Public Healthcare Expenditure and Ageing: A Macroeconomic Analysis of Short- and Long-Run Dynamics for the Italian regions

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Abstract

We study the drivers of regional-level public healthcare expenditure (HCE) in Italy, focusing on ageing. After analysing the time-series properties of HCE, we estimate an Error Correction Model to disentangle the short- from the long-run effects of ageing on HCE. We find that an ageing population puts upward pressure on the long-term levels of HCE as the share of individuals aged between 65 and 85 years increases; conversely, the share of individuals aged 85 years or older does not impact HCE. In contrast, political economy factors (the proximity to the following regional government election) significantly affect expenditure in the short run. Consistently with this finding, we show that the share of votes to centre-left coalitions – which traditionally propose platforms characterized by higher levels of public social expenditures than other coalitions – increases with the share of the elderly. Hence, analysis of HCE should also account for the role of the elderly as voters and not only as consumers of services.

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1 Introduction

During the last decades, clear upward trends characterized both public healthcare spending (HCE, hereafter) and the share of the elderly across Western high-income countries. As the elderly consume, on average, more healthcare services than the young, a naive argument brings to the conclusion that the upward trend of HCE is mainly determined by the increasing share of the elderly in Western countries populations.

In this paper, we aim to discuss the role of ageing as a driver of public HCE, exploiting the decentralized governance of the Italian NHS and the large variation in the share of the elderly across regions. Our empirical analysis is based on an Error Correction Model applied to a balanced panel of the twenty Regional Healthcare Services (RHSs) observed at a yearly frequency over the period 1997-2018. Besides the population share of the elderly and (future) mortality rates for cancer and cardiovascular diseases, we consider supply-side and political economy factors as potential drivers of per-capita public HCE. To better understand the politics of HCE, we also inspect whether population ageing affects voting, particularly the support received by left-wing parties that traditionally propose higher levels of social spending, including HCE, than right-wing ones. More pressure from elderly voters might be a further channel of HCE growth.

Considering population ageing and constrained public finances, Italy is a significant case study. As for ageing, among Western high-income countries, Italy is currently characterized by one of the highest population shares of the elderly, defined either as the share of individuals above 55, 65 or 85 years old and it is projected to have the highest median age in 2050 (Eurostat, 2020). Concerning public finances, Italy has the second-highest debt-to-GDP ratio in the EU, which makes public finance constraints important for the projected increase in HCE.

The easy argument that HCE is mainly driven by population ageing has been challenged in several directions by a large literature. First, population ageing is the effect of an increase in expected longevity coupled with a decrease in fertility rates, but longevity *per se* does not need to influence spending. What drives spending is morbidity, but the relation between longevity and morbidity is not yet clear. There are mainly three theories: extension (Gruenberg, 1977; Olshansky et al., 1991), compression (Fries, 1980, 2005) or postponement of morbidity (Payne et al., 2007). According to the "extension (compression) of the morbidity" hypothesis, an increase in longevity leads to an increase (decrease) of the period lived with morbidity or disability. The "postponement of morbidity" hypothesis assumes, instead, that a one-year increase in longevity leads to a one-year increase in the period lived in good health, leaving the period lived with morbidity or disability unchanged. The three hypotheses have different implications regarding per-capita HCE: only extension and postponement (compression) of morbidity would imply

an increase (decrease). The empirical literature has shown mixed evidence. Studies based on US data provide findings in line either with the expansion of morbidity hypothesis (Payne, 2022), or with the morbidity compression hypothesis (Manton et al., 2008). There is evidence in favour of compression of morbidity in France (Dormont et al., 2006) and in Italy (Pastore et al., 2023). Hence, it is unclear whether extended longevity will increase or decrease per-capita HCE.[1]

Secondly, a stream of literature supports the idea that population ageing is a "red herring" for HCE. In their seminal contribution, Zweifel et al. (1999) analyze Swiss data for a large sample of patients older than 65 with a remaining lifetime of fewer than two years and find a statistically significant effect of the remaining lifetime on HCE, but no significant effect for their age. They argue that the actual driver of expenditure is "time-to-death", not age *per se* and that the relation that emerges at an aggregate level between age and per-capita HCE is the result of a spurious correlation since, on average, older cohorts have a higher share of individuals in last years of their life than younger cohorts. The authors also find a statistically significant role for age, after controlling for the remaining lifetime, once focusing on patients younger than 65 years old, arguing that *ceteris paribus* relatively younger patients are treated more aggressively than older patients for a given pathology since potential benefits (in terms of the value of life years gained) are higher. A similar point on the role of age has been made by a recent study that compares decedents and survivors with similar initial prognoses using Israeli data for oncological patients (Zeltzer et al., 2023). They find that higher spending for decedents is driven by inpatient spending, particularly for low-intensity admissions, and that spending for decedents decreases with age. More generally, a growing stream of literature discusses the role of ageing and the "red herring" hypothesis, with mixed results. Some papers stress the role of age over "time-to-death" (Seshamani and Gray, 2004; Breyer et al., 2010; Yang et al., 2003; De Nardi et al., 2016). Other contributions are, instead, in favour of the time-to-death hypothesis (Palangkaraya and Yong, 2009; Riley and Lubitz, 2010; Einav et al., 2018; Bekelman et al., 2016; French et al., 2017; Zweifel et al., 2004).

Besides demographic factors, other variables can affect HCE (Gerdtham and Jönsson, 2000). For example, technological progress, except cost-reducing innovations, usually inflates HCE (Cahan et al., 2020). Healthcare is also a labour-intensive sector where productivity grows slowly compared with most sectors, leading to Baumol's cost disease (Baumol, 1993) that - ceteris paribus - causes the growth of the incidence of HCE on GDP over time. Economic growth affects HCE, too: the elasticity of per-capita HCE to per-

[1]Some studies that focus either on cross-section or time-series data (Crivelli et al., 2006; Di Matteo, 2005; Murthy and Okunade, 2016) highlight the existence of a relation between the share of the elderly and per-capita HCE in a given region.

capita income is estimated to be positive and at least unitary elastic (Ke et al., 2011), with some studies pointing to an elasticity strictly larger than one (Baltagi et al., 2017). But political economy factors are also relevant (Costa-Font et al., 2020, 2023), especially for countries where HCE is mainly publicly financed. First, self-interested voters and politicians make decisions that maximise their private benefit. Since each voter will select candidates whose programs are the closest to one's own preferences, voters' preferences influence government policies and political proposals of different parties in democracies. As far as the majority of voters are individuals with below-average income or greater-than-average healthcare needs, voters ask to "expand healthcare beyond private levels" (Congleton, 2023). Such preferences press political incumbents to increase HCE. Hence, political incumbents may decide to increase the level and the allocation of resources to public healthcare to increase the likelihood of re-election. This is particularly true when healthcare governance is decentralized and political power is closer to citizens (Costa-Font et al., 2020). Second, from a theoretical point of view, decentralization is also an important driver of spending: decentralized systems are more efficient than unitary ones, experience a lower degree of rent-seeking, and stimulate innovation to a greater extent (Congleton, 2023). Empirical papers on the decentralized Italian NHS corroborate the theoretical point on efficiency (Bordignon and Turati, 2009; Francese et al., 2014; Piacenza and Turati, 2014; Cavalieri and Ferrante, 2016). However, these efficiency arguments can be threatened by soft budget constraint (SBC) problems: if regional governments expect a bailout from the central government, they may inefficiently increase spending (e.g., Bordignon and Turati, 2009). SBC problems can be particularly severe when spending decentralization is not aligned with fiscal decentralization. The issue of soft budget constraints and bailout expectations have also been studied for other countries different from Italy (e.g., Ferrario et al., 2023). Ageing can produce additional effects on spending also via political economy variables: an elderly population is likely to vote differently than a younger population, and these differences can be affected by the decentralization of spending and tax responsibilities.

This paper provides three contributions, bridging the literature on the impact of longevity and ageing on HCE with the political economy of health and healthcare. First, we add to the literature that debates the effects of longevity and ageing on HCE. Following previous studies (Jensen, 2011; Herwartz and Theilen, 2014; Abbott and Jones, 2021; Theilen, 2023), we first perform appropriate panel unit root and cointegration tests to detect the presence of a cointegrating relation among HCE, macroeconomic variables and demographic variables.[2] We then employ an Error Correction Model

[2]Evidence of a cointegrating relation can also be found in earlier studies (Hansen and King, 1996; O'Connell, 1996; Blomqvist and Carter, 1997; McCoskey and Selden, 1998; Gerdtham and Jönsson, 2000).

(ECM) to separate the short- and long-run effects of the variables of interest on HCE. The presence of non-stationarity, if not appropriately accounted for, may lead to estimate a spurious relationship between the share of the elderly and per-capita HCE. We contribute to this literature by showing that an ageing population puts upward pressure only on the long-term value of HCE, while short-run movements in HCE are not directly affected by ageing. In particular, the long-term value of HCE increases when the share of individuals between 65 and 85 years old (the "elderly") increases; conversely, the population share of "very elderly", defined as those older than 85 years, has no impact on HCE.

