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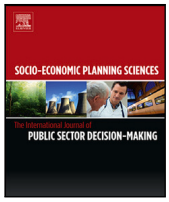

Political electoral cycles and evolution of Italian health care system financing. A long run perspective

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ABSTRACT

A notable feature of the Italian healthcare system – where funding is centralized and regions manage services locally – is the mismatch between expenditure and funding dynamics, leading to a structural deficit and frequent bailouts on the part the regions. To explain the actions of central and regional governments, we propose a strategic game. The nature of the game varies depending on whether we are in an electoral period for the renewal of the regional government. During elections, regional incumbents use their information advantages, and it is rational for them to increase the deficit, whereas for the central government, it is rational to reduce transfers.

That result is confirmed by the empirical analysis run on the 15 Italian Regions with ordinary statutes between 1982 and 2020. We have used Italy as a case study to demonstrate the relevance of our hypothesis, but we believe that the theoretical framework proposed in our paper can be applied to explain the significance of political cycles in determining the interaction between different levels of government in other federal contexts.

1. Introduction

This paper offers a novel analysis of the strategic interactions between different layers of government arising when the provision of healthcare is decentralized to regions. We propose a general model that we test on the Italian national healthcare system (NHS).

The case of Italy highlights how public health policy results from the interaction of two levels of government: the central government finances the NHS, while regional governments provide and manage services. The Italian NHS is taken as an example of all the federal contexts in which there are shared responsibilities in the healthcare sector. In the case of Italy, a strategic game is played between the central and regional governments. The former oversees mainly the funding of the NHS, while regional governments are in charge of spending resources. A notable characteristic of the Italian NHS is the disparity between expenditure and financing dynamics, leading to frequent bailouts of the regional healthcare systems [3,5,6]. The strategic game changes when moving from non-electoral years to electoral years. The Italian NHS serves as an excellent example of a public good managed at the regional level but dependent on central government transfers, which can be affected by both political cycles and the logic of soft budget constraints.

The topic has been examined in various papers [3,7–12]. However, those studies have consistently overlooked the significance of political cycles in the interaction between the central and regional governments. The general belief is that regional governments logically shape bailout expectations when their relationship with the central government is defined by soft budget constraints.[1] Soft budget constraints are crucial for health spending, as the central government cannot credibly allow regional governments to fail in providing basic public services (typically recognized as essential constitutional rights) without incurring substantial political costs.

To the best of our knowledge, the only endeavor to incorporate political economics into the soft budget constraint dilemma is exemplified

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[1] To establish the presence of soft budget constraints in the delivery of local public goods, it is crucial to demonstrate the role that these expectations have in shaping subnational government behavior. However, as expectations are unobservable, that creates a challenging task. Rodden [1] has attempted to model expectations using suggested proxies from theory for Germany, while Pettersson-Lidbom [2] has done the same for Sweden and Bordignon and Turati [3] and Padovano [4] for Italy.

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by Kaiser and Taugourdeau [13] theoretical model.[2] Nonetheless, that particular approach relating to the relationship between electoral cycles and soft budget constraints does not align well with the specific problem we wish to address in this paper. Local government studies provide valuable insights into political economics, especially regarding the rational behavior of voters who have a better understanding of the management of public goods at the local level.[3]

Our paper develops the literature on electoral political cycles while proposing a complementary story to that presented by scholars who have emphasized the relevance of soft budget constraints. Bordignon and Turati [3] suggest that bailout is reduced and deficit is smaller when the central government is stronger, i.e. they can commit to the transfer rules they set up. Such an idea explains very well why regions run deficit, but does not explain why the central government seems to accept a vertical imbalance by under-financing the regional healthcare system.[4]

In our paper,we demonstrate that, during election, the regional incumbent commits to the highest level of healthcare provision in order to be re-elected. Such commitment increases the strength of regional governments in the interplay with the central government and makes them run a greater deficit. As a reaction, the central government reduces financing by considering the increase in regional spending as a lesser need of resources for the region. That practice legitimizes the distorted incentives that arise due to the regional electoral cycle.[5] During elections, regions' incumbents utilize their informational advantages and set the highest level of provision in order to be re-elected, before entering in the game with the central government. In the game between regional and central governments, each region has an incentive to act as Stackelberg leader during electoral time. Following Minervini and Vinella [23], we may define such condition as "decentralized leadership".

The paper is structured as follows: in the next section we present the institutional background of Italian NHS, Section 3 describes the theoretical model, in Section 4 we discuss the empirical strategy to test the model and in Section 5, after a brief description of the dataset, we present the key findings.[6]

2. Institutional background

The Italian NHS was created in 1978 by bailing out old mutual funds that were running large deficits. It is based on the principles of universal coverage, social financing through general taxation and non-discriminatory access to healthcare services. Until 1992, healthcare spending was financed mainly by social security contributions (largely paid by employers) and by resources from the state budget: everything went into the National Health Fund (NHF), which was then distributed among the various regions (and within each region) according to the guidelines of the national and regional health plans. Italian Law No. 833/78 is a measure that is essentially indifferent to resource constraints. Suffice it to point out that the institutional responsibility for determining the resources to be allocated to healthcare was entrusted to the national health plan, but the first plan would not come to light until 1994.

The first reform of the NHS, born to achieve a better balance between the use of resources and the satisfaction of needs, introduced new rules both in the organization and in the financing of healthcare (Italian Legislative Decree 502/1992, supplemented by Italian Legislative Decree 517, 1993). That reform established that the National Health Plan defines the levels of services that the NHS had to guarantee uniformly throughout the nation, and therefore the planning function remained centralized. On the other hand, the main changes concerned the increase in regional competences and the adoption of management tools by local healthcare authorities. The reform modified the financing system, i.e. for the first time, a fee-for-service financing system was introduced for inpatient admissions, classified according to the Diagnostic Related Groups system, and for outpatient services.[7] These changes were further supported by Italian Law 59 of 1997, which transformed the Italian administrative system from state to regional-local, a trend that would experience a significant evolution with the constitutional reform of 2001. Despite this new regulation, the problem of the historical imbalance between expenditure and financing remained unchanged.

The second reform of the NHS (Italian Legislative Decree 229/99) was only partially the logical continuation of the previous reform path: while local health authorities were strengthened by granting them entrepreneurial autonomy, as well as legal, accounting, organizational and patrimonial autonomy, the process of regionalization and the introduction of competition systems in healthcare was critically rethought. In particular, the mechanism of competition (and the related system of financing through fees) was mitigated by the system of contracts/agreements between local health authorities and public/private providers.

A final relevant aspect concerns the simultaneous definition of essential and uniform levels of care and the means to guarantee them, as well as the participation of the regions in defining the NHS. For the financing of services not guaranteed by the NHS, the establishment of supplementary funds for guaranteed levels of healthcare was foreseen.

From 2000–2001, when the constitutional reform of Title V granted greater autonomy to sub-national governments, the Italian central government tended to set up the financing rules in agreement with the regions immediately after the start of a new legislature. The actual institutional change began with the agreements of 3rd August 2000, 22nd March 2001 and 8th August 2001, which later became Italian Decree-Law 347/2001. The effect is a reduction in deficits, with some notable exceptions.

Fig. 1 shows that, in the 1990 election year, the ratio between expenses and ordinary financing (deficit ratio indicated by the thick line) presents a maximum for all regions, such ratio decreases in mid-Nineties. Since the 2000s, the various regions have shown heterogeneous deficit trends. Since the 2000s, the various regions have shown heterogeneous deficit trends. In the context of the 2005 elections, the

[2] The model determines the circumstances in which the problem of soft budget constraints is exacerbated, i.e., whether it worsens with simultaneous central and regional office terms (synchronized elections) or with non-coinciding tenures of office (staggered elections).

[3] See Geys [14], Veiga and Veiga [15], Sakurai and Menezes-Filho [16] and Gainza and Livert [17]. All these papers investigate whether transfers from the central government to local governments have been allocated to gain electoral advantage and discover empirical evidence of electoral and partisan cycles. Bee and Moulton [18] study assists in identifying the variables that are significantly impacted by electoral cycles at the sub-national level, particularly in the case of a well-established democracy. An increase in total municipal employment for local public goods such as police, education, and sanitation is found. To grasp the rationale behind the electoral cycle at the sub-national level, one must have a thorough understanding of the direct responsibilities that local governments can take on and the administrative duties required of them by higher levels of government as shown by Garmann [19].

[4] For instance, in 1999, Reviglio wrote: "Faced with a tendentially increasing healthcare expenditure, we find inadequate financing and together the de facto financial irresponsibility of the Regions (...) The formation of deficits in the management of the Regions' healthcare is a recurring feature likely to affect the coming years as well (...) The inadequacy of the financing of the Regions' healthcare expenditure persists, despite far-reaching funding reforms" (pp. 92–95).

[5] The impact of electoral terms on economic policy decisions is a widely researched area within the social sciences [21,22].

[6] Some robustness checks, which we present in the Appendix, complete the empirical analysis.

[7] The reform was limited to hospitals, leaving out all primary care services.

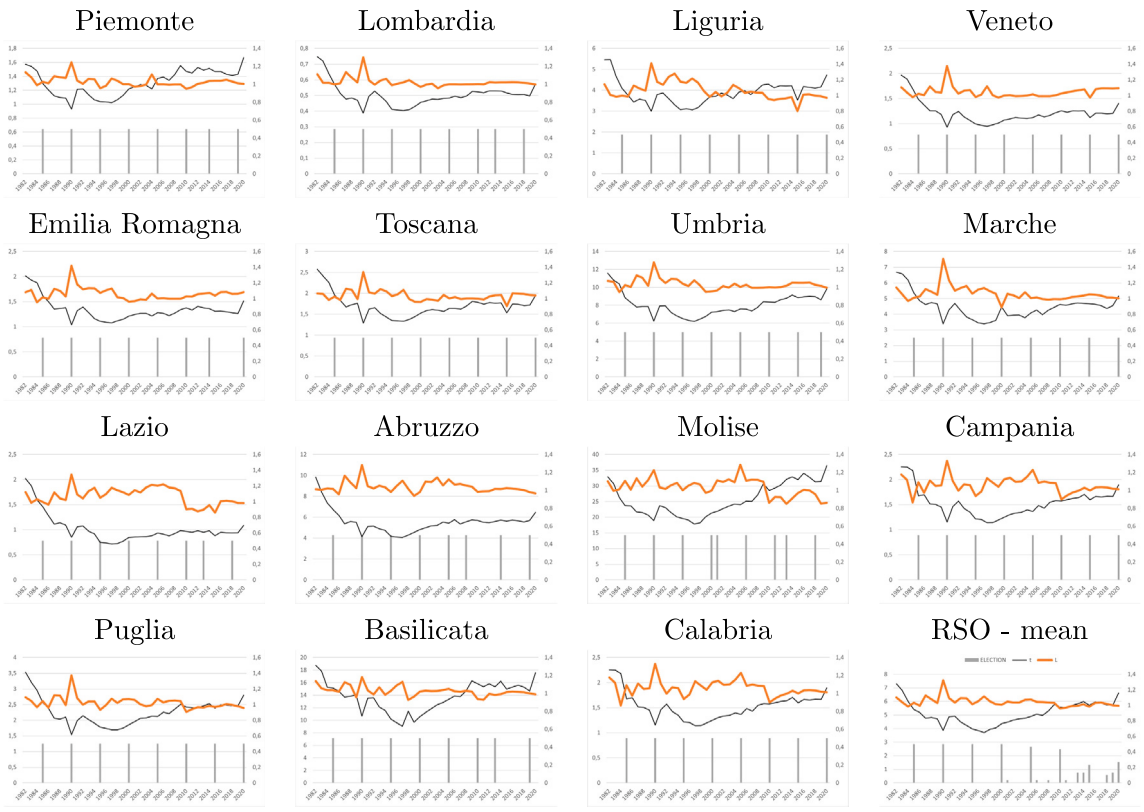

Fig. 1. Regional HCSs transfers, deficits and elections.

increase in overspending can still be observed in Abruzzo, Calabria, Campania, Lazio, Molise and, to a lesser extent, Puglia. These are precisely the regions that are currently subject to the Deficit Recovery Plans and that, with the exception of Puglia, have been placed under Commissioner status (Abruzzo in the period 2008–2016, Lazio 2008–2020, Campania 2009–2020, Molise July 2009–today, Calabria July 2010–today).

The Deficit Recovery Plans are the solution proposed by the central government to curb the growth of expenditure and deficits and have led to a tightening of sub-national budgetary constraints through administrative subordination [12]. The imbalance between resources and spending in the NHS persists even as the institutional features governing its financing change, just as the phenomenon of deficit recovery at the regional level cyclically returns.

The fact that the history of the NHS is characterized by episodes of extraordinary ex-post coverage of deficits raises suspicions of a clear public finance strategy: the affair of annual allocations to the national NHF is significant evidence of a distortion of public finance decision-making procedures, which allows the regions to accuse the government of manipulating public accounts and the government to accuse the regions of financial irresponsibility.

3. The model

Our study presents a game between citizens, central government and a regional incumbent. To keep the model simple, we assume that taxes are collected only by the central government, and healthcare is provided solely by the region.[8]

The players and their objective functions: **Citizens** vote to confirm or not the regional incumbent on the basis of the level of healthcare provided, which becomes a signal of competence. The choice of citizens is based on the expectation as to which between the incumbent and an outsider could provide the highest utility in periods after the election.

For simplicity, we assume that the expected actual value of utility flows at time τ is $W_\tau = w_\tau + \frac{1}{1+i}W_{\tau+1}$, where i is the interest rate, W_τ and $W_{\tau+1}$ are the actual value at time τ and $\tau+1$ respectively.[9] w_j is the per period utility that we assume separable in consumption C_τ and healthcare provision H_τ:

$$w_\tau = c(C_\tau) + h(H_\tau) - l(\lambda_\tau, \psi) \tag{1}$$

where we assume a decreasing marginal benefit of C_τ and H_τ:

$$\frac{\partial c(C_\tau)}{\partial C_\tau} > 0, \quad \frac{\partial h(H_\tau)}{\partial H_\tau} > 0,$$
$$\frac{\partial^2 c(C_\tau)}{\partial C_\tau^2} < 0, \quad \frac{\partial^2 h(H_\tau)}{\partial H_\tau^2} < 0.$$

We, also, assume that private consumption and healthcare services are complements rather than substitutes, as confirmed by the estimation of healthcare demand [24]; hence, the demand for healthcare is inelastic, as empirical estimations confirm [25].[10]

The function l represents the perceived costs for citizens of running a deficit. Let us describe the intuition behind l: such costs depend on the fact that citizens know that when the region runs new debt, sooner or later they will pay for it in terms of lower provision of healthcare, higher taxes, and so on. The parameter ψ_τ indicates the toughness of formal and informal fiscal rules against debt, thus also capturing the institutional context. The costs are higher when fiscal rules are stricter.

