THE EFFECT OF THE NATIONAL ECOVERY AND RESILIENCE PLAN ON THE HEALTHCARE SUPPLY IN THE ITALIAN PROVINCES

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Abstract. The monitoring of the economic, social and environmental phenomena on which National Recovery and Resilience Plan funds represents a challenge for the policy makers. The integration between data at provincial level on the characteristics of the provinces and the open data on the NRRP funds represents an important monitoring support resource for public decision makers. The data available in the Italian government platform allows us to quantify the NRRP financing by unique project code and local project code, being able to trace the amount allocated to the provinces and individual municipalities for the NRRP missions. The scope of this work is to analyse the effect of NRRP funds on the healthcare supply in the Italian provinces estimating an econometric model in order to obtain a parameter to evaluate the impact of NRRP contributions to the access to the healthcare facilities.

1. Introduction

Monitoring the economic, social and environmental phenomena affected by National Recovery and Resilience Plan (NRRP) funds is essential for policy makers to assess the effectiveness of their decisions and implementation strategies. This study analyses the impact of NRRP funds on healthcare provision in Italian regions and provinces by estimating an econometric model. The analysis focuses on evaluating how NRRP contributions affect access to healthcare facilities. To achieve this, we integrate provincial-level data on healthcare facilities with open data on NRRP funds, creating a comprehensive resource for public policy makers. The Italian government's platform (www.italiadomani.gov.it) provides data to quantify NRRP funding by unique and local project codes, allowing the tracking of funds allocated to municipalities for NRRP tasks.

On the one hand, we investigate whether NRRP funds increase healthcare expenditure and examine the potential crowding-out effect (Park et al. 2024) of these financial resources on private spending, given that a large increase in public spending could stimulate inflationary growth and thus induce monetary policymakers to raise interest rates, thereby reducing private investment demand. In addition, we analyze the impact of NRRP funds on the presence of healthcare facilities, considered here as a proxy for healthcare provision (Pamolli et al. 2017). The second section provides

an overview of NRRP missions by region, a literature review on the healthcare market, and a description of demand and supply indicators, including healthcare expenditure by region and healthcare facilities by province. Control variables relevant to healthcare expenditure are also discussed (Meskarpour et al. 2021). The third section describes the data and methods used for the econometric model. Finally, the fourth section concludes the study with a summary of findings and implications.

2. NRRP and Healthcare Expenditure in Italian Provinces

Divided into seven missions, the NRRP has three main objectives. The first, with a short-term horizon, focuses on repairing the economic and social damage caused by the pandemic crisis. In the medium to long term, the plan addresses persistent weaknesses in the Italian economy and society, including territorial disparities, gender inequalities, low productivity growth and limited investment in human and physical capital. Finally, the plan aims to promote a comprehensive ecological transition.

The resource allocation by NRRP is a comprehensive reform package aimed at overcoming historical barriers that have hampered public and private investments, stunted growth and resulted in sub-optimal employment levels, particularly for women and young people.

The NRRP should support the economic recovery by boosting GDP growth and sustaining high-income dynamics in subsequent years. It also aims to increase potential growth and productivity through innovation, digitalisation and investment in human capital. According to the Italian Ministry of Finance, based on the QUEST model developed by the European Commission (D'Auria et al., 2009), GDP is projected to be 3.6 percentage points higher by 2026 compared to a baseline scenario. While these estimates assume efficient public investments, they do not take into account additional gains from the reforms proposed in the plan, in particular those related to youth and female employment. With effective reforms to improve competitiveness, actual growth could exceed these projections.

The EU's Next Generation initiative promotes a robust economic recovery across Europe, emphasizing ecological transition, digitalisation, competitiveness, training, social and territorial inclusion and gender equality, social and territorial inclusion and gender equality.