Second, we add to the literature on the time-to-death hypothesis (Zweifel et al., 1999). This literature provides mixed findings. We show that the sign of the impact of future mortality depends on the cause of mortality, which is prevalent in different groups of patients in terms of age. On the one hand, we find that the lead value of cancer mortality increases the long-term value of HCE. On the other hand, the lead value of mortality for cardiovascular diseases decreases HCE in both the short- and the long-run. One possible explanation is related to the different treatments provided to the two types of patients.

Third, we also add to the literature on the political economy of health and healthcare. We contribute with two findings to this literature: first, we show that regional HCE increases as the regional government election approaches, leading, *ceteris paribus*, to almost a one percentage point increase in the yearly growth rate of HCE between the beginning and the end of the term of office. Previously, country-level studies found an increase in HCE of around one percentage point before elections (Potrafke, 2010; Herwartz and Theilen, 2014) and analysis at the municipality level in Japan found that, in election years, incumbent mayors increase the number of physicians in hospitals by one percentage point (Takaku and Bessho, 2018). Secondly, looking at the results of regional elections at the municipality level, we show that the share of votes going to centre-left coalitions, which traditionally propose platforms characterised by higher levels of public healthcare and social expenditure than other coalitions, increases with the population share of the elderly. The intuition is that, as the aged patient-citizen prefers higher public spending, population ageing might put pressure on political parties to increase HCE.

The rest of the paper is organized as follows: Section 2 summarizes the institutional background of the Italian NHS. Section 3 presents the data. Section 4 displays the empirical strategy and discusses the results for spending; Section 5 focuses on voting. Finally, Section 6 concludes.

2 Institutional background

The Italian NHS was established in 1978. It is based on the principles of universal coverage, social financing via general taxation, and nondiscriminatory access to healthcare services. In terms of governance, according to the 2001 reformed Constitution, healthcare is a joint competence of the central government and of sub-national (regional) governments. The central government is responsible for defining *i*) the minimum levels of care (the so-called *Livelli Essenziali di Assistenza*) that have to be provided in the whole country and have to be satisfied in each single Regional Health System (RHS), and *ii*) the level and the allocation of funding to the different RHSs; this allocation is proportional to the number of individuals in each Region with a correction for the differences in the age distribution of the population of the different Regions (a proxy for needs). Regional governments, in turn, are responsible for (*i*) legislating within the limits defined by the national framework legislation in order to (*ii*) organize the local supply of healthcare services within the two constraints of the minimum required level of care and the financial resources allocated.

Since 2000, the NHS funding and the criteria for the allocation to Regional Healthcare Services (RHSs) have been negotiated in three-year agreements called "Pact for health" (literally, the *Patto per la Salute*) between the central government and all regional governments. These pacts are not binding for the central government, which renegotiated the level of funding several times because of the tightness in the national budget imposed by the EU fiscal rules.

To make regional governments more accountable for their budget and solve SBC problems, the National Budget Law for 2007 introduced a Recovery Plan (*Piano di Rientro*) for regional governments in financial trouble. The Plan imposes restructuring RHS to achieve a structurally balanced budget (e.g., by closing inefficient hospitals) while contemporaneously guaranteeing the provision of essential levels of care (e.g., Bordignon et al., 2020).

3 Data

We build a balanced panel for the twenty Italian regions at yearly frequency, covering the period 1997-2018. Data for our empirical analysis come from several sources. We retrieve data on per-capita nominal public current HCE at the regional level from the dataset *Health for All* (HFA), managed by the Italian National Statistical Institute (*ISTAT*). HFA provides also regional-level data on the population share of the elderly (either older than 65 years or older than 85 years), on the mortality rate due to cancer (that is the primary cause of death among decedents younger than 70 years) and to cardiovascular diseases (that is the primary cause of death among decedents

older than 70 years), on the rate of hospital beds per 10,000 inhabitants, and on per-capita nominal GDP. We deflate HCE and GDP per capita data by applying ISTAT revaluation coefficients (the reference year is 2022). We also compute, from the population share older than 65 and the one older than 85, the population share of individuals between 65 and 85 years old. The variable "Time to election" (TTE) is equal to the number of years before the following regional election. Hence, TTE is equal to zero in the year when the regional election takes place. Furthermore, in an additional analysis, we will consider expenditures for Long-Term Care benefits, expressed in real terms per capita rather than HCE. The Istat Datawarehouse provides data on these benefits for 2012-2018.

Descriptive statistics for all the variables, descriptive plots of variables for selected Regions, and a summary of the timing of the regional elections are provided in Appendix A. The main variable, per-capita real public HCE, follows an ascending trend until the beginning of the Great Recession at the national level, then a descending trend during the Great Recession and the sovereign debt crisis, and remains approximately constant in the last years under analysis. The level has been quite heterogeneous, both from a time-series and a cross-sectional point of view, ranging from a figure of €1,220 in Sicily (1997) to €2,633 in the Aosta Valley (2008). Also, the dynamics are partially different across different RHSs; for example, after 2007, several RHSs were forced to sign a recovery plan, leading them to contain nominal HCE compared to more "virtuous" RHSs. Both the share of the "elderly" and the one of the "very elderly" present an upward trend in almost all Regions. The share of "elderly" ranges from 11.96% in Campania (1997) to 23.55% in Liguria (2006). The share of "very elderly" ranges from a minimum of 1.07% in Campania (1997) to a maximum of 5.09% in Liguria (2018). The mortality rate for cancer presents heterogeneous trends - ranging from significantly ascending to significantly descending - across the different regions. To account for the "time-to-death" hypothesis, we consider the second lead $(t+2)$ of mortality for spending in year t. The cancer mortality rate ranges from 19 per 10,000 inhabitants in Calabria (1999) to 41.2 in Sardinia (2020). The mortality rate due to cardiovascular diseases, instead, has a non-increasing trend in most Regions. The minimum is 28.64 per 10,000 inhabitants in Sardinia (2014), and the maximum is 57.75 in Liguria (2003). The hospital beds rate shows a decreasing trend, from 71.27 beds per 10,000 inhabitants in Lazio (1997) to 20.87 in Calabria (2015). Per-capita GDP, in real terms, presents limited time variation as a consequence of the very slow economic growth observed in the country in the last decades. However, cross-sectional differences are relevant, with Northern regions consistently recording a higher GDP per capita than Southern ones. The per-capita GDP ranged from €17,460 in Calabria (1997) to €47,245 in the Aosta Valley (2007).

4 Ageing and HCE

4.1 Empirical strategy

To understand which, among three different models, is the correct one to use to model HCE dynamics over time, we need to perform unit-root tests and panel cointegration tests and compute the variance inflation factor (VIF). Unit-root tests identify the order of integration of our main variables. We perform panel unit root tests based on the estimation of augmented Dickey-Fuller (ADF) regressions for each time series, either assuming cross-sectional dependence (Pesaran CIPS Pesaran, 2007) or cross-sectional independence: Levin–Lin–Chu test (Levin et al., 2002), Breitung test (Breitung, 2001), Im–Pesaran–Shin test (Im et al., 2003), and the ADF-Fisher Chi-Square and the PP-Fisher Chi-Square tests (Choi, 2001). We then perform a Panel cointegration test (Pedroni, 1999, 2004).[3]

In case of stationarity, we will adopt a simple model in levels:

$$\begin{aligned} 100\ln(HCE_{i,t}) =& \beta_0 + \beta_1 E_{i,t}^{65-85} + \beta_2 E_{i,t}^{85} + \beta_3 M_{i,t+2}^{Cancer} + \beta_4 M_{i,t+2}^{Cardio} \\ &+ \beta_5 Beds_{i,t} + \beta_6 100\ln(GDP_{i,t}) + \beta_7 TTE_{i,t} + \theta_i + \alpha_t + \epsilon_{i,t} \end{aligned} \tag{1}$$

where $HCE_{i,t}$ represents the per-capita public current HCE, in real terms, $E_{i,t}^{65-85}$ represents the population share of individuals aged between 65 and 85 years old (the "elderly"), $E_{i,t}^{85}$ represents the population share of individuals older than 85 years (the "very elderly"). $M_{i,t+2}^{Cancer}$ and $M_{i,t+2}^{Cardio}$ are the two-year lead value of mortality rates due to cancer and cardiovascular diseases, respectively: following the "time-to-death" hypothesis (Zweifel et al., 1999), we consider the second lead of mortality rates rather than the contemporaneous value since individual HCE increases in the last two years of one's life. $Beds_{i,t}$ is the rate of hospital beds per 10,000 inhabitants, $GDP_{i,t}$ is per-capita real GDP, $TTE_{i,t}$ is the number of years to the following regional government election. We include both regional (θ_i) and time (α_t) fixed effects. $\epsilon_{i,t}$ is the usual error term. Unless differently specified, all estimates assume White diagonal robust standard errors.[4]

Second, if the series are non-stationary and integrated of order one - meaning that they need to be first-differenced in order to obtain a covariance-stationary series - and not cointegrated, we will use a model in the first

[3]The Variance Inflation Factor (VIF) estimates the degree of multicollinearity among regressors in our model for the variables in levels. A value of VIF higher than five represents critical levels of multicollinearity where the coefficients are poorly estimated and the p-values are questionable.