[8] However, we could relax that assumption and consider that the region could raise taxes.

[9] $W_{\tau+1}$ represents the continuation value.

[10] Hence we assume $0 < -\frac{\frac{\partial h(H_\tau)}{\partial H}}{H_\tau \frac{\partial^2 h(H_\tau)}{\partial H^2}} < 1$. See the Appendix for details.

These rules can take either a formal form, such as an internal stability pact, or an informal form, such as blame against debt. Since the actual costs that citizens perceive depend on both legal, psychological, and cultural factors, we prefer not to model it as a discounting of future expenses due to debt payment but to leave it implicit.[11] Regarding the functional form of the cost function l, therefore, it is plausible that it increases with both λ_τ and ψ_τ, and that the marginal cost of λ_τ rises with the deficit rate and the toughness of fiscal rules:

$$\frac{\partial l(\lambda_\tau)}{\partial \lambda_\tau} > 0, \ \frac{\partial l(\psi_\tau)}{\partial \psi_\tau} > 0,$$
$$\frac{\partial^2 l(\lambda_\tau)}{\partial \lambda_\tau^2} > 0, \ \frac{\partial^2 l(\lambda_\tau)}{\partial \lambda_\tau \partial \psi_\tau} > 0.$$

Citizens do not directly decide on C_τ and on H_τ, but can only vote for a candidate who provides them the higher expected values of utility on the basis of the observed provision of healthcare services at electoral time τ. In a non-electoral periods, citizens plays no role.

The central government sets taxes to finance healthcare (t) while avoiding that the ratio between regional debt and GDP becomes too high ($D_\tau/Y_\tau \leq \gamma$). In our model, the tax rate represents also the financing rate of NHS and the ratio between ordinary transfer for financing the NHS and regional GDP. To keep the ratio below the threshold (γ), the central government establishes an additional tax rate (b), resulting in an overall tax burden of $(t_\tau + b_\tau)Y_\tau$.[12] It is important to note that in this simplified model, the only way to address the region's debt issue is to raise taxes for citizens and utilize tax revenue to pay off the deficit. Therefore, b_τ represents the bailout rate.

Private consumption is defined as:

$$C_\tau = Y_\tau - t_\tau Y_\tau - b_\tau Y_\tau \tag{2}$$

Thus, we can interpret C_τ and Y_τ as regional private consumption and regional GDP at time τ.

For simplicity sake's, we do not consider elections for central government and we assume that it is benevolent.[13] Hence, the maximization problem for the central government is as follows:

$$\begin{aligned}\max_{b_\tau, t_\tau} \mathbb{E}\left[W_\tau | I_\tau^C\right] = \max_{b_\tau, t_\tau} \mathbb{E}\left[w_\tau | I_\tau^C\right] \\ + \frac{1}{1+i} \max_{b_{\tau+1}, t_{\tau+1}} \mathbb{E}\left[W_{\tau+1} | I_\tau^C\right] \\ \text{s.t.} \frac{D_\tau}{Y_\tau} \leq \gamma\end{aligned} \tag{3}$$

where I_τ^C is the information set of the central government at time τ. Debt evolution is described by:

$$D_{\tau+1} = D_\tau(1+i) + \lambda_\tau t_\tau Y_\tau - b_\tau Y_\tau, \tag{4}$$

Where $\lambda_\tau t_\tau Y_\tau$ is the new debt generated at a regional level, $b_\tau Y_\tau$ is the taxes raised in order to reduce the debt level and i is the interest rate. Moreover, we define the regional GDP rate of growth as $g = \frac{y_{\tau+1} - Y_\tau}{Y_\tau}$.

The incumbent of regional government establishes a deficit rate λ_τ to fund healthcare expenditures $p_\tau H_\tau$ above what is available through transfers $t_\tau Y_\tau$. Here, p_τ is the price of a unit of healthcare provision, and H_τ is the aggregate quantity of services provided. Healthcare provision is defined as such:

$$H_\tau = \left(1 + \lambda_\tau\right) \frac{t_\tau Y_\tau}{p_\tau} \tag{5}$$

therefore, λ_τ represents the portion of healthcare expenditure financed via new debt. The higher the λ_τ value, the higher the deficit region incurs to finance healthcare beyond the transfer's allowable level. The price of healthcare provision (p_τ) depends on general economic conditions (the general price level) and the ability of the regional incumbent to sign cost-effective contracts with healthcare providers. Therefore, price is an index of efficient healthcare expenditure: the higher the price, the more inefficient expenditure. It is important to note that, for a given transfer ($\hat{t}_\tau Y$) optimally chosen by the central government, the observed healthcare provision could be financed with the optimal solution ($\hat{t}_\tau, \hat{\lambda}_\tau$), which depends on the true price $\hat{p}_t au$ which leads to the provision of $\hat{H}_\tau = (1 + \hat{\lambda}_\tau)\frac{\hat{t}_\tau Y}{\hat{p}_\tau}$. However, the same healthcare provision can also be achieved by choosing a different pair (p_τ, λ_τ) such that

$$\frac{1 + \lambda_\tau}{p_\tau} = \frac{1 + \hat{\lambda}_\tau}{\hat{p}_\tau}. \tag{6}$$

Consequently, a more inefficient region could provide the same healthcare services by increasing the overspending throughout the deficit.

As in Rogoff [21], we assume that the incumbent of regional governments is quasi benevolent: they consider the utility function of citizens W_j corrected by an ego rent X_j they receive when in charge. Such ego rent can be expressed as $X_\tau = x + \frac{1}{1+i} P_{\tau+1} X_{\tau+1}$, where x is the ego rent to be in charge one year and $P_{\tau+1}$ is the probability to be in charge at time $\tau + 1$. Hence, $P_{\tau+1} = 1$ if the incumbent in charge at time τ is confirmed at time $\tau + 1$, if not confirmed, it holds $P_{\tau+1} = 0$. Obviously, if τ is a non-electoral period, the incumbent at time τ is in charge also at time $\tau + 1$. Therefore, the problem of regional incumbent is choosing λ_τ in order to maximize the following inter-temporal utility:

$$\begin{aligned}\max_{\lambda_\tau} \mathbb{E}\left[W_\tau + X_\tau | I_\tau^R\right] = \max_{\lambda_\tau} \mathbb{E}\left[w_\tau + x | I_\tau^R\right] \\ + \frac{1}{1+i} \max_{\lambda_{\tau+1}} \mathbb{E}\left[W_{t+1} + P_{\tau+1} X_{\tau+1} | I_\tau^R\right],\end{aligned} \tag{7}$$

where I_τ^R is the information set of the regional incumbent at time τ. It is immediate to see that the maximization problem for the central government is the same in electoral and non-electoral period; it is not the same for the regional incumbent, instead. Indeed, if the region is in non-electoral period, then $P_{\tau+1} = 1$. Otherwise, it depends on what the regional incumbent did during electoral time. Specifically, if τ is an electoral time, the probability of being in charge at time $\tau + 1$ depends on the provision of healthcare $P_{\tau+1} = P(H_\tau)$. Increasing H_τ makes the probability increases less than proportionally, then $\frac{\partial P_{\tau+1}}{\partial H_\tau} > 0$ and $\frac{\partial^2 P_{\tau+1}}{\partial H_\tau^2} < 0$.

The timing of the game: We can imagine an alternation of two periods. In the first period, the incumbent of a regional government faces an election, the second period is a non-electoral time. Let us define $j = E, \ NE$ as the index which indicate an electoral period $j = E$ and a non-electoral one $j = NE$.

Hence, in the first period, the regional incumbent plays two games. Firstly, they provide healthcare to citizens in order to be re-elected. Secondly, they play with the central government with regard to grants transferred to finance healthcare, and deficits incurred by the regional government to provide more healthcare services than what can be funded by the central government. We abstract from the interplay among regions and assume their equivalence in terms of regional GDP (Y). It is worth to note that the value of P_{E+1} depends on citizens' vote during electoral periods ($j = E$), which depends on the healthcare provided during that period $P_{E+1} = P(H_E)$. In other words, the value of P_{E+1} depends on the electoral game between citizen and regional incumbent in the electoral period $j = E$.

In the second period, the regional incumbent plays only with the central government on grants and deficit, since no election takes place. In that case, citizens play no role.

[11] Alternatively, we may model the cost of running debt as an explicit inter-temporal equilibrium; that will add analytical complications and will impose some explicit assumptions on functional forms without providing a more insightful analysis.

[12] We are assuming a representative individual.

[13] We briefly discuss the case with a non benevolent central government in the conclusions.

The information structure: We model the true price as a stochastic variable as:

$$\hat{p}_\tau = \frac{1}{1+\eta_\tau+\eta_{\tau-1}}, \quad E[\eta_j] = E[\eta_{\tau-1}] = 0, \tag{8}$$

where, η_τ and $\eta_{\tau-1}$ respectively are stochastic shocks on prices in the current period and in the previous year. Both shocks can assume only two values: a and $-a$ with probability 0.5, where $0 < a < 0.5$. Therefore, prices can assume only three values: $p_A = \frac{1}{1+2a}$ with probability 0.25, $p_B = 1$ with probability 0.5, and $p_C = \frac{1}{1-2a}$ with probability 0.25. That shock is candidate/incumbent specific, a different candidate in charge is associated with a different price, hence the actual price is known only by the regional incumbent.

When healthcare is provided, citizens and the central government do not know the actual price $\hat{p}_\tau$ and the rate of deficit λ_τ. Their true values will only be known by citizens when all decisions have been made and the new deficit ($\lambda_\tau t_\tau Y_\tau$) is reported on the financial statement issued at time $\tau+1$. In other term, prices are uncertain and there exists an asymmetric information on them. The information structure about prices is very similar to the one proposed by Rogoff [21] for describing the competence index.[14] A lower price indicates that the incumbent is competent in administrative, organizational, and other exogenous factors. We assume that citizens and the central government infer the price value at time τ observing the healthcare provision made by the regional government. Therefore their information set is $I_\tau^C = \eta_{\tau-1}, H_\tau$.

Indeed, price is the very element with regard to which information is asymmetric and it is on that asymmetric knowledge that the possibility to expand the deficit during electoral time is based, as we will show. Hence the information set of the regional incumbent is $I_\tau^R = \eta_\tau, \eta_{\tau-1}$, while the information sets of the central government, and of citizens, always contain $\eta_{\tau-1}$; they may contain also η_τ depending on the possibility of calculating it on the basis of the information provided by the regional incumbent, as we will show hereafter.

Note that the true value of $\eta_{\tau-1}$ for opponent politicians cannot be calculated[15]; in that case, the price associated to an opponent is such that $\mathbb{E}\left[\frac{1}{p\tau}\right] = \frac{1}{p_B} = 1$.

3.1. The solutions of the model

Since (3) and (7) are Bellman's problems, we solve the model backward by calculating the reaction function as their first order condition and describing the voting decision of citizens. We relegate calculus in the Appendix and we will show that there are two different regimes describing the behavior of governments during non-electoral and electoral periods.

As will become apparent soon, for the central government, optimal response at time τ is independent from time $\tau+1$. The same is true for the voting behavior of citizens.[16] Also, the optimal response of the regional incumbent when time τ is a non-electoral period is independent from time $\tau+1$.[17] On the contrary, the decision of the regional incumbent when τ is an electoral period determines the possibility of being in charge in the following periods; therefore, in the electoral time, the decision taken at time τ is not independent from time $\tau+1$. In order to be re-elected, regional incumbent takes a strong commitment with their citizens, and such commitment changes the game between regional incumbent and the central government.

Therefore, our problem is solved backward as a solution of a three stage game. The first stage is the electoral game at time $\tau = E$, where the regional incumbent provides H_E and citizens decide to confirm them or not. The second stage is at time $\tau = E$ between regional incumbent and central government, at this stage, the pair (t_E, λ_E) is decided. Finally, the third stage is the government game at time $\tau+1 = E+1 = NE$ between regional incumbent and central government, at this stage (t_{NE}, λ_{NE}) is decided.

3.2. The reaction functions

3.2.1. Central government

Because the decision of central government is time independent, the maximization problem (3) becomes:

$$\begin{aligned}\max_{b_\tau, t_\tau} w_\tau &= c(Y_\tau - t_\tau Y_\tau - bY_\tau) \\ &+ h(1+\lambda_\tau)t_\tau Y_\tau \mathbb{E}\left[\frac{1}{p_\tau}|I_\tau^C\right] - l(\lambda_\tau, \psi_\tau) \\ &\text{s.t.} b_\tau \geq \lambda_\tau t_\tau - \gamma(g-i)\end{aligned} \tag{9}$$

Note that the national government is required to employ additional taxes (b_τ) to curtail the growth of regional debt.[18]

In order to solve such problem, for each value of λ_τ, the central government sets the optimal response function, $b_\tau = b(\lambda_\tau)$ and $t_\tau = t(\lambda_\tau)$, as the solution of the following system:

$$b_\tau = \max[0; \lambda_\tau t_\tau - \gamma(g-i)] \tag{10}$$

$$\frac{\frac{\partial h(H_\tau)}{\partial H_\tau}}{\frac{\partial c(C_\tau)}{\partial C_\tau}} = p_\tau \frac{1+\frac{db_\tau}{dt}}{1+\lambda_\tau} \tag{11}$$

From (10), the constraint in Eq. (9) is not binding ($b_\tau = 0$) if the rate of growth is sufficiently high; otherwise, it is binding ($b_\tau > 0$). Hence, when the central government raise taxes to finance regional debt, the constraint is binding, $\frac{db_\tau}{dt} = \lambda_\tau$, the price the region has to pay for healthcare is equal to the marginal rate of substitution between consumption and healthcare. Otherwise, when the constraint is not binding ($b_\tau = 0$), the region is able to pay a higher price for healthcare, since financing healthcare with debt permits to reduce the actual cost that the region pays or alternatively to provide more healthcare services. We can consider (11) as the reaction function of the central government, on which the next two propositions are based:

Proposition 1. *The optimal financing rate (t_τ) is decreasing on deficit rate (λ_τ). When the cost of healthcare (p_τ) increases, the optimal financing rate (t_τ) increases.*

Proof. See Appendix □

3.2.2. Regional government

At the generic time τ, the problem of maximization is

$$\begin{aligned}\max_{\lambda_\tau} w_\tau + x \\ + \frac{1}{1+i}\max_{\lambda_{\tau+1}} \mathbb{E}\left[W_{t+1} + P_{\tau+1}X_{\tau+1}|\eta_{\tau-1}, \eta_\tau\right],\end{aligned} \tag{12}$$

[14] Note that we use price that corresponds to the inverse of Rogoff's index.