The Regulation for the Recovery and Resilience Facility identifies six key intervention areas: green transition, digital transformation, sustainable and inclusive growth, social and territorial cohesion, health resilience and policies for younger generations. Based on these pillars, the Italian government has structured the 2021 NRRP into six missions (Figure 1): 1. Digitalisation, innovation, competitiveness,

culture and tourism; 2. Green revolution and ecological transition; 3. Infrastructure for sustainable mobility; 4. Education and research; 5. Inclusion and cohesion; 6. Health.

Figure 1 – *NPRR Funds by region.*
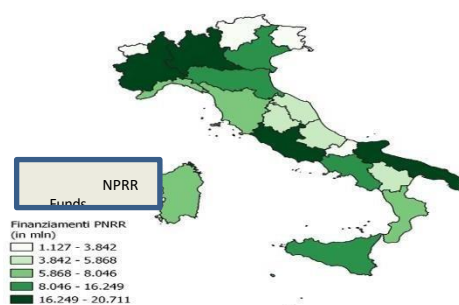
Source: our elaborations on Italia domani data.

The strategy for Mission 6 focuses on aligning healthcare services with the needs of patients across Italy through major reforms and investments. Resources allocation will improve infrastructure, promote research and innovation, and improve the technical, digital and management skills of healthcare workers.

In 2023, the EU launched a seventh mission, RePowerEU, to support the ecological transition. It aims to accelerate renewable energy production, strengthen distribution networks and promote energy efficiency, while fostering green skills in the public and private sectors.

The healthcare sector is characterized by unique service characteristics, as outlined by Batley and McLoughlin (2015): a) The nature of goods and services: Rivalry and/or excludability; (b) Market failure characteristics: Monopoly tendency, positive or negative externalities, information asymmetry; (c) Task-related characteristics: Visibility + measurability of processes and outputs = imputability, discretion of frontline staff, transaction intensity, variability of treatment, provider autonomy; d) Demand characteristics: Frequency of use, predictability of use, territoriality. These characteristics require significant public intervention, particularly to address externalities. The government has to decide whether to manage healthcare institutions directly or to grant concessions to private entities for the provision of services, following a cost-transaction approach (Hart et al., 1997; Shleifer, 2000).

In Italy, the healthcare system is of a mixed type. Public and private institutions coexist, with private providers receiving subsidies from local governments to

provide services. There is also a grey zone of hybrid public/private schemes (Falsone, 2024), arising from the fact that many Italian healthcare entities are non-profit associations, consortia, social cooperatives, ecclesiastical organizations, legal moral bodies, private individuals, foundations, limited liability companies, and cooperative in-house companies. These entities operate on the borderline between public and private, yet they are subject to private business law. In recent years, the significant share of out-of-pocket payments by households confirms that the Italian healthcare system is of a mixed type, characterized by a higher incidence of private expenditure on total healthcare spending compared to the European average. Specifically, out-of-pocket payments accounted for 26.3% of total healthcare expenditures in Italy in 2021, compared to the EU average of 18.9% (OECD, State of Health in the EU, Italy Country Health Profile, 2023). The Italian mixed healthcare system has also been impacted by the reordering of local public services of economic relevance (Legislative Decree no. 201/2022), which does not explicitly exclude social and healthcare services from its scope (Falsone, op. cit.). The improvement of available facilities in this complex mixed system, along with the reorganization of territorial community healthcare services following the COVID-19 emergency and the implementation of Electronic Health Records (Cacciatore et al., 2023), represents a major challenge for NRRP funds.

To assess the impact of NRRP funding, this study uses public healthcare expenditure and the number of healthcare facilities (hospitals) as proxies for goods and services provided in the healthcare sector.