[4]Robust standard errors provide conservative estimates. Clustered (region, period, two-way) standard errors yield even more significant results.

differences:

$$\begin{aligned} 100\Delta \ln(HCE_{i,t}) =& \beta_0 + \beta_1 \Delta E_{i,t}^{65-85} + \beta_2 \Delta E_{i,t}^{85} + \beta_3 \Delta M_{i,t+2}^{Cancer} + \\ &+ \beta_4 \Delta M_{i,t+2}^{Cardio} + \beta_5 \Delta Beds_{i,t} + \beta_6 100\Delta \ln(GDP_{i,t}) + \\ &+ \beta_7 TTE_{i,t} + \alpha_t + \epsilon_{i,t} \end{aligned} \tag{2}$$

The variables shown in Eq. 2 are the same as described above but considered in first differences rather than in levels, except for TTE. We do not include cross-sectional fixed effects in this specification because they are netted out by first differencing. The model in first differences estimates the effect of year-on-year variations in the explanatory variables on the year-on-year variation of HCE, avoiding estimating the spurious regression.

Finally, if the series are integrated of order one and cointegrated, meaning that a linear combination of the series is integrated of order zero, we will consider an Error Correction Model (ECM) to disentangle the short- and the long-run impact of the variables (e.g., Perman, 1991). The intuition is as follows: if $C_t = bY_t + \epsilon_t$, where C_t and Y_t are I(1), $\epsilon_t \sim IN(0, \sigma^2)$ and $C_t - bY_t$ is I(0), it is possible to correctly estimate $\Delta C_t = a\Delta Y_t + \lambda(C - bY)_{t-1} + \upsilon_t$, given that ΔC_t, ΔY_t and $(C - bY)_{t-1}$ are all I(0) (Perman, 1991). From this, it is possible to get to the two-stage procedure where the first stage is $C_t = \hat{b}Y_t + \hat{\epsilon}_t$ and the second one is $\Delta C_t = \hat{a}\Delta Y_t + \hat{\lambda}\hat{\epsilon}_{t-1} + \hat{\upsilon}_t$.

Hence, the first stage of the ECM consists of estimating the long-run relation with variables in levels[5]:

$$\begin{aligned} 100 \ln(HCE_{i,t}) =& \beta_{0i} + \beta_1 E_{i,t}^{65-85} + \beta_2 E_{i,t}^{85+} + \beta_3 M_{i,t+2}^{Cancer} + \\ &+ \beta_4 M_{i,t+2}^{Cardio} + \beta_5 100 \ln(GDP_{i,t}) + \beta_6 Beds_{i,t} + u_{it} \end{aligned} \tag{3}$$

The long-run regression includes cross-sectional coefficients for the constant (β_{0i}). The residual from the long-run regression Eq. (3) is then included as an error correction term (ECT) in the short-run relation, Eq. (4), that includes dependent and independent variables that are first differenced, plus TTE:

$$\begin{aligned} 100\Delta \ln(HCE_{i,t}) =& \gamma_0 + \gamma_1 \Delta E_{i,t}^{65-85} + \gamma_2 \Delta E_{i,t}^{85+} + \gamma_3 \Delta M_{i,t+2}^{Cancer} + \\ &+ \gamma_4 \Delta M_{i,t+2}^{Cardio} + \gamma_5 100\Delta \ln(GDP_{i,t}) + \gamma_6 \Delta Beds_{i,t} + \\ &+ \gamma_7 TTE_t + \gamma_8 ECT_{i,t-1} + \alpha_t + \epsilon_{it} \end{aligned} \tag{4}$$

[5]In a more general version of the model, we included among the controls also two measures of interregional mobility (i.e., the share of patients migrating to other RHS for acute hospitalization, both ordinary and day-hospital), reducing the time range of the sample to 2000-2018. Results are reported in Appendix C (see Table 16 and 17) The economic interpretation of the coefficients is substantially unaffected by the inclusion of this additional control, hence we opted for the more parsimonious version of the model.

where

$$ECT_{i,t} = \hat{u}_{i,t} = 100 \ln(HCE_{i,t}) - \hat{\beta}_{0i} - \hat{\beta}_{1i} t - \hat{\beta}_2 E_{i,t}^{65-85} - \hat{\beta}_3 E_{i,t}^{65-85} - \hat{\beta}_4 M_{i,t+2}^{Cancer} - \hat{\beta}_5 M_{i,t+2}^{Cardio} - \hat{\beta}_6 100 \ln(GDP_{i,t}) - \hat{\beta}_7 Beds_{i,t} \quad (5)$$

The intuition is as follows: the first stage looks at the long-run relation between HCE and the explanatory variables. Assuming a scenario in which (*i*) explanatory variables do not change over time[6], and (*ii*) HCE is exactly equal to the long-term steady-state value implied by the long-run relation, then there are no reasons to expect HCE to change in the following periods. Conversely, if there is any deviation from the long-term value, we expect a sequence of short-term adjustments until the long-term value is (asymptotically) reached. Therefore, γ_8 should have a value between zero and minus one since any deviation from the long-run value (the error correction term) should be followed by less-than-proportional changes in HCE of the opposite sign - e.g. if HCE is "too high" we expect negative values of ΔHCE for the following periods.

4.2 Results and discussion

The detailed results from the preliminary analysis, which aims at identifying (*i*) the order of integration of the main variables in our analysis, (*ii*) whether among integrated series there is cointegration, and (*iii*) the degree of multicollinearity among covariates using VIF, are reported in Appendix B. Panel unit root tests reveal that the relevant time series are I(1). Panel cointegration tests indicate that the considered variables are cointegrated. Estimates for VIF reveal the absence of multicollinearity issues. Hence, the "correct" model to use is the ECM described in Eq. 3 and 4.

Before describing the ECM results, Table 1 presents the estimate of the simpler model in first differences (Eq. 2). Among the covariates, two are the coefficients statistically significant. The first is relative to the share of "Elderly" (E^{65-85}), with a positive sign. An increase of one percentage point (pp hereafter) in the share of the "Elderly" in a given region leads to an average increase of 2.436 pp in the real per-capita HCE growth rate. The other significant variable is the "Time to the following regional election" (TTE), with a negative sign: each year further from the following regional election, the growth rate of HCE decreases by 0.233 pp. Put differently, given that regional governments have a statutory five-year term, there is *ceteris paribus* almost a one pp difference between HCE growth rate the

[6] TTE is not included in the long-run regression because, by construction, it cannot be constant over time; hence, there would be no economic interpretation of a coefficient multiplying a long-term value of TTE.

calendar year after an election ($TTE = 4$) and the calendar year of the following election ($TTE = 0$). The behaviour of regional governments in Italy is a clear example of political budget cycles (e.g., Costa-Font et al., 2020, Costa-Font et al., 2023), and it is in line with the results of studies run at the country level that find a 1% increase of HCE before national elections (Potrafke, 2010; Herwartz and Theilen, 2014).

Perhaps surprisingly, an increase in the share of individuals older than 85 years ("very elderly") is not associated with a higher growth rate of healthcare expenditure. There are a couple of possible explanations. First, relatively younger patients are treated more aggressively. This intuition is supported by the literature (Zeltzer et al., 2023, provides a recent example) as well as by data from the Italian Ministry of Health. The Ministry yearly report on HCE (Ministero dell'Economia e delle Finanze - RGS, 2021) shows that per-capita spending for outpatient services increases up to 77-78 years and then decreases. In this sense, the very elderly patients usually need long-term care (LTC) treatments for chronic diseases, including social services and assistance that are not accounted for in HCE, rather than "pure" healthcare services. We will focus on LTC benefits that are provided to disabled people, a kind of expenditure that falls outside HCE aggregate, in Section 4.2.1.

