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Structural and Short-Run Determinants of Life Expectancy in the European Union: Evidence from Panel Data Analysis

Abstract. *This paper examines the determinants of life expectancy across European Union member states over the period 2014–2022, with particular emphasis on distinguishing short-run within-country dynamics from long-run structural differences across countries. Using panel data for 27 EU countries, the study employs pooled estimations, two-way fixed effects models, and a hybrid (Mundlak) specification to disentangle within-country and between-country effects. The analysis considers healthcare expenditure, healthcare system capacity, socioeconomic deprivation, demographic dynamics, and governance quality as key determinants of population health outcomes. Lagged healthcare expenditure and robust inference techniques are used to mitigate potential endogeneity and cross-sectional dependence. The results indicate that healthcare expenditure is positively associated with life expectancy in pooled and between-country estimations, but the relationship becomes statistically insignificant in within-country models once unobserved heterogeneity is controlled for. In contrast, socioeconomic deprivation emerges as a robust determinant of life expectancy both within and between countries, while governance quality and inequality mainly explain persistent cross-country differences. These findings suggest that disparities in life expectancy across the European Union are driven primarily by long-term socioeconomic and institutional factors, rather than by short-term changes in healthcare spending. The results highlight the importance of integrated health and social policies aimed at reducing socioeconomic vulnerability in order to achieve sustained improvements in population health.*

Keywords: *life expectancy, panel data analysis, healthcare expenditure, socioeconomic deprivation, governance quality, hybrid (Mundlak) models, European Union.*

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1. Introduction

Life expectancy is widely used as a synthetic indicator of population health and social welfare, reflecting not only the performance of healthcare systems but also broader socioeconomic and institutional conditions. Across the European Union, substantial disparities in life expectancy persist despite decades of policy coordination, fiscal convergence efforts, and increased public expenditure on health. These differences raise a fundamental policy question: *to what extent can governments improve population health outcomes through changes in healthcare inputs, and how much of the observed variation reflects deeper structural and institutional factors that evolve only slowly over time?*

Existing empirical literature has extensively documented a positive association between health expenditure and life expectancy in cross-country settings. However, the results are far less conclusive once the unobserved heterogeneity across countries is considered. Countries differ in historical health-system design, demographic structure, cultural attitudes toward health, and institutional quality – factors that are largely time-invariant but strongly correlated with both health spending and outcomes. Failure to control for such heterogeneity risks overstating the effectiveness of short-term policy interventions and underestimating the role of structural conditions.

This paper contributes to the literature by explicitly distinguishing between within-country and between-country determinants of life expectancy in the European Union over the period 2014-2022. Using a balanced panel of EU member states, the analysis combines two-way fixed effects and hybrid (Mundlak) panel models to disentangle the impact of changes occurring within countries over time from persistent cross-country differences. This approach allows for a more nuanced assessment of whether increases in healthcare resources and improvements in socioeconomic conditions translate into measurable gains in life expectancy in the short to medium run, or whether such gains primarily reflect long-standing structural characteristics.

In addition to healthcare inputs, the analysis incorporates indicators of socioeconomic pressure and institutional quality, recognising that health outcomes are shaped by a complex interaction between material conditions, demographic dynamics, and governance. By focusing on the European Union – a relatively homogeneous institutional setting with comparable statistical standards – the study reduces measurement bias while still capturing meaningful variation in policy choices and outcomes.

The findings have direct implications for health and social policy. If improvements in life expectancy are driven mainly by between-country differences rather than within-country changes, this would suggest that marginal increases in health expenditure may have limited short-run effects, and that broader structural and institutional reforms are necessary to achieve sustained improvements in population health. Conversely, evidence of significant within-country effects would support the effectiveness of targeted policy interventions. By clarifying these

mechanisms, the paper aims to inform both national policymakers and EU-level coordination efforts.

2. Literature review

A substantial body of empirical research has examined the relationship between healthcare expenditure and population health outcomes, with life expectancy being one of the most widely used indicators. Early cross-country studies report a positive association between public health spending and life expectancy, suggesting that greater financial resources allocated to healthcare systems improve access to medical services and contribute to reductions in mortality (Berger & Messer, 2002; Nixon & Ulmann, 2006). These effects appear particularly strong when comparing countries in different stages of economic development.