[15] The information asymmetry between the regional incumbent and central governments that characterizes the game is also relevant in the presence of multiple regions. Since the regional incumbents are not identical, the comparability between their actions is very weak, so the central government has a reduced ability to extract information by exploiting the correlation between them. That consideration allows us to consider each region separately.

[16] The information structure implies that citizens decide to confirm the incumbent at electoral time τ only on the basis of health provision in that period.

[17] As we show in the Appendix, when a decision at time τ is independent from time $\tau+1$, the maximization problems (3) and (7) coincide with maximizing the respective per period utility.

[18] The model remains consistent whether we interpret b_τ as additional taxes that regions must implement to repay the debt. In that case, t_τ would be the sum of the national transfer and the standard regional tax rate, while b_τ would represent the additional tax rate set by the central government to pay off excessive debt or, alternatively, the additional tax rate imposed on regions to cover it.

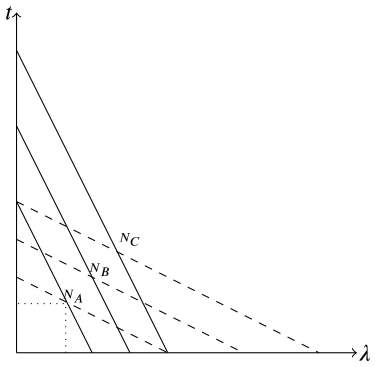

Fig. 2. The bail out game.

where $P_{\tau+1} = P(H_\tau(\lambda_\tau))$. Note that for the regional incumbent the information structure is always $I^R_\tau = \eta_\tau, \eta_{\tau-1}$. Therefore the first order condition is

$$\frac{Y_\tau \cdot t_\tau}{p_\tau}\left(\frac{\partial h}{\partial H_\tau} + \frac{X_{\tau+1}}{1+i}\frac{\partial P_{\tau+1}}{\partial H_\tau}\right) - \frac{\partial l}{\partial \lambda_\tau} = 0. \tag{13}$$

In that case, when we are in an electoral period, $\tau = E$, λ_E influences the continuation values since $\frac{\partial P_{E+1}}{\partial H_E} \geq 0$, while it has no influence in non-electoral periods, hence $\frac{\partial P_{NE+1}}{\partial H_{NE}} = 0$.

When there is no election ($\tau = NE$), the game involves only governments, and citizens do not play any role in healthcare provision decisions. In that case, the decision at time τ is independent on $\tau + 1$ thus the maximization problem (12) coincides with a per period maximization. For each pair of (t_{NE}, b_{NE}), the optimal response functions $\lambda_{NE} = \lambda(t_{NE}, b_{NE})$ is the solution of (13) with $\frac{dP_{NE+1}}{dH_{NE}} = 0$. The following propositions hold:

Proposition 2. *The optimal deficit rate (λ_{NE}) is decreasing on transfer (t_{NE}). When the cost of healthcare (p_{NE}) increases, the optimal deficit rate (λ_{NE}) increases. The optimal deficit rate decreases as the toughness of fiscal rules increases.*

Proof. See Appendix. □

It is worth to note that, in a non-electoral period, the regional government provides the quantity of healthcare ($\hat{H}_{NE}$) that correspond to the true value of the price. A different provision of healthcare ($H \neq \hat{H}_{NE}$) will be sub-optimal ($w(\hat{C}_{NE}, H) < w(\hat{C}_{NE}, \hat{H}_{NE})$). Therefore, in a non-electoral period, the central government and citizens can infer the true value of price observing the actual healthcare provision: $p_{NE} = (1 + \hat{\lambda}_{NE})\frac{\hat{t}_{NE} Y_{NE}}{\hat{H}_{NE}}$. In other terms $I^C_{NE} = \eta_{NE}, \eta_{NE-1}$.

3.3. The third stage, the intergovernmental game in non-electoral time

The Nash equilibrium $(\hat{t}_{NE}, \hat{\lambda}_{NE})$ can be calculated solving the system of the two FOCs (Eqs. (11) and (13)).

The following proposition holds:

Proposition 3. *In non-electoral time, if price p_{NE} increases both transfers rate (t_{NE}) and deficit rate (λ_{NE}) increase.*

Proof. See Appendix □

Graphically, the equilibrium is depicted in Fig. 2, where $p_A < p_B < p_C$ corresponds to Nash equilibrium N_A, N_B, N_C. The levels of provision, $\hat{H}_A > \hat{H}_B > \hat{H}_C$, and the utility, $\hat{w}_{NE,A} > \hat{w}_{NE,B} > \hat{w}_{NE,C}$, correspond to the optimal level that reflects the true prices. It is implied that the game results in the identical solution as a Nash–Cournot game under certainty.

3.4. The second stage: the intergovernmental game in electoral time

In the second stage we are during an electoral period, regional incumbent and central government play in order to set (t_E, λ_E). The following is true:

Proposition 4. *For any given values of t and b, in an electoral period the optimal response is a deficit rate not lower then the optimal response in a non-electoral period. $\lambda_E(t, b) \geq \lambda_{NE}(t, b)$.*

Proof. That comes straightforwardly from (13) and consequently (A.7). When $\frac{dP_t}{dH_\tau} > 0$, the reaction function moves right. □

In order to have a higher continuation values and to remain in charge, region increases its deficit rate when $\frac{dP_t}{dH_\tau} > 0$. In that scenario, the incumbent may strive to provide a greater quantity of healthcare ($\widetilde{H}$) than the optimal level $\hat{H}_{NE}$ that characterized the provision when no vote occurs ($\widetilde{H}(p) \geq \hat{H}_{NE}(p)$) in order to maximize their chances of re-election. Note that such provision can be granted only with an increase in deficit rate. Because of (6), the regional incumbent could always provide a greater value of H increasing the deficit, signaling a lower price. Thus, in order to be re-elected, the regional incumbent may run deficit that is higher than the optimal deficit they would run in non-electoral times. The actual behavior of the regional incumbent depends on the solution of the first stage of the game.

It is worth to note that, in an electoral period, the provision of healthcare does not permit to calculate the true price and thus the true value of deficit. In this case the informative set is $I^C_E = \eta_{E-1}, \widetilde{H} \neq I^R_E = \eta_{E-1}, \eta_E$.

Since the central government's reaction function does not change between periods, the increase in healthcare services provision at the regional level is interpreted as a signal of price reduction. The following proposition holds:

Proposition 5. *During the electoral period, the central government reduces healthcare transfer (t) to the region with respect to the transfer in the non-electoral period.*

Proof. See Appendix. □

3.5. The first stage, the electoral game

During the electoral period ($\tau = E$), citizens must cast their votes. As we show, the optimal response of the regional incumbent in setting λ_E depends not only on t_E and b_E, but also on the probability of being in charge P_{E+1}, which depends on citizens' vote. The regional incumbent might lose their ego rent if they are not re-elected. In that scenario, the incumbent may strive to provide a greater quantity of healthcare ($\widetilde{H}$) than the optimal level $\hat{H}_{NE}$ that characterized the provision when no vote occurs ($\widetilde{H} > \hat{H}_{NE}$) in order to maximize their chances of re-election. As detailed in Appendix, in the electoral period, an incumbent with $\eta_E = -a$ would raise the provision of healthcare, signaling a lower price if

$$X_{E+1} > w^O - w^F_{E+1} \tag{14}$$

where w^F_{E+1} is the utility providing $\widetilde{H} = H_A > H_B$ if $\eta_{E-1} = a$, and providing $\widetilde{H} = H_B > H_C$ if $\eta_{E-1} = -a$, in both case signaling a lower price. Condition (14) indicate that incumbent will provide $\widetilde{H}$ if the ego rent of being in charge from period $E + 1$ is greater than the gain of being substituted by an opponent net of the utility of providing a sub-optimal healthcare provision.

Note that the following proposition holds:

Proposition 6. *If during electoral time condition (14) holds, the commitment on $\widetilde{H}$ and the level of λ are independent on the values of t and of b.*

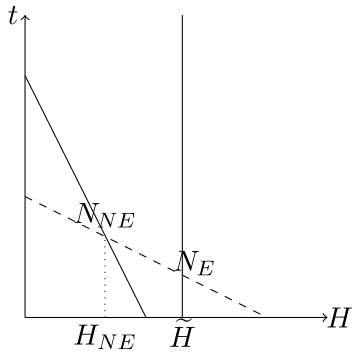

Fig. 3. The game in electoral period.

Proof. The proposition can be easily proved from (6), and because of the sequential structure of the game. See Appendix for further details. □

Graphically (Fig. 3), in the electoral period, the reaction function of the regional incumbent moves outward and does not depend on t_E, as the region exploits its informative advantages and behaves as a Stackelberg leader.

4. The empirical strategy to test the model

The main testable assertion of the model is a regime switch for the reaction function of the regional incumbent. The region follows a Nash equilibrium during non-election periods, while it acts as a Stackelberg leader during election periods because of its information advantages. Consistent with the theoretical framework suggestions of our model, we have to estimate two structural equations that correspond to the reaction functions described in Section 3. Therefore, the estimations should test the regime switch on the reaction function of the regional incumbent and an adequate estimation strategy should be adopted.

In order to estimate the regional incumbent reaction function, we use as dependent variable the overspending ratio calculated as the ratio between healthcare expenditure and transfer $L = 1 + \lambda$.[19]

In that case, our model suggests to estimate a deterministic regime switch equation:

$$\begin{aligned} L_{R\tau} = {} & \left(\alpha_1^E + \alpha_2^E t_{R\tau} + \alpha_3^E p_{R\tau}\right. \\ & \left. + \alpha_4^E \psi_{R\tau} + \gamma^E X_{R\tau}^{\lambda}\right) ELER_{R\tau} \\ & + \left(\alpha_1^{NE} + \alpha_2^{NE} t_{R\tau} + \alpha_3^{NE} p_{R\tau}\right. \\ & \left. + \alpha_4^{NE} \psi_{R\tau} + \gamma^{NE} X_{R\tau}^{\lambda}\right)(1 - ELER_{R\tau}) + \mu_{R\tau}^{L} \end{aligned} \tag{15}$$

where the index R indicates the region and τ the year, $X_{R\tau}^{\lambda}$ is the vector of controls, $\mu_{R\tau}^{L}$ is the associated error term. Its distribution has standard errors clustered at the regional level..

The parameters α_1^E, α_2^E, α_3^E, α_4^E refer respectively to the constant, the ordinary financing rate t, the price of healthcare p and the toughness of rules ψ, which are the variables of our model. The vector of parameters γ^E refers to controls during electoral periods. The parameters α_1^{NE}, α_2^{NE}, α_3^{NE}, α_4^{NE} and γ^{NE} refer to the same variables in non-electoral period. $ELER_{R\tau}$ is a dummy equal to 1 in electoral periods and indicates the regime (Nash or Stackelberg's equilibrium). Proposition 2 is correct if the impact of financing rate during non-electoral periods (α_2^{NE}) is negative, if the impact of price (α_3^{NE}) is positive and if the impact of toughness (α_4^{NE}) is negative. Moreover, Propositions 4 and 6 suggest that during electoral time the deficit should be independent from t, thus $\alpha_2^E = 0$. Regarding α_3^E, we expect that the effect of price on deficit would be positive also in electoral periods because of (6). Finally, the impact of fiscal rules toughness is negative. We may argue that, if both implicit and explicit rules are well-designed, their impact should be more pronounced during electoral periods, thus $\alpha_4^E < \alpha_4^{NE} < 0$.

Regarding the reaction function of central government, our model suggests that there is no regime switch. Thus we estimate:

$$t_{R\tau} = \beta_1 + \beta_2 L_{R\tau} + \beta_3 p_{R\tau} + \delta X_{R\tau}^{t} + \mu_{R\tau}^{t} \tag{16}$$

where β_1, β_2 and β_3 refer respectively to the constant, the overspending ratio L and the price of healthcare, $X_{R\tau}^{t}$ are controls, and δ is the vector of parameters associated to them, $\mu^t R\tau$ is the associated error term. Its distribution has standard errors clustered at the regional level.. Proposition 1 suggests that the slope of reaction function is negative ($\beta_2 < 0$) and that the impact of price on ordinary financing rate is positive ($\beta_3 < 0$).

In our theoretical model, we adopt a parsimonious formulation, with price and toughness being the only two independent variables,[20] in order to make the analysis well focused on the nature of the game that takes place between central government and regional incumbent. However, the model could be extended in several directions, which we are going to discuss in terms of the results to be derived from the empirical exercise. While doing so, we shall indicate in italics the variables to be used as controls in our estimations

The first extension is to consider a multi regional framework where regions have different per capita income and population. In that case, the central government sets the transfers funds through an equalization mechanism from rich to poor regions. Thus, the financing rate t should be inversely related to regional per capita income (GDP_PC).[21] Transfers could be related also to the size (in population) of each region (POP). In that case, an increase in population decreases the transfer rate, reducing the necessity for transfers, assuming the healthcare provision is non-rival or some scale economy exists. Conversely, an increase in population could have a positive effect on t if larger regions provide more complex healthcare services or if the central government is more inclined to favor larger regions due to political consensus. Therefore, the impact of size on the reaction function is an empirical matter. This extension is not expected to have a clear effect on overspending ratio. On one hand, a bigger and richer regional population could exert greater pressure on the healthcare system, pushing for a higher overspending ratio; on the other hand, larger and richer regions are often more efficient, resulting in a lower pressure of deficit creation. Furthermore, we consider as control also demographic structure with the ratio of population over 65 year ($Ratio65$) and regional dummies.