Table 2 and Table 3 present the estimates of the long-run (3) and the short-run (4) ECM equations, respectively. First, except for the share of the "very elderly", all covariates affect HCE long-term value. A one percentage point increase in the share of the "elderly" increases HCE by 2.134 pp, highlighting the long-term impact of ageing on HCE. Interestingly, there is a different role for the two mortality rates. On the one hand, the lead value of cancer mortality positively affects HCE. On the other hand, the coefficient on cardiovascular disease mortality is negative. This is possibly related to the different age structures between the two categories of decedents: cancer is the leading cause of death among decedents younger than 70 years, and younger patients are treated more aggressively (Zeltzer et al., 2023); conversely, cardiovascular diseases are the leading cause of death among decedents older than 70 years old, and these patients are treated less aggressively. A one percentage point increase in GDP leads to an increase of 0.828 pp in HCE, which is not far from one. Estimates of the elasticity of country-level HCE to country-level GDP are unitary or above unitary (Baltagi et al., 2017); however, as briefly explained in Section 2, budget allocation is decided at the central government level, and a one-percent increase in Regional GDP does not need to translate into a one-percent increase of the budget available to the RHS. Hence, a less-than-unitary estimate for elasticity is reasonable, especially in the presence of a tight central government budget. Finally, the coefficient on hospital bed rate is negative. This sign can be explained by a more efficient use of beds (in terms of higher occupancy rates and a better rotation of patients) where the rate is higher. To summarize, the long-term value of HCE is affected by demographic factors (ageing, mortality), supply-

Table 1: Model in first differences. Dependent variable: $100\Delta \ln(HCE_t)$

Variable	**Coef.**	**p-value**
Constant	1.865***	0.000
ΔE_t^{65-85}	2.436**	0.034
ΔE_t^{85}	-0.515	0.888
ΔM_{t+2}^{Cardio}	-0.061	0.653
ΔM_{t+2}^{Cancer}	0.148	0.477
$\Delta Beds_t$	0.078	0.300
$100\Delta \ln(GDP_t)$	-0.014	0.779
Time to regional election	-0.233*	0.083
Cross-sectional F.E.		
Period F.E.	✓	
Sample (adjusted)	1997 2018	
Periods included:	22	
Cross-sections included:	20	
Total panel (balanced) observations:	440	
Adjusted R^2	0.552	
F-test (p-value)	0.000	

Notes: $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X. White diagonal standard errors.

side factors (hospital beds), and the amount of available resources (GDP).

The story, in the short run, is remarkably different. With the possible exception of the mortality rate for cardiovascular diseases, which is (barely) significant, neither the shares of the elderly nor any other variables included in the long-run equation affect year-over-year changes in regional HCE. Short-run dynamics are significantly affected by the political economy variable (expenditure increases faster closer to regional elections) and by the deviation from the long-term value. The coefficient on TTE implies a 0.844 pp difference in HCE growth rate between the calendar year after an election ($TTE = 4$) and the calendar year of the following election ($TTE = 0$). The coefficient on the error correction term implies that if HCE in year $t-1$ was one percentage point higher (lower) than its long-term value, *ceteris paribus* then HCE growth rate in year t will be 0.213 pp lower (higher).

Put differently, the long-run relation emphasizes that the ageing process dynamics affect the demand for services and hence HCE. However, policy-makers' year-over-year decisions are not directly affected by these dynamics.

Table 2: ECM: Long-run relationship. Dependent variable: $100\ln(HCE_t)$

Variable	**Coef.**	**p-value**
E_t^{65-85}	2.134***	0.006
E_t^{85}	0.467	0.737
M_{t+2}^{Cardio}	-1.397***	0.000
M_{t+2}^{Cancer}	1.225***	0.002
$Beds_t$	-0.439***	0.000
$100\ln(GDP_t)$	0.828***	0.000
Cross-sectional F.E.	✓	
Period F.E.		
Sample (adjusted)	1997 2018	
Periods included:	22	
Cross-sections included:	20	
Total panel (balanced) observations:	440	
Adjusted R^2	0.742	
F-test	0.000	

Notes: $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. $Beds$ is the rate of hospital beds per 10,000 inhabitants. $ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X.

The closer to the elections, the more HCE will grow in response to the pressure of the "patient citizen" to increase the probability of the incumbents' re-election. HCE also slowly adjusts to the dynamics of its long-term value, but no significant effects of short-run changes in demand variables are appreciable.

Considering *Health for all* data, HCE can also be decomposed into different items, from spending relative to services directly supplied by public hospitals to pharmaceutical spending, from spending for primary care to spending for services produced by private providers. An analysis of each item points out that the item that is sensitive to the proximity to elections is the one related to directly supplied services. The results of the ECM that focuses on this expenditure item are reported in Appendix C (Table 18 and Table 19).[7] This is also the most relevant item, as it was worth approximately 60% of total public HCE over the considered period.

[7]For the other items, TTE is not a significant regressor. These (insignificant) results are omitted to save space, but available upon request

Table 3: ECM: Short-run relationship. Dependent variable: $100\Delta \ln(HCE_t)$

Variable	**Coef.**	**p-value**
Constant	1.442***	0.001
ΔE_t^{65-85}	1.584	0.169
ΔE_t^{85}	0.991	0.790
ΔM_{t+2}^{Cardio}	-0.215*	0.096
ΔM_{t+2}^{Cancer}	0.202	0.289
$\Delta Beds_t$	-0.012	0.874
$100\Delta \ln(GDP_t)$	0.076	0.284
TTE_t	-0.211*	0.077
ECT_{t-1}	-0.213***	0.000
Cross-sectional F.E.		
Period F.E.	✓	
Sample (adjusted)	1998 2018	
Periods included:	21	
Cross-sections included:	20	
Total panel (balanced) observations:	420	
Adjusted R^2	0.615	
F-test (p-value)	0.000	

Notes: $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X. White diagonal standard errors.

4.2.1 Spending for LTC benefits

We account for the possibility that the insignificant coefficient for the "very elderly" in Section 4 is because statistical measures of HCE do not include spending for long-term care (LTC). The prevalence of chronic diseases and disability among the "very elderly" may affect the expenditure for long-term care (de Meijer et al., 2011; de Meijer et al., 2013) that, in statistical terms, largely falls outside expenditure strictly related to healthcare services.

It is complex to precisely measure and compare LTC spending across countries, given that it involves a wide range of both healthcare services and social services, which are provided both formally and informally (Di Novi, ming). The consensus view is that public assistance for LTC is insufficient in most European countries, leading to residual demand that is unmet by both formal and informal care (Carrino et al., 2018). Italy has a relatively low level of public expenditure for LTC if compared with the other OECD

countries (OECD, 2023); the low public expenditure prevents low-income individuals from accessing formal care, forcing them to rely on informal care only (Carrieri et al., 2017). In turn, the possibility of benefiting from informal care is affected by the demographic transition that sees an increase in the elderly dependency rate and the female employment rate. Therefore, inequality in access to - formal or informal - LTC services is doomed to increase in the absence of a policy intervention in the following years. In this sense, there is a large stream of literature discussing the impact of population ageing on the demand for LTC services (Breyer et al., 2010; Costa-Font et al., 2008; Costa-Font, 2010, among others). Some works specifically focus on LTC spending in Italy (Gabriele and Tediosi, 2014; Arlotti et al., 2021; Marenzi et al., 2023, among others).

To complement the analysis on HCE, we consider an ECM for spending on per-capita LTC benefits (in Italian, *Indennità di accompagnamento*). LTC benefits are not means-tested and are provided to disabled people who require continuous help to conduct daily activities. Even though this benefit is not formally limited to elderly people (but also to young disabled), the benefits mainly accrue to old-age individuals.

Data on LTC benefits expenditure (LTCE) at the regional level is limited to 2012-2018, a shorter period than the one considered for HCE. The ECM is described by Eq. (6) and (7), that are equal to Eq. (3) and (4) except for the dependent variable, that is LTCE rather than HCE, and for an alternative supply-side variable, that is the residential beds rate ($ResidentialBeds$) rather than ordinary hospital beds rate ($Beds$) originally considered in the analysis for HCE:

$$\begin{aligned} 100\ln(LTCE_{i,t}) = \beta_{0i} + \beta_1 E_{i,t}^{65-85} + \beta_2 E_{i,t}^{85+} + \beta_3 M_{i,t+2}^{Cancer} + \beta_4 M_{i,t+2}^{Cardio} + \\ + \beta_5 100\ln(GDP_{i,t}) + \beta_6 Beds_{i,t} + \\ + \beta_7 ResidentialBeds_{i,t} + u_{it} \end{aligned} \tag{6}$$

$$\begin{aligned} 100\Delta\ln(LTCE_{i,t}) = \gamma_0 + \gamma_1 \Delta E_{i,t}^{65-85} + \gamma_2 \Delta E_{i,t}^{85+} + \gamma_3 \Delta M_{i,t+2}^{Cardio} + \\ \gamma_4 \Delta M_{i,t+2}^{Cancer} + \gamma_5 100\Delta\ln(GDP_{i,t}) + \gamma_6 \Delta Beds_{i,t} + \\ + \gamma_7 \Delta ResidentialBeds_{i,t} + \gamma_8 TTE_t + \\ + \gamma_9 ECT_{i,t-1} + \alpha_t + \epsilon_{it} \end{aligned} \tag{7}$$

where $ECT_{i,t-1}$ in Eq. (7) is the residual from Eq. (6).