However, more recent evidence focusing on OECD and European Union member states indicates that the marginal impact of health expenditure on life expectancy diminishes as countries reach higher levels of income and baseline longevity. Panel data analyses controlling for unobserved heterogeneity show that once country fixed effects are included, the estimated effect of healthcare spending on life expectancy often weakens or becomes statistically insignificant (Costa-Font & Pons-Novell, 2007; Baltagi & Moscone, 2010). This suggests that cross-country differences in spending levels explain much of the observed correlation, while short-run increases in expenditure within a country may have limited immediate effects on longevity.

At the same time, several studies argue that the effect of healthcare expenditure on life expectancy may materialise with a delay, reflecting the time required for investments in infrastructure, workforce, and preventive care to influence mortality patterns (Bokhari, Gai, & Gottret, 2007; Moreno-Serra & Smith, 2015). This body of literature supports the use of lagged expenditure and panel techniques that distinguish between within-country and between-country variation.

Hypothesis 1 (H1). *Higher healthcare expenditure is positively associated with life expectancy.*

Beyond healthcare financing, a large and influential literature emphasises the role of socioeconomic conditions in shaping population health outcomes. The social determinants of health framework posit that material living conditions, employment security, housing quality, and access to basic resources exert a direct and powerful influence on mortality and longevity (Marmot, 2005; Marmot et al., 2008). Empirical studies consistently document a strong social gradient in life expectancy, whereby populations experiencing higher levels of deprivation exhibit worse health outcomes, even in countries with universal healthcare systems.

In the European context, comparative research shows that material deprivation is a key driver of health inequalities both within and between countries. Countries and regions with higher shares of materially deprived populations tend to record a lower life expectancy and a higher premature mortality, reflecting cumulative

exposure to health risks and barriers to effective healthcare access (Mackenbach et al., 2013; Mackenbach et al., 2015). Importantly, panel evidence suggests that reductions in deprivation over time are associated with measurable improvements in population health, indicating that socioeconomic conditions can influence life expectancy even in the medium run.

This literature provides a strong rationale for including deprivation indicators alongside healthcare variables when modelling life expectancy dynamics in advanced economies.

Hypothesis 2 (H2). *Higher levels of material deprivation are negatively associated with life expectancy.*

Closely related to material deprivation, income inequality has been widely studied as a determinant of population health outcomes. A prominent strand of literature argues that higher inequality is associated with worse health outcomes through mechanisms such as psychosocial stress, erosion of social cohesion, and underinvestment in public goods that benefit population health (Wilkinson & Pickett, 2006; Pickett & Wilkinson, 2015). Cross-national studies often find that more unequal societies exhibit lower life expectancy and higher mortality rates, even after controlling for average income levels.

While the inequality–health relationship remains contested, particularly regarding causality and measurement, recent reviews and European-focused studies provide support for a negative association between inequality and health outcomes in high-income countries (Fritzell et al., 2012; European Commission, 2020). Importantly, inequality tends to be relatively persistent over time, suggesting that its effects may operate primarily through long-term structural channels rather than short-run fluctuations.

These findings imply that inequality should be considered a key explanatory factor in cross-country analyses of life expectancy, particularly when distinguishing between structural differences and short-run dynamics.

Hypothesis 3 (H3). *Higher income inequality is negatively associated with life expectancy.*

Institutional quality and governance have increasingly been recognised as critical determinants of public-sector performance, including healthcare systems. Governance affects how resources are allocated, how services are delivered, and how effectively policies are implemented. Empirical studies demonstrate that countries with better governance and lower levels of corruption achieve superior health outcomes at comparable levels of healthcare expenditure (Gupta et al., 2000; Rajkumar & Swaroop, 2008).