The second extension encompasses an examination of not only national taxation but also regional taxation. That assumes that the burden of regional debt constraints falls directly on the regions themselves, requiring them to raise their own tax rates to meet these constraints. If we assume that all regions are equal, the core of the model remains unchanged. However, when we introduce fiscal equalization and transfers from richer to poorer regions, two conflicting effects come into play. Rich regions are characterized by greater fiscal autonomy (*tax autonomy*), which makes them more responsible and incentivizes them to avoid deficits and their associated costs. Alternatively, the potential ego rent is higher in wealthier regions, which can create a stronger incentive to increase deficits.[22]

[19] It is a simple transformation of the variable presented in the model that does not impact the results.

[20] We will discuss these two variables later when we discuss the endogeneity problem.

[21] In that case, tax rate and financing rate diverges, our model still applies on the financing rate.

[22] Also in this case structural variables as size (POP) and per capita income (GDP_PC) could account for the issues raised here

The third extension considers the political dimension of the central government. As suggested by Bracco et al. [26], the central government may allocate more resources, resulting in a higher transfer rate, to politically aligned regions. Consequently, the central government might be more inclined to allow a deficit for politically aligned regional incumbent compared to non-aligned ones. On the other hand, this seems to be in line with the empirical evidence on partisan approaches [16,17]. To assess the potential impact of the regional incumbent sharing the same political affiliation as the central government, two variables are introduced: $DAligning\_1$ and $DAligning\_2$. $DAligning\_1$ is a dummy variable that equals 1 when the political alignment of the regional incumbent matches that of the central government, and 0 otherwise. Conversely, $DAligning\_2$ is set to 1 when the President of the region and the Prime Minister belong to the same political party, and 0 otherwise.

The identification problem: Obviously, the estimation of Eqs. ((15) and (16)) poses an identification issue. Exactly as in Bordignon and Turati [3], we are faced with the need not to treat our dependent variables as exogenous. If the governments' behavioral equation is not specified correctly, we may not make a correct inference about the causal relationship between ordinary financing rate (t) and the ratio between expenditure and transfer (L). Hence, in order to identify the reaction function of the central government, we have to find instrumental variables that do not directly affect t, but only through L. It is immediately evident from the model that toughness (ψ) explains (negatively) λ but does not affect t, therefore it is a good candidate as instrument of L.

Following Rodden [1] and Bordignon and Turati [3], toughness should be connected to strengthening the central government's commitment. As those authors suggest, it is possible to use different proxies. In our paper we use three proxies that may make the threat more credible by the central government not to bail out a region [27,28]. The first proxy that we consider is regional *Tax autonomy*. A greater tax autonomy increases accountability, offers regions more tools to fulfill their financial obligations, and makes the commitment to not bail out credible. Alongside *Tax autonomy*, we consider two dummies ($D1999$ and $RPLAN$) that account for institutional change and therefore could enforce the toughness of the fiscal rule.

The first is the dummy $D1999$ that has been set equal to 1 from 1999 onwards. In the year 1999 several measures that enforce fiscal rule were introduced in Italy. As we discussed in Section 2, the second reform of NHS took place in 1999. Since that year, sub-national governments have had to respect the internal stability pact in order to meet the EU stability and growth pact [29]. In the same year, the regional production tax IRAP (Imposta regionale sulle Attività Produttive) was introduced, which is a local tax on productive activities realized within a regional area.[23] All of the revenue from IRAP is allocated to the regions to contribute to the financing of the NHS. The introduction of that tax essentially coincided with a very significant institutional change in the relations between the central State and the regions within the Italian NHS, which took place with Constitutional Law No. 3 of 18 October 2001, entrusting the safeguarding of health to concurrent legislation between the State and the regions and expanding the role and competences of local bodies. All these institutional changes should enforce the strength of the fiscal rule. In a similar vein, we define the dummy variable $RPLAN$, which is 1 from 2007, the year when the central government began imposing recovery plans on regions with high healthcare debt [30] prompting the regional governments to respect more the budget rules (as shown in Fig. 1).

Moreover, the model suggests that the regime in the electoral year identifies the reaction function of the central government itself. Indeed, it is evident from the discussion that λ should not depend on t during the electoral year. The presence of two regimes, instead, can be considered to identify t, therefore all the variables that explain the value of λ in the electoral regime could be used as its instruments. We can thus conclude that, in order to identify the reaction function of central government, it is correct to consider both regimes in the same estimation using the explanatory variables of L in electoral regime as instruments.[24] Finally, another instrument can be considered based on the model: it is the increase in prices with respect to pre-electoral price ($p_E/p_{E-1} > 1$). A real increase in price during an electoral period is a condition for strategically increasing the regional deficit, signaling competence and securing re-election.[25] Such a variable represents actual increases for the regional incumbent, while it indicates an expectation for the national one. Therefore, a direct impact[26] on t can be interpreted as how central government anticipates the possible deficit expansion during electoral time.

To identify the regional reaction function we have to find instruments that affect L not directly, but through t. In that case, the model does not explicitly recommend any specific instruments, but, as we see, the effect of structural variables POP, $Ratio65$ and GDP_PC on L are ambiguous, thus such variables are good candidates as instruments for identifying the reaction function of the regional incumbent.

In order to face the identification problem, we adopt a two-stage approach. For selecting the instrumental variables, we proceed in this way: firstly, through two reduced forms, we estimate the movements of the equilibrium pairs,[27] which correspond to the equilibrium points N_{NE} and N_E in Figs. 2 and 3 with respect to parameters. That estimation enables us to verify the consistency of the variables that model the suggests, and to select the correct instruments. The estimations of reduced forms also allows us to verify Proposition 3, 4 and 6.

After selecting such instruments, we calculate both the structural forms. Unlike previous literature [3], we do not test the soft budget constraint, but we estimate the reaction functions of the central government and the incumbent of regional government respectively, explaining that the interplay between the two is influenced by the electoral political cycle. In our framework, the deficit 'measures' the soft budget constraint and varies according to the incentive of regional incumbents to signal themselves as competent. One could therefore also say that bailout expectations are shaped by the electoral political cycle.

5. Data and empirical results

5.1. Data

Our empirical analysis is centered on Italian regional public healthcare expenditure and funding spanning the years 1982 to 2020. The estimations are calculated only for the 15 Italian regions governed by ordinary statutes. That choice is due to the considerable differences in funding rules for regions with special statutes.[28] We hereafter report the sources of raw data, based on which the variables used in the empirical analysis were constructed consistent with the theoretical model.

[23] The standard rate is 3.9%, but higher IRAP rates are, for example, applicable to banks and financial institutions (4.65%) and insurance companies (5.90%). Regional authorities have the right to increase or decrease the IRAP rates within the limit of 0.92%.

[24] Using two separate estimations for electoral and non electoral times would not permit to account for this correctly. Further details are provided in Section 5.

[25] Remembering that citizens and the central government know at time $\tau+1$ the actual value of price and deficit at time τ. An increase in real current price implies that the real value of $\eta_\tau = -a$. As we see, during an electoral period when the price is high and efficiency is low, the regional incumbent has the incentive to signal a higher level of efficiency.

[26] A direct impact on t would indicate that $p_E/p_{E-1} > 1$ is a common control for both L and t.

[27] (t^{NE}, λ^{NE}) in non-electoral period and (t^E, λ^E) in electoral period.

[28] Italian special-statute regions (Valle d'Aosta, Trentino Alto Adige, Friuli Venezia Giulia, Sardinia and Sicily) fully fund their own expenditure, including the regional healthcare system, through tax revenues received in the form of co-participation in national taxes. In contrast, Italian regions with ordinary statutes are financed by central transfers.

We obtained data on Italian regional public healthcare expenditure and ordinary financing since 1990 from the ISTAT database known as "Health for All - Italy", which is part of a program managed by the World Health Organization. For the 1980s, we relied on data from other sources, which sometimes use different definitions of public health expenditure than the Health for All database (HFA). Specifically, we gathered information from the Italian Ministry of Economy and Finance's "Relazione generale sulla situazione economica del Paese", which provides the average yearly expenditure of USL (local healthcare units).[29] Data on deficits is computed as simple differences between the annual expenditure and the ordinary financing.

We collected data on regional own taxes and regional current revenue from the ISTAT time series "Finanze degli Enti Locali Bilanci delle Regioni e delle Province Autonome" ("Finance of Local Authorities Final balance sheets of regional and autonomous provincial governments") for the period 2000–2020 and from the "Court of Auditors' Reports" [31] for the period 1992–1999. The data on own tax revenues for the period 1982–1991 is very small in magnitude, and in the absence of official statistical information, it has been assumed to tend towards zero. From that data, we calculated *Tax autonomy* as the ratio between regional own taxes and regional current revenue. We define t for each region as the ratio between ordinary financing and regional GDP, and L as the regional overspending ratio, i.e., the ratio between total healthcare expenditure and ordinary financing.[30]

To estimate a proxy for the price (p) of healthcare, we divided the total expenditure, calculated in EUR at the real value of the year 2000, by the number of regional public hospital beds, which we consider a proxy for the entire healthcare provision.[31] Indeed, hospital beds are strongly and positively correlated with other healthcare services (such as doctors, nurses, diagnostic activities associated with hospitalization) that contribute to health expenditures.[32] Therefore a high price indicates that the regional healthcare system is not efficient. Since, during electoral periods, citizens and the central government are aware of the prices from previous years, but they will only know the current prices when the financial statement is published, that implies that when the central government makes decisions, it uses the lagged price p_{-1} as a proxy for the current price.[33] That proxy is reliable, with a correlation of approximately 99.6%. Table 1 presents the descriptive statistics for the variables we have described.

Although in general, the values of the variables are not that different in non-election and election years, it is nevertheless possible to find lower mean values of the t variable and higher mean values of the L variable in election years.[34] That is consistent with what we have argued in the theoretical model.

Table 1
Descriptive statistics.

Entire sample (n = 585):					
	Mean	Median	S.D.	Min	Max
t	5.073	2.258	6.574	0.3870	36.49
L	1.041	1.026	0.07979	0.8004	1.506
p	0.2307	0.1036	0.3556	0.006599	2.613
p/p_{-1}	1.072	1.053	0.08370	0.8094	1.490
Tax autonomy	26.65	26.36	19.52	1.000	85.84
GDP_PC	0.01944	0.01875	0.008691	0.003448	0.04000
POP	3.280	3.558	2.376	0.2974	10.05
Ratio65	0.1922	0.1966	0.04082	0.09372	0.2881
DAligning_1	0.2860	0.0000	0.4523	0.0000	1.000
DAligning_2	0.3281	0.0000	0.4699	0.0000	1.000
ELER	0.2123	0.0000	0.4093	0.0000	1.000
D1999	0.5789	1.000	0.4942	0.0000	1.000
RPLAN	0.3684	0.0000	0.4828	0.0000	1.000
Non electoral periods (n = 464):					
	Mean	Median	S.D.	Min	Max
t	5.131	2.307	6.637	0.4036	36.49
L	1.041	1.031	0.06322	0.8521	1.287
p	0.2195	0.09835	0.3458	0.006439	2.613
p/p_{-1}	1.071	1.051	0.08375	0.8094	1.490
Tax autonomy	25.81	25.60	19.82	1.000	78.79
GDP_PC	0.01890	0.01814	0.008999	0.002847	0.04000
POP	3.280	3.560	2.369	0.2974	10.05
Ratio65	0.1901	0.1942	0.04153	0.09372	0.2877
DAligning_1	0.3017	0.0000	0.4595	0.0000	1.000
DAligning_2	0.3341	0.0000	0.4722	0.0000	1.000
D1999	0.5474	1.000	0.4983	0.0000	1.000
RPLAN	0.3556	0.0000	0.4792	0.0000	1.000
Electoral periods (n = 121):					
	Mean	Median	S.D.	Min	Max
t	5.127	2.385	6.649	0.3870	32.13
L	1.049	1.016	0.1241	0.8004	1.506
p	0.2497	0.1058	0.3769	0.006906	2.240
p/p_{-1}	1.074	1.060	0.08379	0.9078	1.437
Tax autonomy	26.69	25.94	19.24	1.000	85.84
GDP_PC	0.01968	0.01907	0.008475	0.004474	0.03905
POP	3.269	3.556	2.398	0.3052	9.999
Ratio65	0.1937	0.1990	0.04068	0.09461	0.2881
DAligning_1	0.3058	0.0000	0.4627	0.0000	1.000
DAligning_2	0.2645	0.0000	0.4429	0.0000	1.000
D1999	0.6281	1.000	0.4853	0.0000	1.000
RPLAN	0.3719	0.0000	0.4853	0.0000	1.000

5.2. The estimation of the first stage and the choice of the instruments

In order to test if the candidate instruments that we derive from the theoretical model are good, we estimated the reduced forms of t and L, imposing a regime switch between non-electoral and electoral periods. Then we tested if such switch actually exists. For that reason, it is convenient to estimate the reduced form of a variable y parameterized as

$$y = \chi \cdot Z + \chi_E(Z \cdot ELER)$$

where y may be t or L of our model, Z is the matrix of independent variables, and $Z \cdot ELER$ are the same values during electoral time, χ is the vector of parameters that refers to non-electoral periods and χ_E is the vector of parameters that refers to the difference between electoral and non-electoral periods. Therefore, from Table 2, it is immediate to test that the null hypothesis of no regime switch in the reduced form estimation is rejected (H0: $\chi_E = 0$).

[29] It is worth noting that data on ASL/USL expenditure may underestimate expenditures as it does not account for inter-regional mobility settlements.

[30] Istat is the source of GDP_PC, POP and $Ratio65$, The source of $ELER$ is the Ministry of Interior. The construction of the other dummy variables is explained in the previous section.

[31] We obtained data on regional public hospital beds per thousand inhabitants from the "Health for All" database and the ISTAT time series "Health - Health facilities and hospitalizations".

