People proper breakfast 3+ M+F	0.00235					0.00345		0.00315	0.00416
	[0.049]**					[0.062]*		[0.044]**	[0.007]***
% People main meal dinner 3+ M+F	0.000631					0.00120		0.00215	0.00198
	[0.684]					[0.593]		[0.164]	[0.208]
Malignant tumours incidence rate 0-84 M	0.000914					-0.00550		0.00205	0.00659
	[0.737]					[0.010]***		[0.504]	[0.010]**
Malignant tumours incidence rate 0-84 M (square)	-0.00000134					0.00000453		-0.00000269	-0.00000651
	[0.582]					[0.023]**		[0.343]	[0.004]***
Composite indicator - Diseases related to the psychological sphere	0.0860					0.0702		0.0469	0.0992
	[0.204]					[0.530]		[0.595]	[0.115]
Composite indicator - Diseases related to metabolic disorders	0.143					0.0955		0.147	0.136
	[0.175]					[0.571]		[0.157]	[0.094]*
Num. observations	383	384	384	384	384	383	384	383	383
R^2	0.761	0.343	0.347	0.352	0.656	0.546	0.440	0.708	
Adjusted R^2	0.722	0.307	0.304	0.315	0.629	0.505	0.396	0.669	
F test for excluded instruments (p-value)									6.06 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(7)$ (p-value)									15.250 (0.0329)

Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

Variable	Output function							Demand function	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
SUPPLY CONTEXTUAL COVARIATES (used as instrumental variables for the output in demand function)									
Households health expenditure (%)	0.00607						0.0130		
	[0.091]*						[0.013]**		
Technological progress index in medical supply	0.000582						-0.000404		
	[0.299]						[0.744]		
Activity rate 15+ F	-0.00386						0.00356		
	[0.163]						[0.474]		
% pop. with university degree M+F	-0.00965						-0.00101		
	[0.016]**						[0.923]		
Composite indicator - Diseases related to environmental pollution	-0.0358						0.0329		
	[0.681]						[0.878]		
% families complain about noise pollution	-0.00167						-0.00331		
	[0.011]**						[0.130]		
Life expectancy 75 M	0.00340						0.0199		
	[0.853]						[0.598]		
Life expectancy 75 F	-0.0175						-0.0188		
	[0.319]						[0.615]		
EXPENDITURE COVARIATES									
Current public health spending per capita								-0.00000529	-0.000483
								[0.929]	[0.000]***
Num. observations	383	384	384	384	384	383	384	383	383
R^2	0.761	0.343	0.347	0.352	0.656	0.546	0.440	0.708	
Adjusted R^2	0.722	0.307	0.304	0.315	0.629	0.505	0.396	0.669	
F test for excluded instruments (p-value)									6.06 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(7)$ (p-value)									15.250 (0.0329)

Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

Method

4 step: Cost function

The last step concerns estimation of the *cost function* in a reduced form (expenditure function) that makes it possible to identify the standard requirements of each region.

- The originality of our approach lies in inclusion of two estimated variables among the regressors: technical inefficiency and *output gap*
- Standard expenditure is estimeated for each region identifying the resources to finance the output gap and the share of historic expenditure due to inefficiency

Expenditure function

Linear panel data model (Within-the-Group estimator):

$$H_{it} = \phi_i + \tau_t + \delta_1 \theta_{it} + \delta_2 w_{it} + \gamma_1 S_{it} + \gamma_2 R_{it} + \gamma_3 D_{it} + \psi_{it}$$

- where: θ_{it} = nonparametric technical inefficiency; w_{it} = output gap; R_{it} = income; D_{it} = demand factors (eg. population by age); S_{it} = supply factors (eg. out-of-pochet exp.); η_t = year fixed effects; ψ_{it} = idiosyncratic error term
- In the absence of information on input (labour and capital) prices, their impact on spending is only approximated by regional fixed effects (α_i)
- *Inefficiency* $I_{it} = \hat{\delta}_1 \theta_{it} + [\hat{\phi}_i - \hat{\phi_{min}}]$
- *output gap in monetary terms* $= \hat{\delta}_2 w_{it}$