Table 4 reports the estimates for the long-run relationship, presenting both the specification with ordinary beds (Model 1) and the one with residential beds (Model 2). In the second specification, four covariates result to be statistically significant (the share of the "elderly", the share of the "very

Table 4: ECM for LTC benefits expenditure: Long-run relationship. Dependent variable: $100 \ln(LTCE_t)$

	(1)		(2)	
Variable	**Coef.**	**p-value**	**Coef.**	**p-value**
E_t^{65-85}	2.702	0.201	3.634*	0.075
E_t^{85}	6.678*	0.097	7.552*	0.050
M_{t+2}^{Cardio}	0.051	0.814	-0.055	0.802
M_{t+2}^{Cancer}	0.743**	0.036	0.647**	0.048
$Beds_t$	-0.019	0.950		
$ResidentialBeds_t$			-0.013	0.101
$100 \ln(GDP_t)$	0.594***	0.000	0.590***	0.000
Cross-sectional F.E.	✓		✓	
Period F.E.				
Sample (adjusted)	2012 2018		2012 2018	
Periods included:	7		7	
Cross-sections included:	20		20	
Total panel (balanced) observations:	140		140	
Adjusted R^2	0.99		0.99	

Notes: $\ln(LTCE)$ is the log of LTC benefits expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. *ResidentialBeds* is the rate of residential beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X. White diagonal standard errors.

elderly", the lead value of cancer mortality, and per-capita GDP), all positively affecting LTCE. A one percentage point increase in the share of Over85 leads to a 7.552 pp increase in LTCE. The intuition is in line with the point made in Section 4.2: on the one hand, the share of the "very elderly" does not impact HCE. On the other hand, over 85 individuals inflate expenditure for other programs through which they receive assistance, whose expenditure is captured in a different aggregate (namely, LTC benefits).

Table 5 shows that the short-term changes in LTCE are affected by the lead value of cancer mortality and per-capita GDP, plus the error correction term. We find no evidence of political economy effects on LTC expenditure, at least regarding regional elections. This reinforces the interpretation of our previous result: differently from HCE, decided by the choices of regional governments, LTC benefits are only marginally decided at the regional level, being the policy strongly in the hands of the Central government (e.g., Marenzi et al., 2023).

Table 5: ECM for LTC benefits expenditure: Short-run relationship. Dependent variable: $100\Delta \ln(LTCE_t)$

	(1)		(2)	
Variable	**Coef.**	**p-value**	**Coef.**	**p-value**
Constant	-0.009	0.990	0.461	0.420
ΔE_t^{65-85}	2.273	0.152	2.439	0.145
ΔE_t^{85}	4.159	0.516	2.625	0.586
ΔM_{t+2}^{Cardio}	0.078	0.599	-0.001	0.993
ΔM_{t+2}^{Cancer}	0.435**	0.015	0.391**	0.019
$\Delta Beds_t$	-0.326	0.227		
$\Delta ResidentialBeds_t$			-0.005	0.360
$100\Delta \ln(GDP_t)$	0.763***	0.000	0.801****	0.000
TTE_t	0.101	0.127	0.035	0.793
ECT_{t-1}	-0.446**	0.035	-0.459***	0.000
Cross-sectional F.E.				
Period F.E.	✓		✓	
Sample (adjusted)	2013 2018		2013 2018	
Periods included:	6		6	
Cross-sections included:	20		20	
Total panel (balanced) observations:	120		120	
Adjusted R^2	0.870		0.839	
F-test (p-value)	0.000		0.000	

Notes: $\ln(LTCE)$ is the log of LTC benefits expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. *ResidentialBeds* is the rate of residential beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X. White diagonal standard errors.

5 Voting as an explanation for the short-term dynamics of HCE

Our baseline results reveal that the variable TTE significantly explains HCE variation in the short run. For this reason, we propose an analysis to determine whether elderly voting preferences are oriented towards parties that traditionally support increases in total public social expenditure. The literature on the topic shows evidence of a positive association between shifts towards left-wing party government and increases in total public social expenditures (Sirén, 2021). The literature has emphasized that the main support base of left parties comprises the less affluent classes (Huber and Stephens, 2012; Korpi, 2020). Looking at data about pension income in Italy, it emerges that the so-called "golden pensions", over 200,000 euros per year, concern less than 27,000 or only 0.2% of pensioners. In contrast, 32.6% of pensioners have an income between 15,000 and 26,000 euros. In addition, almost a mil-

lion pensioners continue to work by supplementing their monthly allowance. At the same time, retirees spend 9 billion euros on medicines, specialist visits, and healthcare, averaging 1,190 euros per pensioner. The evidence above suggests that a large part of the elderly, at least 30%, have income below the average (around 32,000 euros in the last decade, according to ISTAT) and high healthcare expenditures, possibly driving their preferences towards left-wing parties, ideologically in favour of higher levels of HCE (e.g., Costa-Font et al., 2020).

Looking at data on the Italian NHS, we can provide preliminary evidence on whether left-wing governments are associated with increased funding to the NHS. We obtain data for healthcare funding (HF) at the national level for 2000-2019 from the Ministry of Economy and Finance. We describe the variation of HF as a percentage of GDP in relation to the political orientation of the central government. During the second and third Berlusconi governments (06/2001 to 05/2006), HF was, on average, 5.9% of GDP. In contrast, during the second Prodi government (06/2006 to 05/2008), HF was slightly higher, i.e., on average 6.3% of GDP. Then, HF reached the peak of 6.9% of GDP during the fourth Berlusconi government (06/2008 to 11/2011) and the technical government led by Mario Monti (12/2011 to 04/2013). Then HF decreased to about 6.7% of GDP during Letta's (05/2013 to 02/2014) and Renzi's (03/2014 to 12/2016) governments. HF registered similar levels until 2019, the year before the COVID-19 pandemic started, remaining around 6.7% of GDP with both Gentiloni (12/2016 to 06/2018) and Conte I (06/2018 to 09/2019) governments. Considering the evolution described above, it is possible to infer that excluding the fourth Berlusconi government, left-wing governments (Prodi II, Letta, Renzi, Gentiloni) proposed levels of HF, as a share of GDP, that are slightly higher with respect to right-wing ones (Berlusconi II, Berlusconi III).

Now, we turn to the analysis of voting behaviour in Italy. We obtained data about regional elections from 2005 to 2019 from the Italian Home Office.[8] We build a panel following over 7600 municipalities.[9]. We decided to look at regional elections mainly for two reasons: first, in the negotiation phase for NHS funding (see Section 2), regional politicians pressure the central government to obtain the greatest possible funds. Secondly, actual expenditure could be slightly higher than funding without triggering relevant sanctions, including the necessity to draft a recovery plan; this provides some scope for regional governments to arbitrarily increase spending.

We grouped parties according to the following classification: (i) centre-left coalition, (ii) centre-right coalition, (iii) 5-star movement (5SM), and

[8]See https://dait.interno.gov.it/elezioni/open-data.

[9]Over the period 2009–2019, new municipalities appeared due to the merging of small contiguous municipalities. We assigned the ISTAT identifier to the municipalities in the 2019 election. We worked backwards and regrouped municipalities according to the 2019 ISTAT code level for the previous elections

(iv) other parties. We selected this classification to distinguish between centre-left and centre-right parties. As explained above, the former proposes platforms traditionally more oriented towards expanding public social expenditures, while the latter proposes opposite programmes. We consider separately the 5SM because it does not have a precise collocation in the Italian political context. This information is merged with data about population by age obtained from ISTAT and information about income levels grouped into income brackets obtained from the Italian Ministry of Finance, which allows us to calculate average income and a measure of income inequality (i.e., the Gini index) for the municipalities in our sample.

We estimate the following regression model:

$$\begin{aligned} Votes_{mpt} =& \alpha_0 + \alpha_1 E_{mt}^{65-85} + \alpha_2 E_{mt}^{85} + \alpha_3 log(income)_{mt} + \alpha_4 Gini_index_{mt} + \\ &+ \iota_m + \omega_t + \lambda_{rt} + \epsilon_{mt} \end{aligned} \tag{8}$$

$Votes_{mpt}$ represents the share of votes obtained by candidates from coalition p (center-left, center-right, 5SM, other parties) in municipality m during year t. E_{mt}^{65-85} and E_{mt}^{85} are the same variables already described above (see Eq. 1) at the municipality level. We control for municipality (ι_m), year of election (ω_t) and region by year (λ_{rt}) fixed effects. This specification allows us to compare voting behaviours in municipalities with different percentages of elderly people within the same legislature and region. In addition, we control for the (logarithm of the) average income and the Gini index of municipality m in year t.

Results from this analysis are reported in Table 6. Columns (1), (3), (5), and (7) show the effect of the share of elderly distinguishing between those aged between 65-85 and those aged 85 or more on votes received by candidates from the centre-left, centre-right, 5SM or other parties. Columns (2), (4), (6) and (8) report the effect of replacing E_{mt}^{65-85} and E_{mt}^{85} with a single ageing variable - the share of individuals older than 65 years (E_{mt}^{65}). Looking at columns (1) and (2), we can see that the share of individuals aged 65-85 and over 85 is significantly associated with the share of votes received by centre-left candidates. The coefficients are positive, and the magnitude is relevant. An increase of 10 pp in the share of elderly aged 65-85 (over 85) years increases the share of votes to left-wing candidates by 2.2 (2.5) pp, corresponding to about 13% (15%) of the standard deviation. In addition, we find a negative association between income and the share of votes to centre-left parties and a positive association between the Gini index and the share of votes to centre-left parties. This means that municipalities with lower income and higher income inequality tend to vote more for centre-left coalitions, a result in line with expectations. On the contrary, looking at columns (3), (4) and (5), the share of individuals aged 65-85 and over 85 is significantly and negatively associated with the share of votes received by

Table 6: Share of elderly and votes to regional elections 2005-2019.