[32] This measure may have important limitations. Indeed, in an extreme case where regional governments buy services only from private hospitals, public beds are zero and, as a result, spending is classified as very inefficient. We thank an anonymous reviewer from bringing this to our attention. However, as the Italian case is not that extreme, the price index of regional health services here proposed (public spending/regional public hospital beds) appears to be an approximation that should not lead to excessive bias in the empirical analysis. Future research may further evaluate the appropriateness of our choice.

[33] We relegate the correlation matrix to Table 6 in Appendix. Because of the consideration we made in the previous section, we consider also p/p_{-1}.

[34] By election years we mean the years in which elections are held. Although there could be different situations, such as elections in early spring or late fall, it should be considered that the budgetary effects of distortions implemented by the incumbent still emerge at the end of the year when the regional budget is closed. It could be argued that the impact on the regional and central government choices could be anticipated in the previous year or postponed to the following year. However, the preliminary estimates we conducted amply justify our choice, in line with the relevant literature on electoral political cycles.

Table 2
First stage estimation: Reduced form.

Standard errors clustered by 15 values of REG				
Dependent variable	t		L	
const	2.901	2.641	0.7752***	0.7558***
	(1.907)	(1.975)	(0.2838)	(0.2834)
D1999	0.5924***	0.5905***	−0.05410***	−0.05456***
	(0.2268)	(0.2282)	(0.01821)	(0.01766)
RPLAN	0.6359*	0.6318*	−0.02275*	−0.02426*
	(0.3290)	(0.3346)	(0.01371)	(0.01369)
p_{-1}	5.692***	5.711***	−0.04911***	−0.04717***
	(0.9897)	(0.9936)	(0.01315)	(0.01394)
p/p_{-1}	−0.5145**	−0.5200*	0.1753***	0.1756***
	(0.2580)	(0.2725)	(0.03202)	(0.03296)
Tax autonomy	0.002093	0.003420	−9.483e−05	−6.121e−05
	(0.002665)	(0.003096)	(0.0001341)	(0.0001512)
GDP_PC	−74.10*	−75.29*	1.540	1.528
	(38.62)	(38.39)	(2.755)	(2.736)
POP	0.8946*	0.9182*	−0.01322	−0.01200
	(0.4750)	(0.4834)	(0.05694)	(0.05694)
Ratio65	−20.85**	−20.65**	0.6350	0.6863
	(9.766)	(9.907)	(0.5165)	(0.5188)
ELER	−0.7112	−0.3986	−0.06953	−0.06907
	(1.887)	(1.810)	(0.2781)	(0.2697)
$D1999 \cdot ELER$	−0.1174	−0.1523	−0.08810***	−0.09859***
	(0.2188)	(0.2097)	(0.03099)	(0.03244)
$RPLAN \cdot ELER$	−0.1024	−0.1130	−0.05939**	−0.05485**
	(0.1266)	(0.1404)	(0.02826)	(0.02610)
$p_{-1} \cdot ELER$	0.5520**	0.6593***	0.01581	0.01115
	(0.2334)	(0.2425)	(0.02368)	(0.03497)
$p/p_{-1} \cdot ELER$	1.490*	1.242*	0.08507	0.07515
	(0.7706)	(0.7068)	(0.1585)	(0.1596)
$Tax\ autonomy \cdot ELER$	0.0001698	−0.0004090	−0.004043***	−0.003824***
	(0.003284)	(0.004183)	(0.0008217)	(0.0007589)
$GDP\_PC \cdot ELER$	11.79	22.54	9.461***	9.340***
	(25.12)	(31.86)	(2.551)	(3.331)
$POP \cdot ELER$	−0.5576	−0.5186	0.008808	0.002672
	(0.3462)	(0.3494)	(0.03884)	(0.04149)
$Ratio65 \cdot ELER$	6.458	4.653	−0.1786	−0.03397
	(5.391)	(5.600)	(0.4496)	(0.4913)
Regional FE[a]	YES***	YES***	YES***	YES***
Political Ctrls[a]	NO	YES***	NO	YES***
n	570	570	570	570
$\bar{R}^2$	0.9786	0.9786	0.3146	0.3160
ℓ	763.0	761.0	764.0	766.7
H0 $\chi_E = 0$: p-val.	0	0	0	0

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.
[a]: *, ** and ***, indicate that controls are jointly significant.

Generally speaking, a good instrument should be significant only for the estimation of one variable. As shown in Table 2, the size (POP) and the share of elder people ($Ratio65$) are significant only for t, while the $Tax\ autonomy$ of fiscal rules is only significant for the estimation of L. Therefore, several suggestions that we derive from the model are confirmed. POP and $Ratio65$ can be considered instruments of t. The fact that POP and $Ratio65$ are good instruments for t (the ratio between ordinary financing and regional GDP, which identifies the reaction function of the central government) could be connected with the allocation formula of transfers to regions that is defined on a per capita basis corrected for needs which are related to the age structure of the population. $Tax\ autonomy$ is an instrument of L (the ratio between the regional deficit and ordinary financing, which identifies the reaction function of the regional governments) confirming that the introduction of greater accountability through extended tax autonomy exerts an effect on bailout expectations.[35] In addition, since we estimated a model with a non-switching reaction function for the central government, the instruments of L will be also the interactions of each variable with the dummy $ELER$.

The other variables are common controls. Noticeably, we cannot use per-capita income (GDP_PC) only as an instrument of t since it affects positively L during the electoral period. The equilibrium overspending ratio, that regional incumbents set is higher the richer regional inhabitants are. This finding is consistent with one of the possible explanations previously discussed: the richer the region is, the greater the ego-rent is and the stronger the incentive to larger overspending. Finally, we can confirm the impact of price on both variables as suggested by Proposition 3.[36]

5.3. The estimation of the reaction functions

5.3.1. Central government

As discussed in Section 4, we tackle the possible endogeneity by resorting to an instrumental variable approach. In Table 3 we show the result of estimation of the central government's reaction function that derived from our model (Eq. (16)). As a robustness check, we propose here different estimation techniques.[37] The first result is that Hausman's test accepts the null hypothesis that OLS is consistent. Therefore, for the central government, the overspending ratio could be considered as exogenous. that confirms the suggestion of the model that central government is the follower in the game, reacting to the decision made by the region.

As affirmed in Proposition 1, the transfer t is decreasing in the overspending ratio L, since it reduces the incentive to regional transfers from the central government. Moreover, increasing costs for healthcare imply that regional transfers from central government will be higher in order to grant a good level of healthcare to citizens. Such results are confirmed by - and coherent across - the estimations.[38] Estimates show on average that a 10% increase in overspending ratio leads to a 5% decrease in t.[39] Structural parameters (*GDP_PC*, POP and *Ratio65*) matter in defining the rate of transfers. As we expected, it is decreasing in per-capita income. Political variables also matter: as in Bordignon and Turati [3] and Bracco et al. [26], there is an "alignment effect" (measured by *DAlingment_1* and *DAlingment_2*), then central government increases transfers to "friendly regions".

The institutional variables, $D1999$ and $RPLAN$, are positively and significantly correlated with t. The impact of the two institutional changes is respectively linked, on average, to a relative increases of funding ratio t by about 7% and about 10%, respectively.

5.3.2. The regional government

About the regional reaction function, endogeneity seems a problem only in non-electoral periods (Table 4).[40] That feature has been confirmed by Hausman's tests of the two-stage least square estimations, conducted on the complete data set as well as the non-electoral and electoral subsets.

[35] Since the other two variables that capture toughness $D1999$ and $RPLAN$ account also for institutional change, they affect both reduction forms and cannot be considered solely instruments of L.

[36] The impact on t can be calculated straightforwardly. In order to calculate the impact on L, we reiterate that at time τ the regional incumbent knows p_τ, therefore for each value of p in our sample, the overall impact of price on L is greater than $-0.05 \max\left(\frac{p}{p_1}\right) + 0,175 \min p_{-1}$; such value is always positive.

[37] We run a two stage least square estimation with and without political variables (*DAlingment_1* and *DAlingment_2*), a limited information maximum likelihood and a simple OLS as a comparison.

[38] In the Appendix, we use different sets of instruments for L as a robustness check.

[39] From Table 1, on average L is 1.05 and t is 5.13. Therefore an increases in L of 0.1 reduces t to 4.89, with a relative reduction of about 5%.

[40] The estimations on the two distinct sub-samples from which we derive Table 4 are in Appendix.

Table 3
Reaction function of central government (t).

Standard errors clustered by 15 values of REG			
	TSLS	LIML	Pooled OLS
const	4.392*	4.494**	3.943*
	(2.576)	(1.881)	(2.121)
	[0.0882]	[0.0169]	[0.0635]
L	−2.403***	−2.538*	−1.808**
	(0.8890)	(1.392)	(0.7199)
	[0.0069]	[0.0683]	[0.0123]
D1999	0.3556**	0.3465*	0.3958**
	(0.1708)	(0.1927)	(0.1743)
	[0.0373]	[0.0721]	[0.0235]
RPLAN	0.5045*	0.5003***	0.5230*
	(0.2641)	(0.1507)	(0.2753)
	[0.0561]	[0.0009]	[0.0580]
p_{-1}	5.685***	5.679***	5.709***
	(0.9630)	(0.2495)	(0.9635)
	[0.0000]	[0.0000]	[0.0000]
p/p_{-1}	0.1538	0.1759	0.05714
	(0.2502)	(0.5544)	(0.2982)
	[0.5386]	[0.7511]	[0.8481]
GDP_PC	−63.74*	−63.55***	−64.59*
	(34.18)	(17.97)	(33.67)
	[0.0622]	[0.0004]	[0.0556]
POP	0.7108	0.7101**	0.7141
	(0.4765)	(0.2905)	(0.4626)
	[0.1358]	[0.0145]	[0.1232]
Ratio65	−16.09*	−16.00***	−16.48*
	(8.817)	(4.335)	(8.977)
	[0.0680]	[0.0002]	[0.0670]
DAligning_1	0.1812*	0.1836*	0.1705*
	(0.09348)	(0.1098)	(0.09092)
	[0.0526]	[0.0944]	[0.0613]
DAligning_2	0.1582**	0.1600	0.1503**
	(0.07360)	(0.09803)	(0.06872)
	[0.0316]	[0.1027]	[0.0291]
n	570	570	570
$\bar{R}^2$	0.9790		0.9791
ℓ		2524	768
Akaike		5098	1585
Schwarz		5206	1694
Hannan-Quinn		5140	1627
Hausman p-value	0.605		
Over-ident.: p-val.	0.743	0.724	
Weak instruments	4.683	4.683	

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.
[a]: *, ** and ***, indicate that controls are jointly significant.

Table 4
Analysis of endogeneity.

	Entire sample	NELER sample	ELER sample
Hausman p-val.	0.190	0.035**	0.862
Sargan p-val.	0.820	0.484	0.921
Weak instruments	6.734	13.476	2.487

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.

From Table 4, when we estimate the reaction function that characterizes the non-electoral periods (second column), Hausman's test rejects OLS consistency, instruments are valid and not weak. In electoral periods, OLS is consistent. Such feature confirms the idea that two regimes exist and that in non-electoral periods the interplay between the central government and regional incumbents seems to be a Nash game, while during the electoral time, regional incumbents behave as Stackelberg leaders. From an empirical perspective, if the regional incumbents act as a Stackelberg leader, identification issues are absent, and the overspending ratio (hence the deficit) is independent from t.

Table 5
Reaction function of regional incumbent (L).

Standard errors clustered by 15 values of REG				
	OLS with CF	TSLS	LIML	OLS without CF
	All variables are interacted with $1 - ELER$			
t	−0.02666**	−0.02666*	−0.02691**	−0.005386**
	(0.01060)	(0.01420)	(0.01282)	(0.002150)
$\widetilde{\epsilon}_t$	0.02263*			
	(0.01245)			
const	0.8974***	0.8974***	0.8984***	0.8164***
	(0.05299)	(0.04840)	(0.06795)	(0.04360)
D1999	−0.03862**	−0.03862**	−0.03852***	−0.04765**
	(0.01564)	(0.01677)	(0.01429)	(0.01855)
RPLAN	−0.004456	−0.004456	−0.004319	−0.01600
	(0.01557)	(0.01597)	(0.01313)	(0.01807)
p_{-1}	0.1037*	0.1037	0.1049	−0.004897
	(0.05881)	(0.07148)	(0.06766)	(0.01288)
p/p_{-1}	0.1597***	0.1597***	0.1595***	0.1766***
	(0.03512)	(0.03348)	(0.04178)	(0.03388)
GDP_PC	0.08483	0.08483	0.05589	2.531*
	(0.8263)	(0.9650)	(1.891)	(1.296)
Tax autonomy	1.710e−05	1.710e−05	1.702e−05	2.321e−05
	(0.0001636)	(0.0001841)	(0.0002773)	(0.0001704)
DAligning_1	0.01233**	0.01233*	0.01237	0.008978
	(0.005943)	(0.006623)	(0.008862)	(0.005605)
DAligning_2	0.006521	0.006521	0.006563	0.003012
	(0.006895)	(0.007204)	(0.008006)	(0.006327)
Regional FE	YES***	YES***	YES***	YES***
	All variables are interacted with $ELER$			
t	−0.03777	−0.03777	−0.03788	−0.03004***
	(0.02634)	(0.02892)	(0.03402)	(0.01034)
$\widetilde{\epsilon}_t$	0.008127			
	(0.03073)			
const	0.8015***	0.8015***	0.8017***	0.7847***
	(0.1555)	(0.1574)	(0.1224)	(0.1760)
D1999	−0.1365***	−0.1365***	−0.1364***	−0.1392***
	(0.04602)	(0.04628)	(0.03079)	(0.04562)
RPLAN	−0.05793	−0.05793	−0.05789**	−0.06131*
	(0.03795)	(0.03735)	(0.02392)	(0.03437)
p_{-1}	0.2030	0.2030	0.2036	0.1566**
	(0.1515)	(0.1651)	(0.2071)	(0.06434)
p/p_{-1}	0.2773*	0.2773*	0.2773***	0.2745*
	(0.1630)	(0.1642)	(0.08316)	(0.1578)
GDP_PC	9.123**	9.123**	9.112**	9.902***
	(4.238)	(4.282)	(4.140)	(3.091)
Tax autonomy	−0.003783***	−0.003783***	−0.003783***	−0.003815***
	(0.0006987)	(0.0006912)	(0.0005284)	(0.0006659)
DAligning_1	0.02820	0.02820	0.02822	0.02659
	(0.01930)	(0.01942)	(0.01794)	(0.02244)
DAligning_2	0.03026	0.03026	0.03027*	0.02970
	(0.02216)	(0.02220)	(0.01638)	(0.02244)
Regional FE	YES***	YES***	YES***	YES
n	570	570	570	570
$\bar{R}^2$	0.3365	0.2869		0.3352
ℓ	775		3680	774
Akaike	1451		7457	1452
Schwarz	1234		7665	1243
Hannan-Quinn	1366		7538	1370

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.
[a]: *, ** and ***, indicate that controls are jointly significant.