Expenditure function

Table 4: Cost and expenditure function, dependent variable = current public health expenditure per capita, year 1999-2018

Variabili	**Expenditure function**							**Cost function**	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
STRUCTURAL COVARIATES									
Technical inefficiency	221.5	218.9	203.4	234.4	350.0	193.9	121.1	259.8	318.8
	[0.001]***	[0.008]***	[0.016]**	[0.003]***	[0.000]***	[0.004]***	[0.130]	[0.016]**	[0.000]***
Output gap	359.9	471.6	448.3	481.8	472.5	449.0	376.9		
	[0.021]**	[0.007]***	[0.008]***	[0.007]***	[0.004]***	[0.004]***	[0.031]**		
Num. observations	383	383	383	383	383	383	383	384	383
R^2	0.979	0.966	0.967	0.966	0.973	0.969	0.969	0.974	
Adjusted R^2	0.975	0.964	0.965	0.964	0.971	0.966	0.967	0.972	
F test for excluded instruments (p-value)									9.54 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(23)$ (p-value)									58.329 (0.0001)

Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

Variabili	Expenditure function								Cost function
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
CONTEXTUAL DEMAND COVARIATES (used as instrumental variables for the output in cost function)									
GDP at market prices - (€) real per capita (base 2005)	0.332			0.959					
Resident population 0-4 M+F - % total pop.	130.2				142.1				
	[0.027]**				[0.018]**				
Resident population 5-14 M+F - % total pop.	100.1				21.72				
	[0.087]*				[0.601]				
Resident population 15-24 M+F - % total pop.	39.52				46.79				
	[0.230]				[0.077]*				
Resident population 25-34 M+F - % total pop.	11.41				-21.03				
	[0.763]				[0.416]				
Resident population 45-54 M+F - % total pop.	-35.89				4.062				
	[0.417]				[0.879]				
Resident population 55-64 M+F - % total pop.	97.28				81.95				
	[0.006]***				[0.008]***				
Resident population 65-74 M+F - % total pop.	56.99				43.90				
	[0.058]*				[0.060]*				
Resident population 75+ M+F - % total pop.	89.87				88.20				
	[0.009]***				[0.008]***				
% Heavy smokers 15+ M+F	2.806					0.866			
	[0.215]					[0.715]			
Voluntary abortion rate 15-49	-0.844					15.72			
	[0.911]					[0.193]			
% People consuming vegetables once a day 3+ M+F	-2.429					-3.001			
	[0.017]**					[0.051]*			
% People consuming fish once a week 3+ M+F	-1.370					-2.895			
	[0.277]					[0.136]			
% People consuming beef occasionally once a week 3+ M+F	1.319					0.640			
	[0.195]					[0.738]			
% People consuming cheese at least once a day 3+ M+F	0.995					-1.757			
	[0.483]					[0.169]			
% People proper breakfast 3+ M+F	3.007					1.659			
	[0.113]					[0.413]			
% People main meal dinner 3+ M+F	-0.0207					-2.391			
	[0.987]					[0.138]			
Malignant tumours incidence rate 0-84 M	9.506					1.669			
	[0.030]**					[0.395]			
Malignant tumours incidence rate 0-84 M (square)	-0.00865					-0.000925			
	[0.021]**					[0.618]			
Composite indicator - Diseases related to the psychological sphere	68.20					77.31			
	[0.408]					[0.521]			
Composite indicator - Diseases related to metabolic disorders	84.54					-141.6			
	[0.383]					[0.115]			
Num. observations	383	383	383	383	383	383	383	384	383
R^2	0.979	0.966	0.967	0.966	0.973	0.969	0.969	0.974	
Adjusted R^2	0.975	0.964	0.965	0.964	0.971	0.966	0.967	0.972	
F test for excluded instruments (p-value)									9.54 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(23)$ (p-value)									58.329 (0.0001)