Corruption can weaken the effectiveness of healthcare spending by distorting procurement processes, reducing service quality, and diverting resources away from patient care. As a result, nominal increases in health expenditure may fail to translate into improved population health in environments characterised by weak institutions (Lewis, 2006; Holmberg & Rothstein, 2011). In the European Union, governance

disparities remain pronounced, particularly between Western and Eastern member states, and are increasingly cited as contributors to persistent health inequalities.

Evidence from applied research further supports the relevance of governance and institutional quality in shaping public-sector outcomes and social welfare in Central and Eastern Europe (Nicolescu & Paun, 2018; Vătămănescu et al., 2020; Brătianu & Bejinaru, 2021; Popescu, 2022). These studies highlight how institutional trust, managerial quality, and governance practices influence the effectiveness of public policies, including those related to health and social services.

Hypothesis 4 (H4). *Better governance quality (or lower corruption) is positively associated with life expectancy.*

Taken together, these hypotheses establish a coherent empirical framework for evaluating how healthcare inputs, socioeconomic conditions, and institutional quality operate through within-country dynamics and between-country structural differences to shape life expectancy across European Union member states.

3. Model specification

This study employs panel data econometric techniques to examine the determinants of life expectancy across European Union member states over the period 2014–2022. Panel methods are particularly appropriate in this context, as they allow the analysis to exploit both the cross-sectional variation between countries and the time-series variation within countries, while controlling for unobserved heterogeneity and common time shocks. Given the slow-moving nature of life expectancy and the presence of strong structural differences across EU countries, the econometric strategy is explicitly designed to distinguish between within-country effects and between-country effects, thereby providing a more nuanced assessment of policy-relevant determinants.

3.1 Baseline pooled panel model

The empirical analysis begins with a pooled panel regression that includes year-fixed effects to control for shocks common to all countries:

$$LE_{it} = \beta X_{it} + \gamma_t + u_{it}$$

where LE_{it} denotes life expectancy at birth in country i and year t; X_{it} is a vector of time-varying explanatory variables capturing healthcare inputs, socioeconomic conditions, and institutional quality; γ_t represents year fixed effects; and u_{it} is the error term. Standard errors are clustered at the country level to account for the within-country correlation over time.

This specification provides a descriptive benchmark, but does not account for unobserved country-specific characteristics that may be correlated with both the regressors and life expectancy. As a result, coefficient estimates from the pooled model may be biased and are not interpreted as causal.

3.2 Two-way fixed effects model

To control for unobserved, time-invariant heterogeneity across countries, the analysis proceeds with a two-way fixed effects model:

$$LE_{it} = \beta X_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

where α_i denotes country fixed effects capturing factors such as historical health-system design, demographic structure, cultural attitudes toward health, and long-standing institutional arrangements. The inclusion of year fixed effects γ_t controls for EU-wide shocks and trends affecting all countries simultaneously.

This specification identifies effects exclusively from within-country variation over time. Consequently, the estimated coefficients reflect the association between changes in explanatory variables within a given country and changes in life expectancy, holding constant all time-invariant country characteristics. Given the persistence of life expectancy, estimated effects are expected to be modest in magnitude, but are more credible from a policy perspective than pooled estimates.

3.3 Hybrid (Mundlak) model: disentangling within - and between - country effects

While fixed effects models control for unobserved heterogeneity, they do not allow direct estimation of between-country effects. To explicitly separate within-country and between-country relationships, the study employs a hybrid panel model following the Mundlak (1978) approach.

Each time-varying explanatory variable is decomposed into its country-specific mean and its deviation from that mean:

$$X_{it} = (X_{it} - \bar{X}_i) + \bar{X}_i$$

Substituting this decomposition into the regression yields:

$$LE_{it} = \beta_w (X_{it} - \bar{X}_i) + \beta_b \bar{X}_i + \alpha_i + \gamma_t + \varepsilon_{it}$$

where β_w captures within-country effects, reflecting the impact of changes over time within a country, and β_b captures between-country effects, reflecting structural differences across countries.

The hybrid model combines the strengths of fixed and random effects estimators while relaxing the strict exogeneity assumption required by standard random effects models. It allows a direct comparison between short- to medium-term policy-relevant effects and long-run structural determinants of life expectancy, forming the core empirical contribution of this study.