Table 5 presents the estimations of the reaction function of the regional government using different techniques calculated on the entire sample. When we control for endogeneity (the first three columns of Table 5), t is not significant in the electoral period. Furthermore, looking at the first column, in which we use the residuals of the reduced form of $\widetilde{\epsilon}_t$ presented in Table 2 as a control function, we note that only

the interaction of such residuals with $1 - ELER$ is significant. That confirms that t is endogenous only in a non-electoral period.

It is worth noting that price does not appear to have a significant effect during electoral periods, confirming the presence of two regimes. Instead, only institutional and political variables ($D1999$, $Tax\ autonomy$, $Alignment$) appear to determine the overspending ratio. The institutional rules that characterize Italy after 1999 ($D1999$) mitigate the electoral pressure on the ratio health expenditure on ordinary transfer of about 13% while in non-electoral periods the reduction in such a ratio is about 4%. During the non-electoral periods, it becomes evident that an alignment between the regional and central governments has a positive impact on overspending ratio.

6. Conclusions

In conventional models of soft budget constraint, the central government lacks the capacity to commit, because, once a deficit arises at the regional level, central government bails out regions. The regional government expects that conduct and thus creates a deficit.

In our model, instead, the region utilizes signaling and asymmetric information to gain a first-mover advantage. Our model demonstrates that the soft budget constraint can result not only from institutional deficiency at the central level, but also from the commitment strength that the regional level takes with its citizens. Secondly, by taking regional electoral cycles into account, we can identify a logic in the strategic interplay that might otherwise be overlooked.

Depending on whether we are in an election period or not, two different strategies emerge. During non-electoral time, the soft budget constraint problem results from a strategic game played by different levels of government. The presence of that strategic interaction leads to 'ordinary' bailouts. During election years, the regional incumbent expands the deficit, consciously exploiting its informational advantages; as a reaction, the central government restricts ordinary financing. However, the long-run equilibrium of the game will lead to further bailouts.

The observed bailouts represent the equilibrium result of the strategic interaction. Previous attempts to test soft budget constraints have avoided these problems by focusing solely on the behavior of the sub-national government receiving transfers [1,2].

Following the results proposed in our theoretical model, to identify the reaction functions of the central and the regional governments we have to consider the regime switch that depends on electoral cycle. Moreover, such a regime switch affects the endogeneity issue. Therefore, we adopt an adequate empirical strategy, choosing the instruments to adhere to the indications coming from the theoretical model as much as possible.

The paper provides a novel view of the evolution of the Italian NHS. The empirical findings, referring to the Italian case over the 1982–2020 period, confirm the propositions of the theoretical model. It is significant that the introduction of an institutional framework that links ordinary financing to the own resources allocated to the regions - as has been the case in Italy since 1999 - encourages deficit reduction on one hand and increases the level of ordinary financing on the other.

A possible extension of the model involves the inclusion of national elections, which would require the removal of the benevolent central government hypothesis. The presence of both national and regional elections entails a second ego-rent referring to the central government. The provision of signaling services by the incumbent would then depend on how important individual regions are for the re-election of the parliamentarians who support the Prime Minister, whereby the central government might favor some regions and disadvantage others [32].

Further research in these directions may be crucial for designing policy interventions and supporting an important political principle: only a better division of the responsibilities for the financing of the NHS between the central government and regions - including a rethinking of the hardening of sub-national budget constraints that takes into account the role of regional elections in determining deficits - can reduce the instability that political-electoral cycles are likely to bring about. One of the policy implications of our analysis is that the central government should take an active role in setting the electoral timetable for the fiscal discipline of regional governments and the welfare of their citizens, in line with the arguments made by Kaiser and Taugourdeau [13], albeit along a different line of reasoning from the one presented here.

Italy was used as a case study to demonstrate the relevance of our hypothesis, but we believe that the theoretical framework proposed in our paper can be applied to explain the significance of political cycles in determining the interaction between different levels of government in other federal contexts.

CRediT authorship contribution statement

Fabio Fiorillo: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Stefano Lucarelli:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. The model

A.1. Preliminary calculus

Elasticity of substitution

$$\sigma = \frac{\partial \ln\left(\frac{C}{H}\right)}{\partial \ln \frac{\partial p}{p}} = \frac{\partial C}{\partial p}\frac{p}{C} - \frac{\partial H}{\partial p}\frac{p}{H} < 1,$$

therefore $-\frac{\partial H}{\partial p}\frac{p}{H} < 1$. Where $p = \frac{\frac{\partial h}{\partial H}}{\frac{\partial c}{\partial C}}$, hence $\frac{\partial p}{\partial H} = \frac{\frac{\partial^2 h}{\partial H^2}}{\frac{\partial c}{\partial C}}$.

$$\frac{\partial p}{\partial H}\frac{H}{p} = \frac{H\frac{\partial^2 h}{\partial H^2}}{\frac{\partial h}{\partial H}} < -1.$$

That implies $H\frac{\partial^2 h}{\partial H^2} + \frac{\partial h}{\partial H} < 0$.

A.2. The reaction functions

Central government: The constraint of (3) is the dynamic constraint on debt evolution. Following (4), debt increases because of the payment of interest ($D_\tau(1+i_\tau)$) and due to new deficits ($\lambda_\tau t_\tau Y_\tau$). It decreases when an extra tax is imposed to reduce it ($b_\tau Y_\tau$). Therefore, when dividing it by regional GDP, we can rewrite that dynamic constraint as:

$$\frac{D_{\tau+1}}{Y_{\tau+1}}\frac{Y_{\tau+1}}{Y_\tau} = \frac{D_\tau}{Y_\tau}(1+i_\tau) + \lambda_\tau t_\tau - b_\tau.$$

Since $\frac{Y_{\tau+1}}{Y_\tau} = 1+g$, and both $\frac{D_\tau}{Y_\tau} \leq \gamma$, it holds that

$$\frac{D_{\tau+1}}{Y_{\tau+1}}(1+g) \leq \gamma(1+i) + \lambda_\tau t_\tau - b_\tau \leq \gamma(1+g),$$
$$b_\tau \geq \lambda_\tau t_\tau - \gamma(g-i).$$

Maximization problem (3) can be written as the following Lagrangian:

$$\max_{b_\tau, t_\tau} \mathbb{L}_\tau =$$
$$= \max_{b_\tau, t_\tau} \left[\mathbb{E}\left[w_\tau + \mu_\tau\left(b_\tau - \lambda_\tau t_\tau + \gamma(g-i)\right)|\eta_{\tau-1}\right]\right.$$
$$\left. + \frac{1}{1+i}\max_{b_{\tau+1}, t_{\tau+1}} \mathbb{E}\left[\mathbb{L}_{\tau+1}|I_\tau^C\right]\right].$$

Where $\mathbb{L}_\tau$ is the actual value of the Lagrangian at time τ and $\rho_\tau = \mathbb{E}\left[w_\tau + \mu_\tau\left(b_\tau - \lambda_\tau t_\tau + \gamma(g-i)\right)|I_\tau^C\right]$ represents the instantaneous Lagrangian at time τ, $\mathbb{L}_{\tau+1}$ is its continuation value, μ_τ is the Lagrange multiplier at time τ. It is worth to note that the variables b_τ and t_τ are not in the continuation values, therefore maximizing (3) is equivalent to maximizing the instantaneous Lagrangian as we indicated in (9), whose first order conditions are:

$$\frac{\partial \rho_\tau}{\partial b_\tau} = -\frac{\partial c}{\partial C_\tau}Y_\tau + \mu_\tau$$
$$\frac{\partial \rho_\tau}{\partial t_\tau} = -\frac{\partial c}{\partial C_\tau}Y_\tau + \frac{\partial h}{\partial H_\tau}(1+\lambda_\tau)Y_\tau\mathbb{E}\left[\frac{1}{p_\tau}|I_\tau^C\right] + \mu_\tau\lambda_\tau$$
$$\frac{\partial \rho_\tau}{\partial \mu_\tau} = b_\tau - \lambda_\tau t_\tau - \gamma(g-i).$$

Since $\frac{\partial \rho_\tau}{\partial b_\tau} \leq 0$, the solutions are the ones that solve (10) and (11).

Moreover, the only stochastic variable is the price. Note that, for central government it holds that

$$\mathbb{E}\left[\frac{1}{p_{\tau+1}}|I_\tau^C\right] = \mathbb{E}\left[\frac{1}{p_{\tau+2}}|I_\tau^C\right] = \cdots = 1.$$

Proof of Proposition 1. Since (11) can also be calculated when we plug (10) in $\mathbb{E}\left[w_\tau|\eta_{\tau-1}\right]$ and we differentiate by t_τ we have

$$\frac{\partial \mathbb{E}\left[w_\tau|I_\tau^C\right]}{\partial t_\tau} = -Y_\tau\frac{\partial c}{\partial C_\tau}\left(1+\frac{db_\tau}{dt}\right) + (1+\lambda_\tau)Y_\tau\mathbb{E}\left[\frac{1}{p_\tau}|I_\tau^C\right]\frac{\partial h}{\partial H_\tau} = 0. \tag{A.1}$$

Here, the corresponding second-order condition (SOC) holds:

$$\frac{\partial^2 \mathbb{E}\left[w_\tau|I_\tau^C\right]}{\partial t_\tau^2} = Y_\tau^2\left(1+\frac{db_\tau}{dt_\tau}\right)^2\frac{\partial^2 c}{\partial C_\tau^2} + (1+\lambda_\tau)^2Y_\tau^2\mathbb{E}\left[\frac{1}{p_\tau^2}|I_\tau^C\right]\frac{\partial^2 h}{\partial H_\tau^2} < 0. \tag{A.2}$$

By applying the implicit function theorem, it is possible to calculate the slope of the reaction function of the central government to regional decisions on the deficit rate:

$$\frac{dt_\tau}{d\lambda_\tau} = -\frac{\frac{\partial^2 \mathbb{E}[w_\tau|I_\tau^C]}{\partial t_\tau \partial \lambda_\tau}}{\frac{\partial^2 \mathbb{E}[w_\tau|I_\tau^C]}{\partial t_\tau^2}},$$

and, thus, $\frac{dt}{d\lambda} < 0$ if $\frac{\partial^2 \mathbb{E}[w_\tau|I_\tau^C]}{\partial t_\tau \partial \lambda_\tau} < 0$.

$$\frac{\partial^2 \mathbb{E}\left[w_\tau|I_\tau^C\right]}{\partial t_\tau \partial \lambda_\tau} = Y_\tau^2\frac{\partial^2 c}{\partial C_\tau^2}\left(1+\frac{db_\tau}{dt_\tau}\right)\frac{db_\tau}{d\lambda_\tau} + (1+\lambda_\tau)t_\tau Y_\tau^2\mathbb{E}\left[\frac{1}{p_\tau^2}|I_\tau^C\right]\frac{\partial^2 h}{\partial H_\tau^2} + Y_\tau\frac{\partial c}{\partial C_\tau}\left(\frac{1+\frac{db_\tau}{dt_\tau}}{1+\lambda_\tau} - \frac{db_\tau^2}{dt_\tau d\lambda_\tau}\right). \tag{A.3}$$

When the constraint is binding, i.e., $\frac{db_\tau}{dt_\tau} = \lambda_\tau$ and $\frac{db_\tau^2}{dt_\tau d\lambda_\tau} = 1$. In that case:

$$\frac{\partial^2 \mathbb{E}\left[w_\tau|I_\tau^C\right]}{\partial t_\tau \partial \lambda_\tau} = Y_\tau^2\frac{\partial^2 c}{\partial C_\tau^2}\left(1+\lambda_\tau\right)t_\tau + (1+\lambda_\tau)t_\tau Y_\tau^2\mathbb{E}\left[\frac{1}{p_\tau^2}|I_\tau^C\right]\frac{\partial^2 h}{\partial H_\tau^2}. \tag{A.4}$$

In that case, the slope of the reaction function of the central government is negative.

When the constraint is not binding, i.e., $\frac{db_\tau}{dt_\tau} = 0$ and $\frac{db_\tau}{d\lambda_\tau} = 0$, recalling (11) we obtain:

$$\begin{aligned}\frac{\partial^2 \mathbb{E}\left[w_\tau|\eta_{\tau-1}\right]}{\partial t_\tau \partial \lambda_\tau} &= (1+\lambda_\tau)t_\tau Y_\tau^2\mathbb{E}\left[\frac{1}{p_\tau^2}|I_\tau^C\right]\frac{\partial^2 h}{\partial H_\tau^2} + Y_\tau\frac{\partial c}{\partial C_\tau}\left(\frac{1}{1+\lambda_\tau}\right)\\ &= (1+\lambda_\tau)t_\tau\frac{Y_\tau^2}{(1+\eta_{\tau-1})^2}\frac{\partial^2 h}{\partial H_\tau^2} + Y_\tau\mathbb{E}\left[\frac{1}{p_\tau}|I_\tau^C\right]\frac{\partial h}{\partial H_\tau}.\end{aligned} \tag{A.5}$$

Recalling that $(1+\lambda_\tau)\frac{t_\tau Y_\tau}{p_\tau} = H_\tau$, we have:

$$\frac{\partial^2 \mathbb{E}\left[w_\tau|\eta_{\tau-1}\right]}{\partial t_\tau \partial \lambda_\tau} = \frac{Y_\tau}{1+\eta_{\tau-1}}H_\tau\frac{\partial^2 h}{\partial H_\tau^2} + Y_\tau\mathbb{E}\left[\frac{1}{p_\tau}|I_\tau^C\right]\frac{\partial h}{\partial H_\tau},$$

which is negative because of our assumption about the elasticity of substitution and, consequently, the demand elasticity.