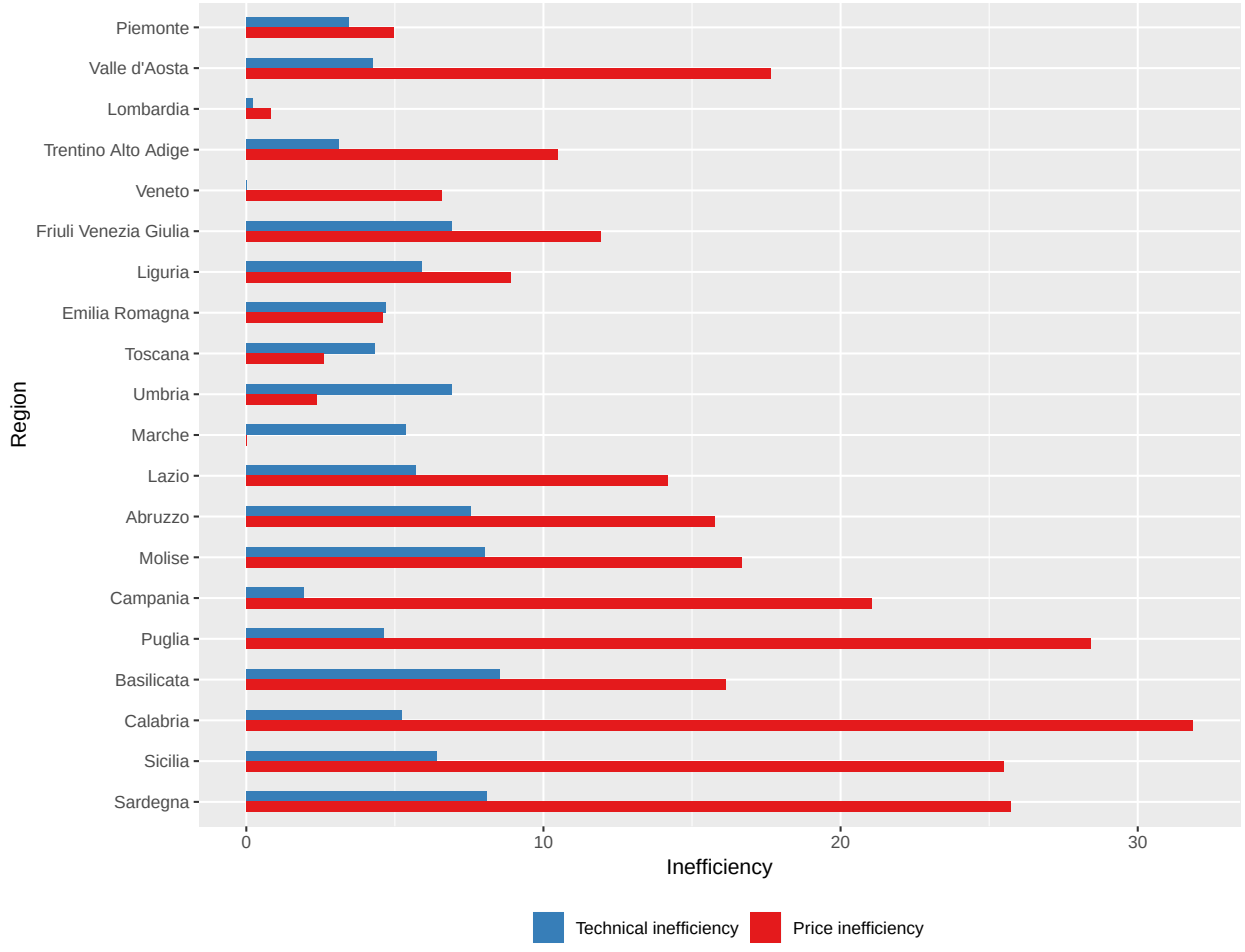
Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