	Center-left		**Center-right**		**5SM**		**Other parties**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
E^{65-85}	0.2210***		-0.2814***		-0.0338		0.0493**	
	(0.054)		(0.070)		(0.038)		(0.021)	
E^{85}	0.2470**		0.0299		-0.1966***		0.0211	
	(0.125)		(0.153)		(0.072)		(0.040)	
E^{65}		0.2233***		-0.2534***		-0.0540		0.0465**
		(0.052)		(0.070)		(0.036)		(0.021)
Income (log)	-0.0577***	-0.0582***	0.0419	0.0364	-0.0083	-0.0058	0.0025	0.0030
	(0.020)	(0.019)	(0.029)	(0.029)	(0.012)	(0.012)	(0.009)	(0.009)
Gini index	0.9932***	0.9985***	-0.7796***	-0.7167***	-0.5611***	-0.5856***	0.0794*	0.0734*
	(0.094)	(0.091)	(0.120)	(0.116)	(0.077)	(0.077)	(0.041)	(0.040)
Constant	0.0889	0.0896	0.6699***	0.6781***	0.6375***	0.6323***	-0.0705	-0.0708
	(0.172)	(0.172)	(0.251)	(0.251)	(0.129)	(0.129)	(0.078)	(0.078)
Municipality FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	20,944	20,944	20,930	20,930	11,377	11,377	17,971	17,971
R-squared	0.86	0.86	0.82	0.82	0.92	0.92	0.59	0.59
Mean of Y	0.357	0.357	0.414	0.414	0.108	0.108	0.0251	0.0251
SD of Y	0.164	0.164	0.192	0.192	0.0739	0.0739	0.0429	0.0429

Notes: E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. Fiscal autonomy is defined as the shares of taxes on current revenues at the municipality level. White diagonal standard errors.

centre-right and 5SM candidates, respectively. We do not find a significant income effect for these two coalitions but a negative correlation with the Gini index. Finally, we see that the share of individuals aged 65-85 is significantly and positively associated with the share of votes received by other parties.

6 Conclusion

In this paper, we exploit the decentralized nature of the Italian NHS to study, through an error correction model (ECM), the role of ageing and mortality as drivers of public healthcare expenditure (HCE) at the regional level. The ECM allows for disentangling long-run and short-run effects. Our results point out that, in the long run, the value of HCE at the regional level is affected by the share of "elderly" aged between 65 and 85 years - with an ageing population in the Region leading to higher HCE - but not by the share of the "very elderly", that is individuals older than 85 years. The long-run value is also affected by the lead value of mortality (Zweifel et al., 1999), by supply-side factors (hospital beds), and by regional income (GDP). The result for the "very elderly" is driven by the fact that standard measures of HCE do not include spending on long-term care (LTC). In an ancillary analysis, we show that an increasing share of individuals older than 85 years positively impacts LTC public spending (proxied by LTC benefits that are provided to disabled people who require help to conduct daily activities), a different aggregate than HCE.

Conversely, short-term (i.e., year-over-year) changes in HCE are not affected by any factors affecting spending in the long run, except for a barely significant mortality rate for cardiovascular diseases. These short-term changes are instead affected by the distance from the long-term value (the error correction term) and, more importantly, by a political economy variable, defined as the distance in years from the following regional election. This result is explained by the pressure of the patient-citizen to expand public HCE, which leads the incumbents to increase HCE while approaching the end of the term of office to increase the probability of re-election. The intuition is corroborated by an ancillary analysis of the results of regional elections at the municipality level. We find a positive and significant relation between the share of votes going to the centre-left coalition, which traditionally proposes platforms characterised by higher social spending than other alternative coalitions, and the share of over65 in the municipality, confirming that the elderly are relatively more likely to vote for left-wing parties.

The overall conclusion is that ageing may affect HCE through two different channels: the first (widely discussed in the literature) is related to the actual needs of an aged individual, who may require higher expenditure. The second, more novel, is related to the role of the elderly as voters: as the aged patient-citizen asks for higher social spending, the different political parties

might propose higher spending to attract the votes of this increasing share of the population. This political economy channel will likely put additional pressure on public HCE, especially in the short run.

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A Descriptive statistics and summary of regional elections

Table 7: Descriptive statistics. Regional-level data, 1997-2018

	Mean	**Median**	**St. Dev.**	**Min**	**Max**
HCE (current prices)	1621.12	1716.00	333.70	779.27	2197.00
HCE (constant prices)	2036.78	2064.10	268.67	1220.34	2633.38
Cancer mortality	29.16	29.03	4.50	19.04	41.20
Cardiovascular diseases mortality	40.24	40.41	6.04	28.64	57.73
Popul. share aged 65 years or older	20.77	20.99	2.99	13.02	28.52
Popul. share 65 to 85 years old	18.07	18.20	2.30	11.95	23.55
Popul. share aged 85 years or older	2.70	2.64	0.79	1.07	5.09
Hospital beds	38.48	36.55	8.43	20.87	71.27
GDP (current prices)	24692.68	24508.30	7032.34	11149.33	42385.28
GDP (constant prices)	31329.32	32115.27	8321.35	17459.84	47245.51
Time to regional election (years)	1.95	2.00	1.39	0.00	5.00

Notes: HCE and GDP are expressed in euro per capita; population shares are expressed in percentage points; mortalities and hospital beds are expressed as rates per 10,000 inhabitants. For mortality rates, we consider the second lead, meaning that we are focusing on the period 1999-2020.

Table 8: Years of regional government election

Region	'97	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22
Abruzzo				✓					✓			✓						✓					✓			
Aosta Valley		✓					✓					✓					✓					✓		✓		
Apulia				✓					✓					✓					✓					✓		
Basilicata				✓					✓					✓			✓						✓			
Calabria				✓					✓					✓				✓						✓	✓	
Campania				✓					✓					✓					✓					✓		
Emilia-Romagna				✓					✓					✓				✓						✓		
Friuli-Venezia Giulia		✓					✓					✓					✓					✓				
Lazio				✓					✓					✓			✓					✓				
Liguria				✓					✓					✓					✓					✓		
Lombardy				✓					✓					✓			✓					✓				
Marche				✓					✓					✓					✓					✓		
Molise				✓	✓					✓					✓		✓					✓				
Piedmont				✓					✓					✓				✓					✓			
Sardinia			✓					✓					✓					✓					✓			
Sicily					✓					✓		✓				✓					✓					✓
Toscana				✓					✓					✓					✓					✓		
Trentino-South Tyrol		✓					✓					✓					✓					✓				
Umbria				✓					✓					✓					✓				✓			
Veneto				✓					✓					✓					✓					✓		