3.4 Endogeneity considerations

A potential concern in estimating the relationship between healthcare expenditure and life expectancy is endogeneity arising from reverse causality and omitted variables. Countries may increase health spending in response to

deteriorating health outcomes, population aging, or epidemiological shocks, leading to biased estimates if contemporaneous expenditure is used.

To reduce simultaneity bias, the main specifications employ lagged healthcare expenditure as an explanatory variable. The empirical model incorporating lagged healthcare expenditure is specified as:

$$\mathrm{LE_{it}} = \beta_1 \ln(\mathrm{HCE_{i,t-1}}) + \sum_{k=2}^{K} \beta_k \mathrm{X_{kit}} + \alpha_i + \gamma_t + \varepsilon_{it}$$

where:

- LE_{it} *denotes life expectancy at birth in country* i *at time* t*;*
- $ln(HCE_{i,t-1})$ *is the natural logarithm of healthcare expenditure lagged by one period;*
- X_{kit} *represents the remaining* $K-1$ *control variables capturing healthcare capacity, socioeconomic conditions, and institutional quality;*
- α_i *denotes country fixed effects;*
- γ_t *denotes year fixed effects;*
- ε_{it} *is the idiosyncratic error term.*

The coefficient β_1 captures the semi-elasticity of life expectancy with respect to lagged healthcare expenditure. It measures the percentage change in healthcare expenditure in period $t-1$ associated with a one-unit change in life expectancy in period t, holding constant all other covariates, country-specific fixed effects, and common time shocks.

The inclusion of lagged healthcare expenditure reduces simultaneity bias by ensuring that current life expectancy is not contemporaneously determining healthcare spending, thereby strengthening the credibility of the estimated association.

The choice of a one-period lag for healthcare expenditure follows common practice in macro-panel analyses of health outcomes, where the primary objective is to mitigate simultaneity bias between health spending and health indicators (Baltagi & Moscone, 2010; Moreno-Serra & Smith, 2015). Although major healthcare investments, such as infrastructure development or preventive programmes, may influence life expectancy over longer horizons, shorter lag structures are often employed in empirical studies with limited time dimensions to preserve degrees of freedom and capture short- to medium-run policy dynamics. Therefore, the lag specification should be interpreted primarily as a strategy to reduce reverse causality, rather than as a complete representation of the long-term adjustment process linking healthcare investment and mortality outcomes.

This approach is consistent with the notion that investments in healthcare affect population health outcomes with a delay and provides a transparent and conservative strategy for addressing endogeneity. Although this does not fully eliminate all sources of endogeneity, it substantially reduces reverse causality concerns and is appropriate given the scope and objectives of the analysis.

3.5 Diagnostic tests and inference

Reliable inference in panel data models requires a careful examination of the error structure. Violations such as serial correlation, heteroskedasticity, or cross-sectional dependence can lead to underestimated standard errors and spurious statistical significance. Accordingly, the study conducts formal diagnostic tests and adopts robust inference methods.

3.5.1 Serial correlation: Wooldridge test for panel data

Serial correlation in the idiosyncratic error term is tested using the Wooldridge test for autocorrelation in panel data. The test is based on the auxiliary regression:

$$\Delta\varepsilon_{it} = \rho\Delta\varepsilon_{i,t-1} + \nu_{it}$$

where $\Delta\varepsilon_{it}$ are first-differenced residuals from the fixed effects model. The null hypothesis is:

$$H_0: \rho = 0 \text{ (no first-order serial correlation)}$$

The test statistics follows an $F(1, N-1)$ distribution. A p-value below conventional significance levels (1%, 5%, or 10%) indicates rejection of the null hypothesis and the presence of serial correlation.

3.5.2 Cross-sectional dependence: Pesaran CD test

To test for cross-sectional dependence, the Pesaran (2004) CD test is employed. The test statistics is defined as:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}$$

where $\hat{\rho}_{ij}$ denotes the pairwise correlation of residuals between countries i and j.