Variabili	Expenditure function							Cost function	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	OLS (7)	OLS (8)	2SLS (9)
SUPPLY CONTEXTUAL COVARIATES									
	[0.786]			[0.484]					
Households health expenditure (%)	-9.790						-6.190	-12.62	-15.16
	[0.026]**						[0.115]	[0.004]***	[0.000]***
Technological progress index in medical supply	2.347						2.343	1.495	0.951
	[0.006]***						[0.002]***	[0.030]**	[0.086]*
Activity rate 15+ F	10.38						6.535	3.646	2.255
	[0.021]**						[0.227]	[0.467]	[0.427]
% pop. with university degree M+F	-0.923						-2.119	-3.323	-4.315
	[0.909]						[0.843]	[0.713]	[0.411]
Composite indicator - Diseases related to environmental pollution	-136.6						123.8	105.2	95.98
	[0.126]						[0.523]	[0.527]	[0.239]
% families complain about noise pollution	0.863						1.654	1.868	1.756
	[0.308]						[0.272]	[0.025]**	[0.063]*
Life expectancy 75 M	16.91						41.26	45.78	50.63
	[0.594]						[0.124]	[0.085]*	[0.029]**
Life expectancy 75 F	9.064						29.62	13.80	2.921
	[0.722]						[0.511]	[0.655]	[0.902]
OUTPUT COVARIATES									
Output composite indicator (Robust BoD)								1141.4	1651.2
								[0.000]***	[0.000]***
Output composite indicator (Robust BoD) - square								-523.4	-807.0
Num. observations	383	383	383	383	383	383	383	384	383
R^2	0.979	0.966	0.967	0.966	0.973	0.969	0.969	0.974	
Adjusted R^2	0.975	0.964	0.965	0.964	0.971	0.966	0.967	0.972	
F test for excluded instruments (p-value)									9.54 (0.0000)
Overidentification test, Sargan Statistics $\chi^2(23)$ (p-value)									58.329 (0.0001)

Num. obs = 383; regional clustered std. error, p-value in parentheses. * significance lower than 10%, ** lower than 5%, *** lower than 1%.
All models include regional and yearly fixed effects from 1998 to 2017.