Public healthcare expenditure refers to the amount financed by the government to provide healthcare goods and services needed by households in a given region. It represents a significant proportion of current expenditure: according to the Ministry of Finance, public healthcare expenditure accounted for 6.3% of GDP in 2023, or

€131.1 billion. Data from the Italian National Institute of Statistics (ISTAT) show that public healthcare expenditure had an average annual growth rate of 1.7% between 2012 and 2023 (Basso et al., 2024). The determinants of healthcare expenditure are both economic and social, as noted by Meskarpour et al. (op. cit.). The economic determinants depends on the overall economic growth of a country, with gross domestic product per capita often used as a key economic context variable (Pamolli et al., op. cit.). Social determinants include the size and age composition of the population analyzed as control variables in studies such as Akca et al. (2017) and Pamolli et al. (op. cit.).

In this study, we consider the presence of healthcare institutions as a proxy for hospital and clinic facilities, which are essential for the provision of healthcare services. These facilities are where sick people go for treatment and recovery. Pamolli et al. (op. cit.) identify accessibility as a critical factor linking the identification of healthcare needs, the location of healthcare services, the ease of

access to these services and the ultimate ability to receive appropriate care. In our analysis, we do not directly consider other components of healthcare, such as professional medical advice, pharmaceuticals and medical technology. However, we hypothesize that improvements in healthcare infrastructure create economies of scale that have a positive impact on other components of service provision in the sector.

3. A Model for Estimating the Impact of NRRP on Healthcare Service

a. The model

To analyze the impact of NRRP funding on healthcare services using the available data, we used a linear regression model (Galton, 1886; Kenney & Keeping, 1962) with healthcare expenditure and number of healthcare facilities as dependent variables. All analyses were carried out using R software (R Core Team, 2022) and associated packages: sf (Pebesma, 2018), dplyr (Wickham *et al.*, 2022) and ggplot2 (Wickham, 2022).

b. Creation of the Database and Estimation Methods

Data on NRRP funding were obtained from the Italian government portal "italiadomani" (https://www.italiadomani.gov.it/), which provides details on funding by mission and local project code (LPC) at the municipal level. We integrated the relevant tables on NPRR at provincial level by local project code and we selected information specific to health-related projects.

We obtained data on healthcare expenditure at regional level and on healthcare institutions at provincial from Istat source, as well as information on GDP per capita and on the resident population. We carried out the analysis at provincial level; therefore, we standardized the data at this territorial level: we aggregated funding data at provincial level, while we disaggregated regional expenditure data by provincial healthcare institutions and GDP per capita. First, we evaluated the correlation between Healthcare expenditure and Healthcare institutions and several control variables (Population, GDP per capita, Age, see Table 1), as reported in the literature mentioned in section 2 (Meskarpour *et al.* op. cit., Akca *et al.* op. cit. and in Pamolli *et al.* op. cit.).

Table 1 – *Correlation matrix among all detected variables.*

	Healthcare inst.	Healthcare exp.	Population	GDP per capita	Age
Healthcare inst.	1.00	0.93	0.94	0.63	-0.45
Healthcare exp.	0.93	1.00	1.00	0.80	-0.30
Population	0.94	1.00	1.00	0.77	-0.33
GDP per capita	0.63	0.80	0.77	1.00	0.04
Age	-0.45	-0.30	-0.33	0.04	1.00

We formulated a linear regression model to estimate healthcare expenditure at the provincial level considering the number of healthcare institutions (Figure 3.1) and to avoid multicollinearity, we used GDP per capita as the control variable selected on the base of the correlation analysis (Table 1):

$$healthcare\_exp = \beta_0 + \beta_1\, n\_healthcare\_inst + \beta_2\, GDP\_per\_capita$$

Applying this model, we obtained the estimated healthcare expenditure at provincial level (Figure 2) and the related estimated coefficients are in the following table (Table 2):

Table 2 - *Results of the regression model: healthcare_exp=β_0+ β_1 n_healthcare_inst+ β_2 GDP per capita.*

| Coefficients:	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	-589.57264	570.32812	-1.034	0.315739
n_healthcare_inst	79.05567	8.76610	9.018	6.88e-08
GDP per capita	0.02088	0.00448	4.661	0.000224

Residual standard error: 1397 on 17 degrees of freedom Multiple R-squared: 0.9379
Adjusted R-squared: 0.9306
*F-statistic: 128.4 on 2 and 17 degrees of freedom p-value: 5.487e-11*
Source: our elaborations on Istat data.