Under the null hypothesis of cross-sectional independence:

$$H_0: \rho_{ij} = 0, \forall i \neq j$$

the CD statistic is asymptotically distributed as a standard normal variable. Absolute values exceeding 1.96 (5% level) or 2.58 (1% level) indicate statistically significant cross-sectional dependence.

3.5.3 Robust inference: Driscoll-Kraay standard errors

Given the likelihood of serial correlation, heteroskedasticity, and cross-sectional dependence, the main regression results are reported using Driscoll-Kraay standard errors. These standard errors extend the Newey-West framework to panel data by allowing for general forms of spatial and temporal dependence in the error structure.

The Driscoll-Kraay variance-covariance matrix is given by:

$$\hat{V}_{DK} = (X'X)^{-1}\left(\sum_{k=-K}^{K} w_k \hat{\Gamma}_k\right)(X'X)^{-1}$$

where $\hat{\Gamma}_k$ denotes the estimated covariance of residuals at lag k, w_k are Bartlett kernel weights, and K is a truncation lag chosen as a function of the time dimension. Inference based on Driscoll-Kraay standard errors remains valid in the presence of cross-sectional dependence and serial correlation, provided that the time dimension is sufficiently large. The diagnostic tests indicated the presence of serial correlation and cross-sectional dependence in the panel residuals, which justifies the use of Driscoll–Kraay standard errors to ensure robust statistical inference.

Coefficient estimates that remain statistically significant under Driscoll–Kraay standard errors are interpreted as robust to the main forms of misspecification encountered in macro-panel data. The emphasis is placed on comparing within-country and between-country effects, as differences between these estimates provide insight into whether improvements in life expectancy are driven by short-run policy changes or by persistent structural characteristics.

4. Results and discussion

This study is based on an unbalanced panel dataset covering 27 European Union member states over the period 2014–2022, yielding a maximum of 243 country–year observations. The chosen time span reflects both data availability and the objective of capturing recent developments in healthcare systems, socioeconomic conditions, and institutional quality within the EU, including the impact of major common stocks such as the COVID-19 pandemic.

All data are obtained from harmonised international sources to ensure cross-country comparability. The panel structure allows the analysis to exploit both variation across countries and variation within countries over time, which is essential for identifying within-country and between-country effects as outlined in the econometric methodology.

4.1 Dependent variable

The dependent variable is life expectancy at birth (LE_{it}), measured in years. Life expectancy is widely used in the health economics and public policy literature as a comprehensive indicator of population health, reflecting cumulative mortality conditions across age groups. Its advantage lies in its broad interpretability and comparability across countries and over time.

Given its stock-like nature and strong persistence, life expectancy is expected to respond gradually to changes in healthcare inputs and socioeconomic conditions. As a result, estimated coefficients should be interpreted as medium-term associations rather than immediate effects.

4.2 Independent variables

Healthcare system capacity and resource allocation are captured through several indicators that reflect both financial and physical inputs.

The key variable of interest is healthcare expenditure (HCE_{it}), measured in real terms and expressed in natural logarithms. Logarithmic transformation reduces skewness and allows coefficient estimates to be interpreted as semi-elasticities. In the main specifications, healthcare expenditure enters the model with a one-period lag ($\ln(HCE_{i,t-1})$) to moderate simultaneity bias and reflect delayed effects of health investment on population outcomes. A positive association with life expectancy is expected.

To capture physical healthcare capacity, the analysis includes hospital beds per 1,000 inhabitants, which reflects the availability of inpatient care infrastructure. While a higher number of beds may signal greater system capacity, the expected sign is ambiguous, as excessive reliance on hospital-based care may also reflect inefficiencies in preventive and outpatient services.

Healthcare utilisation is proxied by medical consultations per capita, which captures access to and use of primary and specialist care. Higher utilisation is generally expected to be associated with improved health outcomes, although diminishing returns and cross-country differences in care-seeking behaviour may attenuate this relationship.

Socioeconomic conditions are captured through indicators reflecting material deprivation and demographic pressures, both of which are closely linked to population health outcomes.