In the same way, we use the implicit function theorem in order to calculate $\frac{d\mathbb{E}[t_\tau|I_\tau^C]}{dp_\tau}$, where $sign\frac{d\mathbb{E}[t_\tau|I_\tau^C]}{dp_\tau} = sign\frac{\partial^2 \mathbb{E}[w_\tau|I_\tau^C]}{\partial t_\tau \partial p_\tau}$, it holds that:

$$\begin{aligned}&\frac{\partial^2 \mathbb{E}\left[w_\tau|I_\tau^C\right]}{\partial t_\tau \partial p_\tau} =\\ &= \mathbb{E}\left[-(1+\lambda_\tau)\frac{Y_\tau}{p_\tau^2}\frac{\partial h}{\partial H_\tau} - \frac{(1+\lambda_\tau)^2Y_\tau^2 t_\tau}{p_\tau^3}\frac{\partial^2 h}{\partial H_\tau^2}|I_\tau^C\right]\\ &= -\mathbb{E}\left[(1+\lambda_\tau)\frac{Y_\tau}{p_\tau^2}\left[\frac{\partial h}{\partial H_\tau} + H_\tau\frac{\partial^2 h}{\partial H_\tau^2}\right]|I_\tau^C\right]\\ &= -H_\tau\frac{\partial^2 h}{\partial H_\tau^2}(1+\lambda_\tau)Y_\tau\left[\frac{\frac{\partial h}{\partial H_\tau}}{H_\tau\frac{\partial^2 h}{\partial H_\tau^2}} + 1\right]\mathbb{E}\left[\frac{1}{p_\tau^2}|I_\tau^C\right].\end{aligned} \tag{A.6}$$

Since we assumed that $-\frac{\frac{\partial h}{\partial H_\tau}}{H_\tau\frac{\partial^2 h}{\partial H_\tau^2}} < 1$, Proposition 1 is proved.

Regional government: In order to find the solution of the game we have to consider also the reaction function of the regional incumbent. The first order condition is (13), while the second order condition is:

$$\frac{Y_\tau^2 t_\tau^2}{p_\tau^2}\left(\frac{\partial^2 h}{\partial H_\tau^2} + \frac{X_{\tau+1}}{1+i}\frac{\partial^2 P_{\tau+1}}{\partial H_\tau^2}\right) - \frac{\partial^2 l}{\partial \lambda_\tau^2} < 0. \tag{A.7}$$

A.3. The third stage, the intergovernmental game in non-electoral time

To demonstrate the proof of this section it is convenient to write the second order condition when $\tau = NE$, which is:

$$\frac{d^2 w_{NE}}{d\lambda_{NE}^2} = \frac{Y_{NE}^2 t_{NE}^2}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2} - \frac{\partial^2 l}{\partial \lambda_{NE}^2} < 0. \tag{A.8}$$

Proof of Proposition 2. Proposition 2 is proved applying the implicit function theorem on (13) considering $\frac{dP_{NE+1}}{dH_{NE}} = 0$. Since the

second order condition (A.8) is negative it holds that $sign\left(\frac{d\lambda_{NE}}{d\bullet}\right) = sign\left(\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial\bullet}\right)$.

$$\begin{aligned}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial t_{NE}} &= \frac{Y_{NE}}{p_{NE}}\frac{\partial h}{\partial H_{NE}} \\ &+ (1+\lambda_{NE})\frac{Y_\tau^2\, t_{NE}}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2} \\ &= \frac{Y_{NE}}{p_{NE}}\left[\frac{\partial h}{\partial H_{NE}} + H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}\right] < 0\end{aligned} \tag{A.9}$$

$$\begin{aligned}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} &= -\frac{Y_{NE}t_{NE}}{p_{NE}^2}\left[\frac{\partial h}{\partial H_{NE}}\right. \\ &\left. + H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}\right] > 0\end{aligned} \tag{A.10}$$

$$\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial\psi_{NE}} = -\frac{\partial^2 l}{\partial\lambda_{NE}\partial\psi_{NE}} < 0. \tag{A.11}$$

Proposition 2 is proved.

Proof of Proposition 3. Equilibrium in non-electoral time is described by (11) and (13), which are the first order conditions of (3) and (7). Therefore, the solution of the Nash equilibrium can be calculated solving the following system:

$$\begin{pmatrix} \frac{\partial\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}} \\ \frac{\partial\left(\mathbb{E}\left[w_{NE}|I_{NE}^R\right]+x_{NE}\right)}{\partial\lambda_{NE}} \end{pmatrix} = \begin{pmatrix} \frac{\partial\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}} \\ \frac{\partial w_{NE}}{\partial\lambda_{NE}} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}.$$

Let us define the pair $(\hat{\iota},\hat{\lambda})$ as the solution for $\hat{p} = \mathbb{E}\left[p_{NE}|I_{NE}^C\right]$ and $p_{NE} = \mathbb{E}\left[p_{NE}|\eta_{NE-1},\eta_{NE}\right] = \frac{1}{1+\eta_{NE-1}+\eta_{NE}}$. In order to analyze how the equilibrium changes when price change, we totally differentiate such system by t_{NE}, λ_{NE} and p_{NE}.

$$\begin{pmatrix} \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2} & \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}} \\ \frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}} & \frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2} \end{pmatrix}\begin{pmatrix} dt \\ d\lambda \end{pmatrix} + \begin{pmatrix} \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}} \\ \frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} \end{pmatrix} dp = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

since during the non-electoral time central government could calculate p_{NE} observing H_{NE}, we can consider $\mathbb{E}\left[\frac{1}{p_{NE}}|I_{NE}^C\right] = \frac{1}{p_{NE}}$. Therefore,

$$\frac{dt}{dp} = \frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} - \frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2} - \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}} \tag{A.12}$$

$$\frac{d\lambda}{dp} = \frac{-\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} + \frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2} - \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}} \tag{A.13}$$

From (A.2) and (A.3), when the constraint is binding, we obtain $\frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}} = \frac{t_{NE}}{1+\lambda_{NE}} < 1$.

When the constraint is not binding, we may re-write

$$\frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}} =$$

$$= \frac{Y_{NE}\mathbb{E}\left[\frac{1}{p_{NE}}|I_{NE}^C\right]\left(H\frac{\partial^2 h}{\partial H_{NE}^2} + \frac{\partial h}{\partial H_{NE}}\right)}{Y_{NE}^2\frac{\partial^2 c}{\partial C_{NE}^2} + (1+\lambda_{NE})^2 Y_{NE}^2\mathbb{E}\left[\frac{1}{p_{NE}^2}|I_{NE}^C\right]\frac{\partial^2 h}{\partial H_{NE}^2}}$$

$$< \frac{Y_{NE}\mathbb{E}\left[\frac{1}{p_{NE}}|I_{NE}^C\right]\left(H\frac{\partial^2 h}{\partial H_{NE}^2}\right)}{(1+\lambda_{NE})^2 Y_{NE}^2\mathbb{E}\left[\frac{1}{p_{NE}^2}|I_{NE}^C\right]\frac{\partial^2 h}{\partial H_{NE}^2}}$$

$$< \frac{t_{NE}}{1+\lambda_{NE}} < 1.$$

From (A.8) and (A.9), we obtain

$$\frac{\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}} = \frac{\frac{Y_{NE}}{p_{NE}}\left(\frac{\partial h}{\partial H_{NE}} + H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}\right)}{\frac{Y_{NE}^2 t_{NE}^2}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2} - \frac{\partial^2 l}{\partial\lambda_{NE}^2}} < \frac{\frac{Y_{NE}}{p_{NE}}\left(H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}\right)}{\frac{Y_{NE}^2 t_{NE}^2}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2}} = \frac{1+\lambda_{NE}}{t_{NE}}.$$

Therefore

$$\begin{aligned}&\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2} \\ &- \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}} \\ =&\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}\cdot \\ &\cdot\left(1 - \frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}}\frac{\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}}\right).\end{aligned}$$

Since

$$\frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}}\frac{\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}} < \frac{t_{NE}}{1+\lambda_{NE}}\frac{1+\lambda_{NE}}{t_{NE}} = 1.$$

It holds that

$$\begin{aligned}&\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2} \\ &- \frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}} > 0.\end{aligned}$$

Let us study if

$$\begin{aligned}&\frac{\partial^2\mathbb{E}\left[w_{NE}|\eta_{NE-1}\right]}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} \\ &- \frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}\frac{\partial^2\mathbb{E}\left[w_{NE}|\eta_{NE-1}\right]}{\partial t_{NE}\partial p_{NE}} > 0.\end{aligned}$$

Which is true if

$$\frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}}} > \frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}}.$$

Recalling (A.6) and (A.10), and that the central government could calculate p_{NE} observing the provision of H_{NE}, the left hand side is

$$\frac{\frac{\partial^2\mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}}} =$$

$$= \frac{-H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}(1+\lambda_{NE})Y_{NE}\mathbb{E}\left[\frac{1}{p_{NE}^2}|I_{NE}^C\right]\left[\frac{\frac{\partial h}{\partial H_{NE}}}{H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}}+1\right]}{-H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}Y_{NE}t_{NE}\mathbb{E}\left[\frac{1}{p_{NE}^2}|I_{NE}^C\right]\left[\frac{\frac{\partial h}{\partial H_{NE}}}{H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}}+1\right]}$$

$$= \frac{1+\lambda_{NE}}{t_{NE}}.$$

The right-hand side could be calculated from (A.3) and (A.8), thus it is:

$$\frac{\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}^2}} \leq \frac{\frac{Y_{NE}}{p_{NE}}H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}+\frac{Y_{NE}}{p_{NE}}\frac{\partial h}{\partial H_{NE}}}{\frac{Y_{NE}^2 t_{NE}^2}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2}}$$

$$= \frac{1+\lambda_{NE}}{t_{NE}}\left[\frac{\frac{\partial h}{\partial H_{NE}}}{H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}}+1\right].$$

Hence the left-hand side is greater than the right and side and $\frac{dt}{dp} > 0$.

In the same way let us study if

$$-\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}} + \frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}} > 0$$

which is true if

$$\frac{t_{NE}}{1+\lambda_{NE}} = \frac{\frac{\partial^2 w_{NE}}{\partial\lambda_{NE}\partial p_{NE}}}{\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}\partial p_{NE}}} > \frac{\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}}.$$

The right-hand side can be calculated from (A.2) and (A.9):

$$\frac{\frac{\partial^2 w_{NE}}{\partial t_{NE}\partial\lambda_{NE}}}{\frac{\partial^2 \mathbb{E}\left[w_{NE}|I_{NE}^C\right]}{\partial t_{NE}^2}} < \frac{\frac{Y_{NE}}{p_{NE}}\left[\frac{\partial h}{\partial H_{NE}}+H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}\right]}{(1+\lambda_{NE})^2\frac{Y_{NE}^2}{p_{NE}^2}\frac{\partial^2 h}{\partial H_{NE}^2}}$$

$$= \frac{t_{NE}}{1+\lambda_{NE}}\left[\frac{\frac{\partial h}{\partial H_{NE}}}{H_{NE}\frac{\partial^2 h}{\partial H_{NE}^2}}+1\right].$$

Then left-hand side is greater then right hand side and $\frac{d\lambda}{dp} > 0$.

A.4. The second stage: the intergovernmental game in electoral time

Proof of Proposition 5. In the electoral time H_E is the quantity that regional incumbent commits with citizens in order to be re-elected $\widetilde{H}(p_E) \geq H_{NE}(p_E)$. Hence

$$t_E(1+\lambda_E)Y_E\mathbb{E}\left[\frac{1}{p_E}|I_E^C\right] = \widetilde{H}.$$

We re-write (11) and (A.1), when $H = \widetilde{H}$ as

$$F(t_E, \widetilde{H}) = -Y_E\frac{\partial c}{\partial C_E}\left(1+\frac{db_E}{dt_\tau}\right) + \widetilde{H}\frac{\partial h}{\partial H_E}\frac{1}{t_E} = 0,$$

which corresponds to the optimal response function of the central government with respect to the healthcare provision. Because of the implicit function theorem we have

$$\frac{dt_E}{d\widetilde{H}} = -\frac{dF(t_E,\widetilde{H})/d\widetilde{H}}{dF(t_E,\widetilde{H})/dt_E} = -\frac{\frac{\partial h}{\partial H_E}\frac{1}{t_E}+\widetilde{H}\frac{\partial h^2}{\partial H_E^2}\frac{1}{t_E}}{Y_E^2\frac{\partial^2 c}{\partial C_E^2}\left(1+\frac{db_E}{dt_\tau}\right)^2} < 0.$$

Since $\widetilde{H} \geq H_{NE}$, the proposition is proved.