Figure 2 − *Estimate of healthcare expenditure in 2021.*
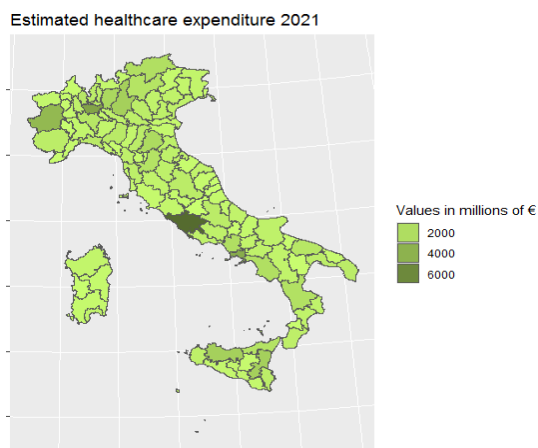
Source: our elaborations on Istat data.

c. Results

After standardizing the data at the provincial level, we analyzed the contribution of NRRP funds to provincial healthcare expenditure (Figure 3). The map shows that in almost all provinces the amount of NRRP funds allocated to healthcare is less than 10% of the estimated provincial healthcare expenditure.

Figure 3 − *Percentage of healthcare expenditure covered by NRRP funds, provincial data.*
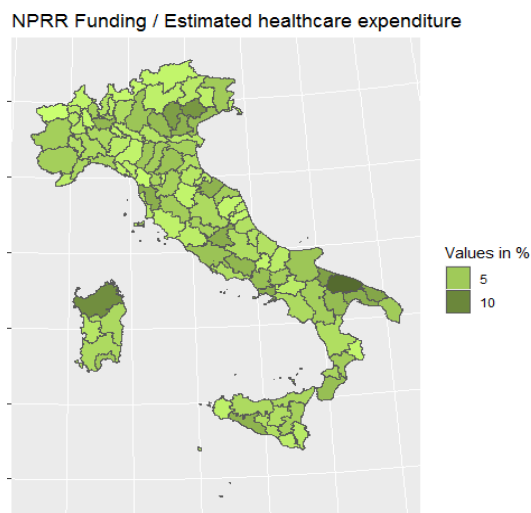
Source: our elaborations on Istat and italiadomani data.

To analyze the relationship between healthcare expenditure and NRRP funding, we applied a logarithmic transformations to the variables:

$$log(est\_healthcare\_expenditure) = \alpha + \beta \, log(NRRP\_funding)$$

The following reasons were on the base of this conversion:

- Linearization of the Relationship: The initial scatterplot of healthcare expenditure versus NRRP funding indicated a nonlinear pattern, suggesting that a simple linear regression model might not accurately capture the relationship. Application of a logarithmic transformation to both variables rendered the relationship linear, allowing for a more precise fit using linear regression techniques. The log-log transformation is especially effective when both variables exhibit a multiplicative or exponential relationship, as it stabilizes variance and linearizes the data.

- Interpretability in Terms of Elasticity: The logarithmic transformation facilitates the interpretation of the coefficient β as the elasticity of healthcare expenditure with respect to NRRP funding. This is particularly pertinent in economic contexts, as it provides insight into the proportional responsiveness of healthcare expenditure to changes in NRRP funding. The coefficient $\beta = 0.53$ indicates that a 1% increase in NRRP funding is associated with a 0.53% increase in healthcare expenditure, thereby highlighting a less-than-proportional response. We present below (Table 3) the results of the model.