Severe material deprivation, measured as the percentage of the population experiencing an enforced lack of basic items, is included as a proxy for socioeconomic vulnerability and inequality. Higher levels of deprivation are expected to be negatively associated with life expectancy, reflecting poorer living conditions, reduced access to healthcare, and higher exposure to health risks.

Demographic structure is proxied by the fertility rate, measured as the average number of births per woman. Fertility captures long-term demographic dynamics and is often correlated with age structure, dependency ratios, and public spending priorities. In high-income EU countries, higher fertility rates may be associated with younger populations and potentially higher life expectancy, although the direction of the relationship is ultimately an empirical question.

Institutional quality is captured through a corruption-related indicator, reflecting the broader governance environment in which healthcare and social policies are implemented. Governance quality affects the efficiency of public spending, service delivery, and trust in public institutions, all of which can influence health outcomes.

The selection of explanatory variables follows the established empirical literature on the determinants of population health and life expectancy in developed economies. Healthcare expenditure is widely used as a proxy for financial resources allocated to healthcare systems and has been extensively analysed in cross-country

studies examining health outcomes (Berger & Messer, 2002; Nixon & Ulmann, 2006; Baltagi & Moscone, 2010). Indicators of healthcare capacity, such as hospital beds and medical consultations, capture the availability and utilisation of healthcare services and are commonly included in empirical analyses of healthcare system performance (Arah et al., 2005; Rechel et al., 2013).

Socioeconomic deprivation reflects the broader social determinants of health, which have been shown to exert a strong influence on mortality and longevity through mechanisms related to living conditions, employment security, and access to resources (Marmot, 2005; Marmot et al., 2008; Mackenbach et al., 2013). Demographic variables such as fertility rates are frequently used in macro-level health studies as indicators of demographic structure and population dynamics (Preston, 1975; Bloom et al., 2004). Finally, governance indicators are included to capture institutional quality, which affects the effectiveness of public spending and the delivery of healthcare services (Gupta et al., 2000; Rajkumar & Swaroop, 2008; Holmberg & Rothstein, 2011).

Together, these variables reflect the multidimensional nature of health outcomes, incorporating healthcare inputs, socioeconomic conditions, demographic dynamics, and institutional quality.

Higher values of the corruption indicator are interpreted according to the original scale of the data source; therefore, careful attention is paid to the direction of the index to ensure correct interpretation. In general, better governance and less corruption are expected to be positively associated with life expectancy through a more effective allocation of public resources and improved service quality.

4.3 Descriptive statistics and variation

Summary statistics indicate substantial variation in life expectancy and explanatory variables in EU member states, reflecting persistent structural differences in income levels, healthcare systems, and social conditions. At the same time, within-country variation over time is more limited, particularly for life expectancy, underscoring the importance of econometric techniques that distinguish between short-run changes and long-run structural factors.

This combination of pronounced between-country variation and modest within-country variation motivates the use of fixed effects and hybrid panel models, as these approaches allow the analysis to identify which determinants are most relevant for short-term policy interventions and which reflect deeper, structural differences across countries.

Table 1 reports descriptive statistics for all variables included in the empirical analysis. The statistics are based on the balanced panel of 27 EU member states observed over the period 2014–2022.

Table 1. Descriptive statistics of the variables included in the model

Variable	Mean	Std. Dev.	Min	Max	Observations
Life expectancy at birth (years)	80.6	2.9	74.6	84.3	243
Healthcare expenditure (log, t–1)	8.62	0.51	7.45	9.55	243
Hospital beds (per 1,000 inhabitants)	5.1	1.9	2	8.1	243
Medical consultations (per capita)	6.9	2.3	2.4	13.1	243
Severe material deprivation (%)	7.8	5.9	1.2	31.4	243
Fertility rate (births per woman)	1.55	0.29	1.13	2.02	243
Governance / corruption index	62.4	11.7	38	89	243

Notes: Healthcare expenditure is expressed in natural logarithms and lagged by one period. Higher values of the governance index indicate better institutional quality.

Source: Authors' processing.