Table 6
Correlation matrix.

t	*L*	*p*	p_{-1}	
1.0000	−0.1035	0.8058	0.8226	*t*
	1.0000	−0.2310	−0.2287	*L*
		1.0000	0.9957	*p*
			1.0000	p_{-1}
p/p_{-1}	*Tax autonomy*	*GDP_PC*	*POP*	
−0.0149	−0.2347	−0.2189	−0.6312	*t*
0.2484	−0.1896	−0.2022	−0.0077	*L*
−0.0562	0.0094	0.1352	−0.4973	*p*
−0.1059	−0.0032	0.1239	−0.4997	p_{-1}
1.0000	−0.1213	−0.1638	−0.0657	p/p_{-1}
	1.0000	0.7489	0.2757	*Tax autonomy*
		1.0000	0.2978	*GDP_PC*
			1.0000	*POP*
Ratio65	*DAligning_1*	*DAligning_2*	*ELER*	
0.1045	−0.0212	0.1043	−0.0007	*t*
−0.1911	0.1518	0.0045	0.0405	*L*
0.4086	−0.1713	0.0920	0.0342	*p*
0.4064	−0.1651	0.0891	0.0219	p_{-1}
−0.1305	0.0900	0.0082	0.0148	p/p_{-1}
0.5022	−0.2978	−0.0833	0.0172	*Tax autonomy*
0.7626	−0.3110	0.0068	0.0346	*GDP_PC*
−0.2460	−0.0638	−0.0163	−0.0014	*POP*
1.0000	−0.2372	−0.0097	0.0345	*Ratio65*
	1.0000	−0.4508	0.0049	*DAligning_1*
		1.0000	−0.0611	*DAligning_2*
			1.0000	*ELER*
D1999	*RPLAN*			
0.0333	0.0679			*t*
−0.3367	−0.3367			*L*
0.3738	0.3781			*p*
0.3685	0.3845			p_{-1}
−0.1242	−0.3373			p/p_{-1}
0.4995	0.2787			*Tax autonomy*
0.7452	0.5932			*GDP_PC*
0.0321	0.0398			*POP*
0.6585	0.5745			*Ratio65*
−0.2819	−0.2044			*DAligning_1*
0.0321	0.0134			*DAligning_2*
0.0650	0.0131			*ELER*
1.0000	0.6574			*D1999*
	1.0000			*RPLAN*

A.5. The first stage, the electoral game

Since the value of η_{-1} that refers to an opponent is unknown, citizens know that the instantaneous utility corresponding to the possible prices is w_A, with a probability of 0.25, w_B with a probability of 0.5, and w_C with a probability of 0.25, where $w_A > w_B > w_C$. Therefore, if citizens elect an opponent, the expected value of instantaneous utility (w^O) that they gain is the average of the optimal utility calculated for each price, i.e.:

$$w^O = 0.25w_A + 0.5w_B + 0.25w_C = w_B.$$

Citizens re-elect the incumbent if

$$E[W_{E+1}^I|\eta_{E-1}, H_E] > W^O,$$

where $E[W_{E+1}^I|\eta_{-1}]$ and W^O are the continuation value of the incumbent and of the opponent after the election which depends on the value of η_{-1} and on the signal based on H_E.

Depending on η_{E-1}, citizens possible decisions are the following four:

Case 1: $\eta_{E-1} = -a$. The incumbent cannot signal $p_E = p_A$ providing H_A, since citizens knows that only p_B or p_C can be the true prices. Only p_B or p_C is signaled.

Table 7
TSLS estimation of ι, various instruments.

Standard errors clustered by 15 values of REG				
Instruments:	Table 2	*ELER*	ELER, *Tax autonomy*	ELER, *Tax autonomy*, ELER· *Tax autonomy*
Regional FE , as instruments	YES	NO	NO	NO
L	−2.403***	−14.33*	−5.003	−3.867**
	(0.8890)	(7.363)	(3.212)	(1.655)
p_{-1}	5.685***	5.201***	5.579***	5.626***
	(0.9630)	(0.6339)	(0.8679)	(0.9108)
p/p_{-1}	0.1538	2.093**	0.5765	0.3918
	(0.2502)	(1.053)	(0.4990)	(0.3207)
n	570	570	570	570
R^2	0.9799	0.9625	0.9788	0.9795
Hausman p-value	0.605	0.080	0.284	0.150
Instruments:	Table 2	*ELER*	ELER, *Tax autonomy*	ELER, *Tax autonomy*, ELER· *Tax autonomy*
Regional FE , as instruments	YES	YES	YES	YES
L	−2.403***	−5.392**	−3.821	−2.739***
	(0.8890)	(2.599)	(2.390)	(0.9899)
p_{-1}	5.685***	5.564***	5.627***	5.671***
	(0.9630)	(0.9707)	(0.9322)	(0.9511)
p/p_{-1}	0.1538	0.6398*	0.3843	0.2084
	(0.2502)	(0.3462)	(0.3619)	(0.2710)
n	570	570	570	570
R^2	0.9799	0.9785	0.9795	0.9798
Hausman p-value	0.605	0.504	0.470	0.471

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.

Case 1a: If the incumbent provides H_B, it signals that $\eta_E = a$, hence $\mathbb{E}\left[\frac{1}{p_{E+1}}|\eta_E = a\right] = 1 + a$, thus citizens calculate that

$$E[W^I_{E+1}|\eta_{E-1}, H_E] = E[w^I_{E+1}| - a, a] + \frac{1}{1+i}W^0 > w^0 + \frac{1}{1+i}W^0,$$

thus $w_A > w_B$. Citizens confirm the incumbent.

Case 1b: If the incumbent provides H_C, it signal that $\eta_E = -a$, hence $\mathbb{E}\left[\frac{1}{p_{E+1}}|\eta_E = -a\right] = 1 - a$, thus citizens calculate that

$$E[W^I_{E+1}|\eta_{E-1}, H_E] = E[w^I_{E+1}| - a, -a] + \frac{1}{1+i}W^0 < w^0 + \frac{1}{1+i}W^0,$$

thus $w_C < w_B$. Citizens do not confirms the incumbent.

Case 2: $\eta_{E-1} = a$. The incumbent can signal both $p_E = p_A$ providing H_A, or p_B providing H_B.

Case 2a: If the incumbent provides H_A, it signals that $\eta_E = a$, hence $\mathbb{E}\left[\frac{1}{p_{E+1}}|\eta_E = a\right] = 1 + a$, thus citizens calculate that

$$E[W^I_{E+1}|\eta_{E-1}, H_E] = E[w^I_{E+1}|a, a] + \frac{1}{1+i}W^0 > w^0 + \frac{1}{1+i}W^0,$$

thus $w_A > w_B$. Citizens confirm the incumbent.

Case 2b: If the incumbent provides H_B, it signals that $\eta_E = -a$, hence $\mathbb{E}\left[\frac{1}{p_{E+1}}|\eta_E = -a\right] = 1 - a$, thus citizens calculate that

$$E[W^I_{E+1}|\eta_{E-1}, H_E] = E[w^I_{E+1}| - a, -a] + \frac{1}{1+i}W^O < w^O + \frac{1}{1+i}W^O,$$

thus $w_C < w_B$. Citizens do not confirm the incumbent.

Proof of Proposition 6. Regional incumbents can signal the true price or not. Let us define w^F_A and $w^F_B$the case that the provision of H^F_A and H^F_B signals a false price. As we demonstrate signaling a false price leads to $w_\tau < w^F_\tau$.

The regional incumbent benefits from signaling a false price if

$$w^F_{E+1} + P_{E+1}(H^F_E)X_{E+1} > \max\left[w^O, w_{E+1} + P_{E+1}(H_E)X_{E+1}\right].$$

Case $\eta_E = a$*:* signaling a false price leads to $P_{E+1}(H^F_E) = 0$, while signaling a true price leads to $P_{E+1}(H^F_E) = 1$. When $\eta_E = a$, regional incumbent always signals the true price in order to be re-elected.

Case $\eta_E = -a$*:* signaling a false price leads to $P_{E+1}(H^F_E) = 1$, while signaling a true price leads to $P_{E+1}(H^F_E) = 0$. When $\eta_E = -a$, regional incumbent signals a false price in order to be re-elected if

$$X_{E+1} > \max\left[w_{E+1} - w^F_{E+1}, w^O - w^F_{E+1}\right].$$

If $\eta_{\tau-1} = -a$, then $w_{E+1} = w_C$ and $w^F_{E+1} = w^F_B < w^C < w_B$. If $\eta_{\tau-1} = a$, then $w_{E+1} = w_B$ and $w^F_{E+1} = w^F_A < w_B$. That proves the proposition 6.

Appendix B. Robustness check

Table 6 presents the correlation matrix.

The reaction function of the central government To demonstrate that the central government operates under a single regime, we need to estimate a structural form able to explicitly consider the two different regimes, testing the null hypothesis that there are no distinct regimes. Such null hypothesis is accepted (p value 0.804).[41]

In Table 7, we present the relevant parameters of two stage estimations calculated with different sets of instruments for L based on the theoretical suggestions,[42] but not using the complete reduced

[41] The test is done without correction for heteroskedasticity, since imposing at the same time a high number of restrictions and robust estimation leads to the impossibility of estimating the restricted model because of singularity of the matrix of constraints corrected by variance and covariance matrix.

[42] The complete estimation is available from authors.

Table 8
Parsimonious models: structural instruments.

Dependent variable L Standard errors clustered by 15 values of REG Instruments: POP, $POP \cdot ELER$, $Ratio65$, $Ratio65 \cdot ELER$				
	(1)	(2)	(3)	(4)
const	0.9101***	0.8845***	1.069***	1.072***
	(0.06193)	(0.05316)	(0.04936)	(0.04994)
ELER	0.01208	0.1139***	0.1076***	0.1081***
	(0.1742)	(0.01114)	(0.01186)	(0.01555)
t	−0.02759*	−0.02821*	−0.03425*	−0.03488*
	(0.01588)	(0.01699)	(0.01998)	(0.02044)
$t \cdot ELER$	−0.008539**	−0.005709***	−0.005337***	−0.007800**
	(0.004029)	(0.001935)	(0.001777)	(0.003589)
p_{-1}	0.1104	0.1269	0.1576	0.1491
	(0.08214)	(0.09052)	(0.1026)	(0.1030)
$p_{-1} \cdot ELER$	0.07967			0.07114
	(0.05447)			(0.05095)
p/p_{-1}	0.1327***	0.1567***		
	(0.03473)	(0.03718)		
$p/p_{-1} \cdot ELER$	0.09538			
	(0.1613)			
Tax autonomy	−0.0002641	−0.0002772*	−0.0004155**	−0.0003796*
	(0.0001753)	(0.0001624)	(0.0001861)	(0.0001951)
Tax autonomy·$ELER$	−0.003067***	−0.002907***	−0.002775***	−0.002937***
	(0.0004285)	(0.0003546)	(0.0003822)	(0.0004770)
D1999	−0.05520***	−0.05426***	−0.04897***	−0.04797**
	(0.02014)	(0.01833)	(0.01881)	(0.01872)
RPLAN	−0.02124	−0.02026	−0.03044	−0.02993
	(0.01946)	(0.01989)	(0.01991)	(0.01979)
GDP_PC	2.074	1.977	1.700	1.553
	(1.277)	(1.401)	(1.632)	(1.613)
DAligning_1	0.01545*	0.01621*	0.01878**	0.01913**
	(0.008488)	(0.008542)	(0.009432)	(0.009613)
DAligning_2	0.01039*	0.01055*	0.01192**	0.01211**
	(0.005921)	(0.006150)	(0.005856)	(0.005598)
Regional FE	YES***	YES***	YES***	YES***
n	570	570	570	570
$\bar{R}^2$	0.2692	0.2711	0.2296	0.2243
Hausman p-value	0.161	0.105	0.061	0.076
Sargan p-value	0.560	0.861	0.897	0.746
Weak instr.	7.489	7.456	7.6466	7.454

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.

Table 9
Parsimonious models: lagged instruments.

Dependent variable L Standard errors clustered by 15 values of REG Instruments: t_{-1}, $t_{-1} \cdot ELER$				
	(1)	(2)	(3)	(4)
const	0.8229***	0.8126***	0.9923***	0.9922***
	(0.04063)	(0.04840)	(0.02448)	(0.02445)
ELER	0.05542	0.1068***	0.1034***	0.1023***
	(0.1569)	(0.009988)	(0.01012)	(0.01109)
t	−0.005707**	−0.005648**	−0.007734***	−0.007743***
	(0.002845)	(0.002815)	(0.002890)	(0.002905)
$t \cdot ELER$	−0.002336**	−0.003160***	−0.002954***	−0.002356**
	(0.001159)	(0.0006367)	(0.0005858)	(0.001072)
p_{-1}	0.007207	0.004090	0.01413	0.01617
	(0.01384)	(0.01326)	(0.01370)	(0.01449)
$p_{-1} \cdot ELER$	−0.01844			−0.01319
	(0.01888)			(0.01805)
p/p_{-1}	0.1540***	0.1635***		
	(0.03170)	(0.03910)		
$p/p_{-1} \cdot ELER$	0.04600			
	(0.1456)			
Tax autonomy·$ELER$	−0.002896***	−0.002972***	−0.002890***	−0.002849***
	(0.0004059)	(0.0003686)	(0.0003866)	(0.0004144)
D1999	−0.06512***	−0.06412***	−0.06024***	−0.06041***
	(0.02271)	(0.02113)	(0.02157)	(0.02158)
RPLAN	−0.03280	−0.03260	−0.04565**	−0.04567**
	(0.02068)	(0.02071)	(0.02034)	(0.02034)
GDP_PC	4.656***	4.588***	4.771***	4.788***
	(1.522)	(1.476)	(1.572)	(1.567)
DAligning_1	0.01121*	0.01177*	0.01375**	0.01368**
	(0.006415)	(0.006275)	(0.006732)	(0.006756)
DAligning_2	0.007221	0.007311	0.008089	0.008082
	(0.006533)	(0.006386)	(0.005932)	(0.005971)
Regional FE	YES***	YES***	YES***	YES***
n	570	570	570	570
$\bar{R}^2$	0.3110	0.3133	0.2899	0.2884
ℓ	3071	3165	3183	3105
Hausman p-value	0.00322	0.0087	0.03501	0.02025
Weak instr.	738.684	751.936	731.804	722.25

Standard errors in parentheses: * significant at the 10 percent level, ** significant at the 5 percent level, *** significant at the 1 percent level.

(*continued on next page*)

form of Table 2, we obtain the outcomes shown in the table below.[43] Results are always consistent with the theoretical model. Furthermore, Hausman's test confirms that OLSs are consistent when we consider the *Tax autonomy* (alone and interacted with *ELER*) among the instruments.

The reaction function of regional government As a robustness check we estimate a more parsimonious model, in which the regime change is considered only on the parameter associated to the variables considered in our propositions, namely on t, p_{-1}, p/p_{-1}, $Tax\ autonomy$. In Table 8, we consider the same instruments we use in the main text. In the Table 9 we use the lagged values of t and its interaction with $ELER$ as instruments.

Both Tables 8 and 9 confirm that there is a regime change in the electoral time, when the incentive to make deficit increases. Moreover, the slope of the reaction function is negative with respect to t and it becomes steeper during electoral time. The increase in price is positive with regard to deficit.

[43] Using a restricted number of instruments and regressors reduces the effect of collinearity problem.

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