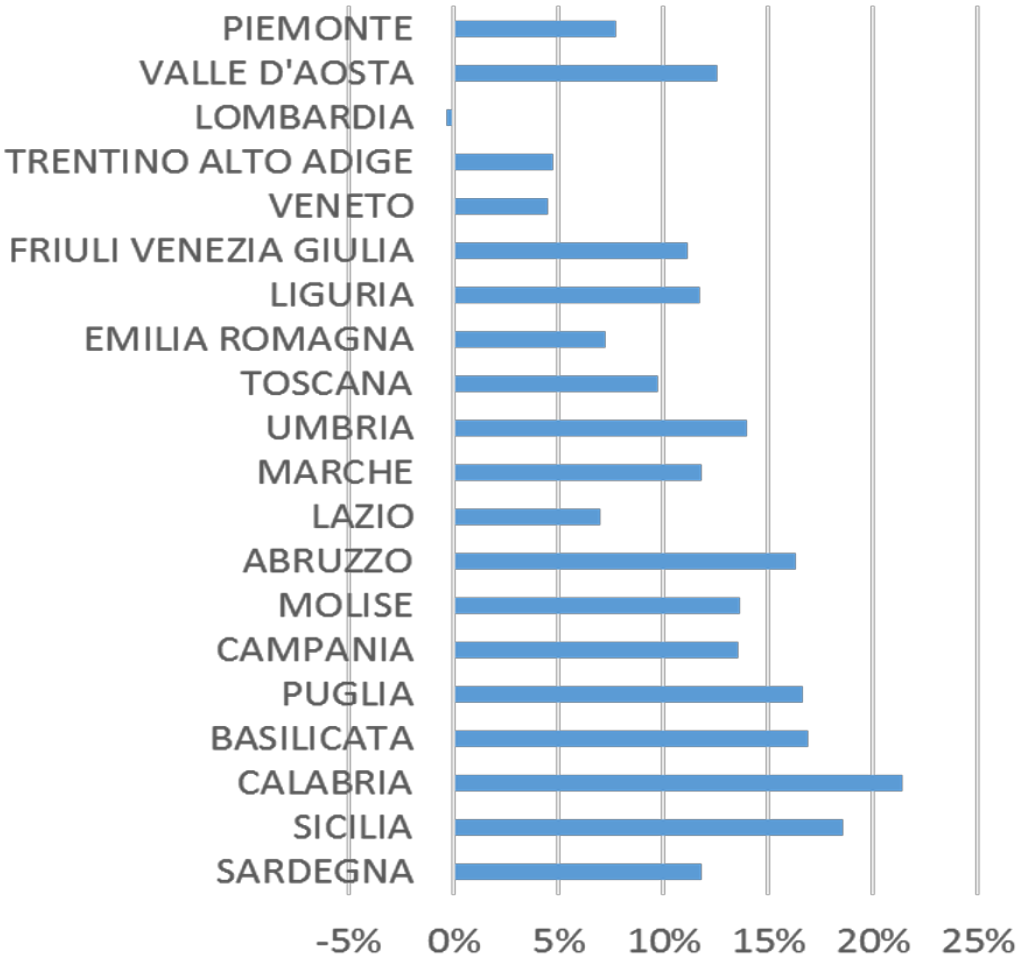
Main Results

Figure 4: Technical and price inefficiency per Region (% of historical expenditure)



Main Results

Figure 5: Output gap by Region (% of historical expenditure), year 2018



Main Results

Table 5: Historical and Standards expenditure by Region, monetary values (millions of €), year 2018

Region	Resident population 2017	Historical expend. 2017	Technical inefficiency	Price inefficiency	Total inefficiency	Own output gap	Mobility output gap	Total output gap	Standard expend. net of total inefficiency	Standard expend. net of total ineff. and output gap	Difference standard - historical with output gap
	(A)	H_{i2017} (B)	θ_{it} (C)	$\hat{\phi}_i - min(\hat{\phi}_i)$ (D)	(E = C+D)	w_{it_own} (F)	w_{it_mob} (G)	(H = C+D)	$\hat{H}^a_{i2019}$ (I = B-E)	$\hat{H}^b_{i2019}$ (K = B-E-H)	$H_{i2017} - \hat{H}^b_{i2017}$ (L = K - B)
Piemonte	4.384.196	8.102	280	402	681	-597	-13	-610	7.421	8.031	-84
Valle d'Aosta	126.543	255	11	45	56	-33	-2	-34	199	233	-23
Lombardia	10.027.712	19.093	39	158	197	-36	239	203	18.896	18.693	-161
Trentino Alto Adige	1.065.254	2.293	71	241	312	-110	-7	-117	1.982	2.099	-201
Veneto	4.906.283	8.895	0	585	585	-454	32	-422	8.310	8.732	-131
Friuli Venezia Giulia	1.216.705	2.366	164	282	446	-291	10	-281	1.920	2.201	-155
Liguria	1.561.144	3.207	189	286	475	-370	-29	-399	2.732	3.130	-105
Emilia Romagna	4.450.735	8.496	399	391	791	-697	140	-557	7.706	8.263	-94
Toscana	3.739.703	7.162	309	187	496	-796	81	-716	6.666	7.381	300
Umbria	886.774	1.712	118	41	159	-264	12	-253	1.554	1.806	106
Marche	1.534.904	2.827	152	0	152	-338	-15	-352	2.676	3.028	186
Lazio	5.897.409	11.199	640	1.587	2.228	-791	-27	-818	8.971	9.790	-1.436
Abruzzo	1.318.722	2.397	181	378	559	-380	-25	-405	1.838	2.243	-180
Molise	309.471	631	51	105	156	-93	2	-92	475	567	-63
Campania	5.832.972	10.050	193	2.114	2.307	-1.305	-117	-1.423	7.743	9.165	-1.002
Puglia	4.056.065	7.479	346	2.126	2.472	-1.240	-51	-1.292	5.008	6.299	-1.231
Basilicata	568.742	1.061	90	171	262	-177	-11	-189	800	988	-84
Calabria	1.960.908	3.428	179	1.092	1.271	-640	-123	-762	2.156	2.919	-632
Sicilia	5.041.815	8.899	569	2.268	2.837	-1.608	-89	-1.697	6.062	7.759	-1.229
Sardegna	1.651.871	3.405	276	876	1.152	-410	-20	-430	2.252	2.682	-742
Italy (total)	60.537.928	112.959	4.258	13.335	17.593	-10.630	-13	-10.643	95.366	106.009	-6.963