The descriptive statistics reveal substantial heterogeneity in life expectancy across EU member states. Average life expectancy in the sample is approximately 81 years, but the range spans nearly ten years between the lowest - and highest - performing countries, highlighting persistent health inequalities within the European Union. This dispersion suggests that structural differences across countries remain pronounced despite overall improvements in population health.

Healthcare expenditure also exhibits considerable cross-country variation, with logged values indicating large differences in real per capita spending levels. Countries with higher healthcare expenditure generally display higher average life expectancy, although this relationship is not uniform, suggesting that spending alone may not fully explain health outcomes. Healthcare system capacity indicators, such as hospital beds and medical consultations, also show wide variation, reflecting differences in health system organisation and care delivery models.

Socioeconomic conditions differ markedly across countries, as evidenced by the large standard deviation and the wide range of severe material deprivation. Although the average deprivation rate is below 8%, several countries record values exceeding 20%, indicating substantial pockets of social vulnerability. Importantly, deprivation also displays meaningful within-country variation over time, particularly in countries affected by economic shocks or structural reforms.

Governance quality varies significantly across the sample, with lower scores concentrated in newer EU member states and higher scores in long-established member states. This pattern reinforces the interpretation of governance as a largely structural characteristic rather than a rapidly changing policy variable.

Overall, the descriptive evidence points to strong between-country variation in life expectancy, healthcare resources, socioeconomic conditions, and institutional quality, alongside more limited but non-negligible within-country variation over time. This combination provides a strong empirical rationale for the use of fixed effects and hybrid panel models to disentangle short-run dynamics from long-run structural determinants of population health.

Based on the existing theoretical and empirical literature, healthcare expenditure and healthcare utilisation are expected to be positively associated with

life expectancy, while material deprivation is expected to have a negative association.

The effects of hospital beds and fertility are theoretically ambiguous and are therefore treated as empirical questions. Institutional quality is expected to exert a positive influence on life expectancy by enhancing the effectiveness of healthcare spending and social policies.

All variables are interpreted in conjunction with country and time fixed effects, ensuring that estimated relationships reflect deviations from country-specific long-run averages and common temporal trends.

4.4 Empirical Results

This section presents the empirical findings of the panel data analysis on the determinants of life expectancy in EU member states. The results are reported progressively, starting with pooled estimations and moving toward fixed effects and hybrid models, in order to distinguish descriptive associations from within-country dynamics and long-run structural relationships.

4.4.1 Baseline pooled panel results

Table 2 reports the results of the baseline pooled OLS estimations with year fixed effects, providing a descriptive benchmark for the association between life expectancy and healthcare, socioeconomic, and governance-related variables across EU member states.

Table 2. Pooled OLS estimates with year fixed effects

Variable	Coefficient (S.E.)
ln(HCE t−1)	1.24 *** (0.18)
Hospital beds	0.31*** (0.09)
Medical consultations	0.12** (0.05)
Severe material deprivation	-0.47*** (0.08)
Fertility rate	-0.65*** (0.22)
Corruption index	0.38*** (0.14)
Observations	243
R^2	0.34

Note: Significance levels: *** p<0.01, ** p<0.05.

Source: Authors' processing.

The pooled panel estimates indicate a strong positive association between healthcare expenditure and life expectancy across EU countries. A 1% increase in lagged healthcare expenditure is associated with an increase of approximately 1.24

years in life expectancy, suggesting a substantial correlation between spending levels and population health outcomes. Similarly, healthcare capacity indicators, such as hospital beds and medical consultations, exhibit positive and statistically significant coefficients.

Socioeconomic conditions also play an important role. Severe material deprivation is strongly and negatively associated with life expectancy, while higher fertility rates are correlated with lower life expectancy in the pooled specification. The governance indicator shows a positive and statistically significant relationship, implying that countries with better institutional quality tend to exhibit a higher life expectancy.

However, these results should be interpreted with caution. The pooled estimator does not control for unobserved country-specific characteristics, such as historical health-system design or cultural factors, which are likely correlated with both the regressors and life expectancy. As such, these estimates primarily reflect between-country differences rather than causal effects of policy changes.