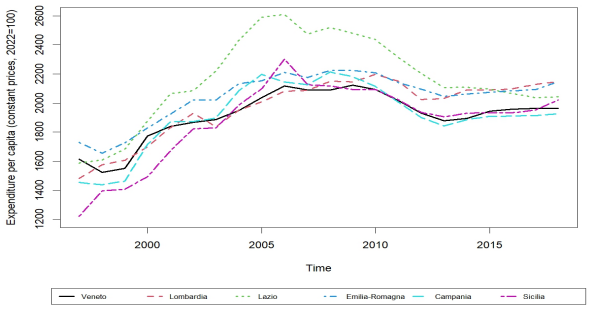


Figure 1: Real HCE for selected regions

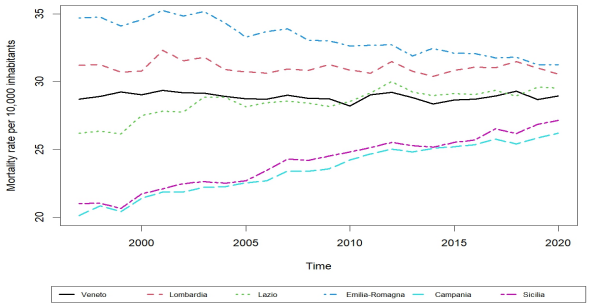


Figure 2: Cancer mortality rate for selected regions

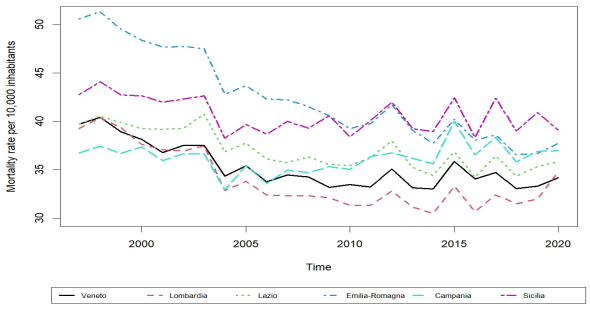


Figure 3: Cardiovascular diseases mortality rate for selected regions

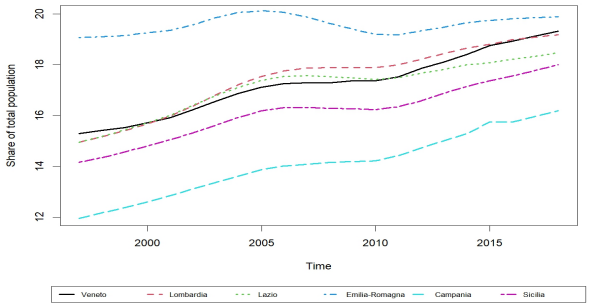


Figure 4: Population share 65 to 85 years old, for selected regions

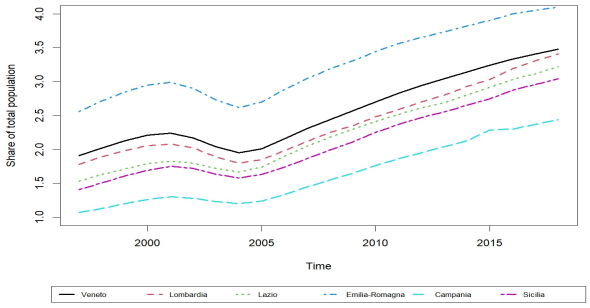


Figure 5: Population share aged 85 years or older, for selected regions

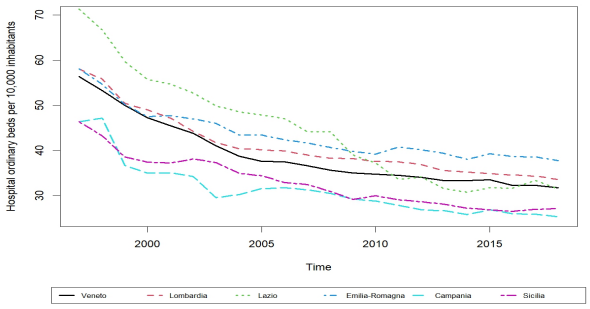


Figure 6: Hospital beds rate, for selected regions

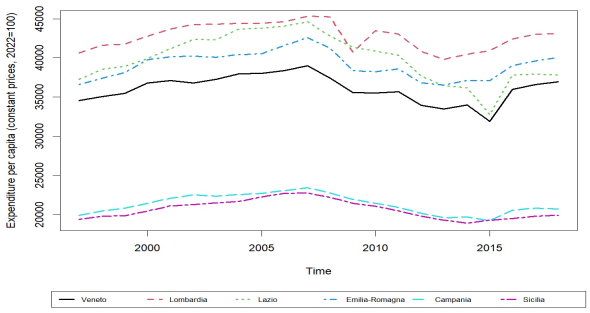


Figure 7: Real GDP for selected regions

B Preliminary analysis - panel unit root test, cointegration and variance inflation factors

Table 9: Panel unit root tests - assuming cross-sectional independence.

Variable	Levin-Lin-Chu	Breitung	Im-Pesaran-Shin	ADF - Fisher	PP - Fisher
$\ln(HCE)$	0.02	1.00	1.00	1.00	1.00
$\Delta \ln(HCE)$	0.00	0.00	0.00	0.00	0.00
E^{65-85}	0.31	0.05	0.01	0.00	1.00
ΔE^{65-85}	0.03	0.00	0.00	0.00	0.21
E^{85+}	1.00	0.02	1.00	1.00	1.00
ΔE^{85+}	0.00	0.00	0.00	0.00	0.82
M^{Cancer}	0.00	0.00	0.00	0.00	0.00
ΔM^{Cancer}	0.00	0.00	0.00	0.00	0.00
M^{Cardio}	0.00	0.64	0.39	0.06	0.00
ΔM^{Cardio}	0.00	0.00	0.00	0.00	0.00
$Beds$	0.00	1.00	0.00	0.00	0.00
$\Delta Beds$	0.00	0.00	0.00	0.00	0.00
$\ln(GDP)$	0.01	0.12	0.19	0.56	0.84
$\Delta \ln(GDP)$	0.00	0.00	0.00	0.00	0.00

Notes: We perform the following panel unit root tests based on the estimation of augmented Dickey-Fuller (ADF) regressions for each time series: Levin– Lin–Chu test (Levin et al., 2002), Breitung test (Breitung, 2001), Im–Pesaran– per 10,000 inhabitantsShin test (Im et al., 2003) and the ADF - Fisher Chi-Square and the PP - Fisher Chi-Square tests (Choi, 2001). Null hypothesis: the existence of a unit root. $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. $Beds$ is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X.

Table 10: Panel unit root tests - assuming cross-sectional dependence - expenditure and ageing variables.

Region	$\ln(HCE)$	$\Delta \ln(HCE)$	E^{65-85}	ΔE^{65-85}	E^{85+}	ΔE^{85+}
Abruzzo	≥ 0.10	< 0.01	≥ 0.1	≥ 0.1	< 0.05	≥ 0.1
Basilicata	≥ 0.10	< 0.01	≥ 0.1	≥ 0.1	< 0.10	≥ 0.1
Calabria	≥ 0.10	< 0.01	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Campania	< 0.01	< 0.01	≥ 0.1	< 0.10	< 0.10	< 0.01
Emilia-Romagna	< 0.10	< 0.05	< 0.05	< 0.10	< 0.05	< 0.10
Friuli Venezia Giulia	≥ 0.10	< 0.05	≥ 0.1	≥ 0.1	< 0.01	≥ 0.1
Lazio	< 0.10	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Liguria	≥ 0.10	≥ 0.1	≥ 0.1	< 0.05	≥ 0.1	< 0.01
Lombardia	≥ 0.10	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Marche	< 0.10	< 0.10	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Molise	< 0.05	< 0.01	≥ 0.1	≥ 0.1	≥ 0.1	< 0.05
Piemonte	< 0.01	< 0.01	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Puglia	≥ 0.10	< 0.05	≥ 0.1	≥ 0.1	≥ 0.1	< 0.01
Sardegna	≥ 0.10	< 0.05	< 0.05	≥ 0.1	≥ 0.1	< 0.05
Sicilia	≥ 0.10	≥ 0.1	< 0.10	≥ 0.1	< 0.05	< 0.10
Toscana	< 0.10	< 0.01	< 0.01	< 0.05	≥ 0.1	< 0.05
Trentino Alto Adige	≥ 0.10	0.05	< 0.05	≥ 0.1	≥ 0.1	≥ 0.1
Umbria	≥ 0.10	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1	≥ 0.1
Valle d'Aosta	< 0.10	< 0.01	≥ 0.1	< 0.10	≥ 0.1	≥ 0.1
Veneto	< 0.05	< 0.01	< 0.05	≥ 0.1	≥ 0.1	< 0.01

Notes: We perform the Pesaran CIPS (Pesaran, 2007) panel unit root test, assuming cross sectional dependence. Null hypothesis: existence of a unit root. $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. ΔX represents the first difference of variable X

Table 11: Panel unit root tests - assuming cross-sectional dependence - mortality rates

Region	M^{Cancer}	ΔM^{Cancer}	M^{Cardio}	ΔM^{Cardio}
Abruzzo	≥ 0.10	< 0.01	≥ 0.10	≥ 0.10
Basilicata	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Calabria	< 0.10	< 0.01	≥ 0.10	< 0.01
Campania	≥ 0.10	≥ 0.10	≥ 0.10	< 0.01
Emilia-Romagna	≥ 0.10	< 0.01	< 0.01	< 0.01
Friuli Venezia Giulia	< 0.10	< 0.01	< 0.05	≥ 0.10
Lazio	≥ 0.10	< 0.05	≥ 0.10	< 0.01
Liguria	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Lombardia	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Marche	< 0.05	< 0.01	< 0.10	< 0.05
Molise	< 0.05	< 0.05	≥ 0.10	< 0.01
Piemonte	≥ 0.10	< 0.01	≥ 0.10	< 0.10
Puglia	< 0.05	< 0.05	< 0.01	< 0.05
Sardegna	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Sicilia	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Toscana	< 0.05	< 0.01	≥ 0.10	< 0.01
Trentino Alto Adige	< 0.01	< 0.01	< 0.05	< 0.01
Umbria	< 0.05	< 0.10	< 0.05	< 0.01
Valle d'Aosta	< 0.05	< 0.01	≥ 0.10	< 0.01
Veneto	≥ 0.10	< 0.01	≥ 0.10	< 0.01

Notes: We perform the Pesaran CIPS (Pesaran, 2007) panel unit root test, assuming cross sectional dependence. Null hypothesis: the existence of a unit root. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. ΔX represents the first difference of variable X

Table 12: Panel unit root tests - assuming cross-sectional dependence - GDP and hospital beds.