Robustnes Checks

Table 6: Appropriateness indices, inefficiency and output gap (€per capita, covariates expressed as a % deviation from national average)

	Dependent variable: Percent of technical and price inefficiency					Dependent variable: Output gap (own and mobility linked)				
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
CPI	1.159	-0.0314				0.899	0.404			
	[0.083]*	[0.964]				[0.031]**	[0.336]			
CIM	2.073		3.076			0.650		1.093		
	[0.005]***		[0.000]***			[0.176]		[0.014]**		
DRG	-1.389			-1.298		-0.824			-0.859	
	[0.000]***			[0.000]***		[0.000]***			[0.000]***	
Caesarean	1.114				1.303	-0.200				-0.233
	[0.000]***				[0.000]***	[0.272]				[0.207]
N	246	246	246	246	246	260	260	260	260	260
R^2	0.978	0.973	0.975	0.972	0.977	0.966	0.962	0.964	0.965	0.963
Regional fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Annual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robustnes Checks

- the Comparative Performance Index (*CPI*) is the ratio of standardized average hospitalization per case-mix to average hospitalization of the reference standard, values above 1 indicate lower efficiency than the standard, and values below 1 reflect higher efficiency than the standard (its polarity is negative);
- the Case Mix Index (*CMI*) is calculated as the ratio of average weighted hospitalization to average weighted admission of the national standard, higher values indicate higher case complexity than the standard (its polarity is positive);

Robustnes Checks

- the percentage of medical Diagnosis Related Groups for surgical wards (*DRG*) is the ratio of the number of patients discharged from DRG surgical wards to the total number of patients discharged from surgical wards, lower values indicate grater appropriateness (its polarity is negative);
- the percentage of Caesarean birth on total (*Caesarean*) is a clinical appropriateness indicator, calculated as the ratio of the number of caesarean births to total births (its polarity is negative).

Robustnes Checks

Table 7: Impact of annual % change in deficit on inefficiency and on global output gap

	Δ Inefficiency (Perc.)	Δ Output gap (Perc.)
Δ Deficit (Perc.)	-0.000235	-0.000573
	[0.960]	[0.000]***
N	246	260
R^2	0.333	0.618
Regional fixed effects	Yes	Yes
Annual fixed effects	Yes	Yes

Δ Deficit = annual percentage variation in regional health care sector deficit.

Concluding remarks

- Develope a **standard expenditure needs model** of the healthcare sector in line with: local demand factors, production efficiency and constitutional mandates.
- Introduction of new factors in the assessment of standard needs (Socio-economic context, Efficiency in the provision of the service, Degree of satisfaction of potential demand), evaluation of two gaps:
  - **output gap** (lack in satisfaction of local demand)
  - **efficiency gap** (potential spending review target)
- Analysis based on the **Italian health care system (pre-covid period)**, decentralization of service provision at regional level, fiscal equalization not fully in line with constitutional principles.

The End