Analyzing the same relationship by rescaling the variables based on GDP (considered as control variable as reported in Table 1), we obtain the following result (Table 4).

$$log\left(\frac{est\ healthcare\ expenditure}{GDP}\right) = \alpha + \beta \, log\left(\frac{NRRP_{funding}}{GDP}\right)$$

Again, with a coefficient of $\beta = 0.53$, there is evidence of what was previously described regarding the elasticity of expenditure with respect to NRRP funding. Rescaling this time only the variable related to NRRP funding relative to GDP, we obtain the following graph (Table 5).

$$log(est\_healthcare\_expenditure) = \alpha + \beta \, log\left(\frac{NRRP_{funding}}{GDP}\right)$$

The coefficient β in this case is 0.44, consistent with previous findings.

Finally, we examined the relationship between the number of healthcare facilities per thousand inhabitants and the amount of NRRP funding per province, rescaled by GDP (Table 6):

$$\log\left(\text{N healthcare } inst \ x \ \frac{Pop}{1000}\right) = \alpha + \beta \log\left(\frac{\text{NRRP}_{\text{funding}}}{\text{GDP}}\right)$$

The coefficient $\beta = 1.55$ indicates that the number of healthcare institutions is more than proportionally reactive to changes in NRRP funding.

Table 3 – *Results of the regression model: Estimated healthcare expenditure ~ NRRP Funding.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	11.5248	0.6421	17.95	<2e-16
log NPRR funding	0.5292	0.0367	14.42	<2e-16

Residual standard error: 0.2816 on 105 degrees of freedom Multiple R-squared: 0.6644
Adjusted R-squared: 0.6612
F-statistic: 207.9 on 1 and 105 degree of freedom p-value: 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 4 – *Results of the regression model: Estimated healthcare expenditure / GDP ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	6.7589	0.2515	26.87	<2e-16
log NPRR Funding / GDP	0.5307	0.0339	15.65	<2e-16

Residual standard error: 0.2684 on 105 degrees of freedom Multiple R-squared: 0.7001
Adjusted R-squared: 0.6972
F-statistic: 245.1 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 5 – *Results of the regression model: Estimated healthcare expenditure ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	17.55768	0.32847	53.452	<2e-16
log NPRR Funding / GDP	0.43579	0.04427	9.844	<2e-16

Residual standard error: 0.3505 on 105 degrees of freedom Multiple R-squared: 0.48
Adjusted R-squared: 0.475
F-statistic: 96.91 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 6 − *Results of the regression model: Number of healthcare institutions * Population/1000 ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	-3.4894	0.8067	-4.325	3.48e-05
log NPRR Funding / GDP	1.5460	0.1087	14.221	< 2e-16

Residual standard error: 0.8609 on 105 degrees of freedom Multiple R-squared: 0.6582
Adjusted R-squared: 0.655
F-statistic: 202.2 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

4. Conclusions

The NPRR funds should increase public healthcare expenditure, and our econometric study confirms this proposition. However, it seems that the increase in public healthcare expenditure is not proportional to that of the NPRR funds. In fact, a possible crowding-out effect on aggregate demand due to an inefficient use of NPRR funds could be at work, particularly as regards public healthcare expenditure. The increase in public expenditure due to the NPRR could affect the level of prices of goods and services related to the missions and a subsequent speed of inflation growth could affect a restrictive monetary policy by increasing the interest rate, thus reducing private aggregate demand. In order to better study this aspect, we have considered as a proxy for the supply of healthcare services the presence of healthcare institutions in the provinces.

Taking into account the effect of the NPRR funds in the healthcare sector on the number of healthcare institutions at the provincial level, we have estimated a direct impact coefficient and the result is an increase of the healthcare supply more than proportional compared to that of the NPRR funds.

In any case, the study needs further investigation, particularly in terms of updating the data both on the actual spending of the NPRR funds received by the Italian government and on the monitoring of the works in progress of the infrastructures planned by the NPRR missions.

On the other hand, the study needs to improve both the applied methodology of the Small Area Indicators and the econometric IV methods.

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