Region	$Beds$	$\Delta Beds$	$\ln(GDP)$	$\Delta \ln(GDP)$
Abruzzo	≥ 0.10	< 0.10	< 0.10	< 0.05
Basilicata	≥ 0.10	≥ 0.10	≥ 0.10	< 0.01
Calabria	≥ 0.10	< 0.01	≥ 0.10	< 0.05
Campania	≥ 0.10	< 0.01	< 0.10	< 0.05
Emilia-Romagna	≥ 0.10	< 0.01	≥ 0.10	< 0.05
Friuli Venezia Giulia	< 0.10	≥ 0.10	≥ 0.10	< 0.05
Lazio	≥ 0.10	< 0.01	< 0.10	< 0.01
Liguria	≥ 0.10	≥ 0.10	< 0.05	≥ 0.10
Lombardia	≥ 0.10	≥ 0.10	< 0.01	< 0.01
Marche	≥ 0.10	< 0.10	< 0.05	< 0.05
Molise	≥ 0.10	≥ 0.10	≥ 0.10	< 0.05
Piemonte	< 0.05	≥ 0.10	≥ 0.10	< 0.01
Puglia	≥ 0.10	< 0.01	< 0.10	≥ 0.10
Sardegna	≥ 0.10	< 0.05	≥ 0.10	< 0.01
Sicilia	≥ 0.10	≥ 0.10	≥ 0.10	< 0.10
Toscana	≥ 0.10	< 0.01	< 0.01	≥ 0.10
Trentino Alto Adige	≥ 0.10	≥ 0.10	< 0.10	< 0.01
Umbria	≥ 0.10	< 0.01	< 0.10	≥ 0.10
Valle d'Aosta	≥ 0.10	< 0.01	≥ 0.10	< 0.01
Veneto	≥ 0.10	< 0.01	≥ 0.10	< 0.01

Notes: We perform the Pesaran CIPS (Pesaran, 2007) panel unit root test, assuming cross sectional dependence. Null hypothesis: the existence of a unit root. $Beds$ is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. ΔX represents the first difference of variable X.

Table 13: Pedroni Residual Cointegration Test with the alternative hypothesis of common AR coefficients.

Test	**Statistic**	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Statistic	-3.23	1.00	-4.46	1.00
Panel rho-Statistic	-0.72	0.24	-0.41	0.34
Panel PP-Statistic	-25.88	0.00	-28.44	0.00
Panel ADF-Statistic	-17.14	0.00	-17.09	0.00

Notes: We perform a Panel cointegration test (Pedroni, 1999, 2004). Alternative hypothesis: common AR coefficients (within-dimension). Null Hypothesis: No cointegration. Trend assumption: Deterministic intercept. Automatic lag length selection based on SIC with a max lag of 2. Newey-West automatic bandwidth selection and Bartlett kernel.

Table 14: Pedroni Residual Cointegration Test with the alternative hypothesis of individual AR coefficients.

Test	**Statistic**	**Prob.**
Group rho-Statistic	0.90	0.82
Group PP-Statistic	-47.15	0.00
Group ADF-Statistic	-19.42	0.00

Notes: We perform a Panel cointegration test (Pedroni, 1999, 2004). Alternative hypothesis: individual AR coefficients (between-dimension). Null Hypothesis: No cointegration. Trend assumption: Deterministic intercept. Automatic lag length selection based on SIC with a max lag of 2. Newey-West automatic bandwidth selection and Bartlett kernel.

Table 15: Variance inflation factor, variables in levels

Variable	**Variance**	**VIF**
E_t^{65-85}	0.596	4.147
E_t^{85+}	1.928	3.812
M_{t+2}^{Cardio}	0.052	2.245
M_{t+2}^{Cancer}	0.151	2.403
$Beds_t$	0.011	3.590
$\ln(GDP)_t$	0.010	1.627

Notes: We calculate the Variance Inflation Factor (VIF) to estimate the degree of multicollinearity among regressors in our model for the variables in levels. A value of VIF higher than five represents critical levels of multicollinearity where the coefficients are poorly estimated and the p-values are questionable.

C Robustness

Table 16: ECM: Long-run relationship. Dependent variable: $100\ln(HCE_t)$

Variable	**Coef.**	**p-value**
E_t^{65-85}	1.530**	0.048
E_t^{85}	0.212	0.865
M_{t+2}^{Cardio}	-1.188***	0.000
M_{t+2}^{Cancer}	0.785**	0.032
$Beds_t$	-0.410***	0.005
$100\ln(GDP_t)$	0.645***	0.000
$Emigr_t^{Day}$	-0.301***	0.006
$Emigr_t^{Ord}$	-0.274	0.434
Cross-sectional F.E.	✓	
Period F.E.		
Sample (adjusted)	2000 2018	
Periods included:	19	
Cross-sections included:	20	
Total panel (balanced) observations:	380	
Adjusted R^2	0.636	

Notes: $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. $Beds$ is the rate of hospital beds per 10,000 inhabitants. $ln(GDP)$ is the log of GDP, expressed per capita and in real terms. $Emigr_t^{Day}$ is the share of emigrants to other RHS for day hospital hospitalization. $Emigr_t^{Ord}$ is the share of emigrants to other RHS for ordinary hospitalization.

Table 17: ECM: Short-run relationship. Dependent variable: $100\Delta \ln(HCE_t)$

Variable	**Coef.**	**p-value**
Constant	1.336***	0.001
ΔE_t^{65-85}	1.756*	0.083
ΔE_t^{85}	0.421	0.909
ΔM_{t+2}^{Cardio}	-0.171	0.114
ΔM_{t+2}^{Cancer}	0.079	0.647
$\Delta Beds_t$	0.001	0.989
$100\Delta \ln(GDP_t)$	0.086	0.172
$\Delta Emigr_t^{Day}$	0.019	0.805
$\Delta Emigr_t^{Ord}$	-0.466*	0.067
TTE_t	-0.248**	0.037
ECT_{t-1}	-0.267***	0.000
Cross-sectional F.E.		
Period F.E.	✓	
Sample (adjusted)	2001 2018	
Periods included:	18	
Cross-sections included:	20	
Total panel (balanced) observations:	360	
Adjusted R^2	0.602	
F-test (p-value)	0.000	

Notes: $\ln(HCE)$ is the log of public healthcare expenditure, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. $Emigr_t^{Day}$ is the share of emigrants to other RHS for day hospital hospitalization. $Emigr_t^{Ord}$ is the share of emigrants to other RHS for ordinary hospitalization. ΔX represents the first difference of variable X. White diagonal standard errors.

Table 18: ECM: Long-run relationship. Dependent variable: $100\ln(HCE_t^{DirSupplServ})$

Variable	**Coef.**	**p-value**
E_t^{65-85}	2.419***	0.002
E_t^{85}	3.105**	0.026
M_{t+2}^{Cardio}	-1.608***	0.000
M_{t+2}^{Cancer}	1.368***	0.000
$Beds_t$	-0.381***	0.000
$100\ln(GDP_t)$	0.680***	0.000
Cross-sectional F.E.	✓	
Period F.E.		
Sample (adjusted)	1997 2018	
Periods included:	22	
Cross-sections included:	20	
Total panel (balanced) observations:	440	
Adjusted R^2	0.848	

Notes: $\ln(HCE^{DirSupplServ})$ is the log of public healthcare expenditure for directly supplied services, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. $ln(GDP)$ is the log of GDP, expressed per capita and in real terms. $Emigr_t^{Day}$ is the share of emigrants to other RHS for day hospital hospitalization. $Emigr_t^{Ord}$ is the share of emigrants to other RHS for ordinary hospitalization.

Table 19: ECM: Short-run relationship. Dependent variable: $100\Delta \ln(HCE_t^{DirSupplServ})$

Variable	**Coef.**	**p-value**
Constant	1.311**	0.025
ΔE_t^{65-85}	2.391	0.118
ΔE_t^{85}	3.278	0.536
ΔM_{t+2}^{Cardio}	-0.522***	0.006
ΔM_{t+2}^{Cancer}	0.419**	0.046
$\Delta Beds_t$	-0.075	0.394
$100\Delta \ln(GDP_t)$	0.142*	0.098
TTE_t	-0.330**	0.045
ECT_{t-1}	-0.322***	0.000
Cross-sectional F.E.		
Period F.E.	✓	
Sample (adjusted)	1998 2018	
Periods included:	21	
Cross-sections included:	20	
Total panel (balanced) observations:	420	
Adjusted R^2	0.499	
F-test (p-value)	0.000	

Notes: $\ln(HCE^{DirSupplServ})$ is the log of public healthcare expenditure for directly supplied services, expressed per capita and in real terms; E^{65-85} is the population share between 65 to 85 years old; E^{85+} is the population share aged 85 years or older. M^{Cancer} is the cancer mortality rate per 10,000 inhabitants. M^{Cardio} is the cardiovascular disease mortality rate per 10,000 inhabitants. *Beds* is the rate of hospital beds per 10,000 inhabitants. $\ln(GDP)$ is the log of GDP, expressed per capita and in real terms. $Emigr_t^{Day}$ is the share of emigrants to other RHS for day hospital hospitalization. $Emigr_t^{Ord}$ is the share of emigrants to other RHS for ordinary hospitalization. ΔX represents the first difference of variable X. White diagonal standard errors.