4.4.2 Two-way fixed effects results

To account for unobserved, time-invariant heterogeneity across countries and isolate within-country variation over time, Table 3 presents the results of the two-way fixed effects estimations with country and year fixed effects.

Table 3. Two-way fixed effects estimates (country and year fixed effects)

Variable	Coefficient (S.E.)
ln(HCE t−1)	0.21 (0.19)
Hospital beds	0.08 (0.07)
Medical consultations	0.05 (0.04)
Severe material deprivation	-0.29** (0.11)
Fertility rate	-0.41** (0.18)
Corruption index	0.09 (0.12)
Country FE	Yes
Year FE	Yes
Observations	243
Within R^2	0.19

Note: Significance levels: ** p<0.05.

Source: Authors' processing.

Once country-specific fixed effects are introduced, the magnitude and statistical significance of several coefficients change markedly. The coefficient on healthcare expenditure becomes small and statistically insignificant, indicating that within-country increases in healthcare spending are not associated with immediate changes

in life expectancy over the period considered. Similar patterns are observed for hospital beds and medical consultations, whose coefficients lose statistical significance under the fixed effects specification.

In contrast, severe material deprivation remains negative and statistically significant, suggesting that reductions in socioeconomic vulnerability within a country are associated with improvements in life expectancy. Fertility also retains a negative and significant coefficient, reflecting demographic dynamics that affect population health outcomes even in the short to medium run.

The governance indicator loses statistical significance once country fixed effects are included, implying that its explanatory power in pooled models primarily reflects persistent cross-country differences rather than changes over time within countries.

Overall, these results suggest that short-run changes in healthcare inputs have limited explanatory power for changes in life expectancy, whereas socioeconomic conditions appear more relevant at the within-country level.

4.4.3 Hybrid (Mundlak) model results: within vs between effects

To explicitly disentangle short-run within-country effects from long-run structural differences across countries, Table 4 reports the estimates from the hybrid (Mundlak) panel model.

Table 4. Hybrid (Mundlak) panel model estimates

Variable	Within effect (S.E.)	Between effect (S.E.)
ln(HCE)	0.18 (0.17)	1.46*** (0.31)
Hospital beds	0.06 (0.05)	0.42 *** (0.14)
Medical consultations	0.04 (0.03)	0.19** (0.09)
Severe material deprivation	-0.27** (0.11)	-0.63*** (0.18)
Fertility rate	-0.38** (0.17)	-0.71*** (0.25)
Corruption index	0.07 (0.10)	0.54*** (0.16)
Country FE	Yes	
Year FE	Yes	
Observations	243	
R^2	0.36	

Note: Significance levels: *** p<0.01, ** p<0.05.

Source: Authors' processing.

The hybrid (Mundlak) model allows a direct decomposition of within-country and between-country relationships, providing additional insight into whether the observed relationships reflect short-run dynamics within countries or persistent

structural differences across countries. For healthcare expenditure, the within-country effect remains small and statistically insignificant, whereas the between-country effect is large, positive, and highly significant. This result suggests that countries with persistently higher levels of healthcare spending tend to display higher life expectancy, reflecting long-standing structural differences across health systems. However, incremental increases in healthcare spending within a country are not associated with statistically significant short-run changes in life expectancy over the period considered.

A similar pattern is observed for hospital beds and medical consultations. Structural differences in healthcare capacity across countries are strongly associated with life expectancy, while short-run changes within countries have limited explanatory power.

In contrast, severe material deprivation exhibits both significant within-country and between-country effects, underscoring its importance as a determinant of population health. Reductions in deprivation within a country are associated with improvements in life expectancy, while countries with systematically lower deprivation levels enjoy substantially higher life expectancy overall.

Institutional quality, as captured by the corruption indicator, shows a strong between-country effect, but no significant within-country effect. This suggests that governance matters primarily as a long-run structural characteristic rather than as a variable that fluctuates sufficiently over time to influence short-run health outcomes.

4.4.4 Robustness checks

Table 5 reports the results of several robustness checks designed to assess the sensitivity of the main findings to alternative specifications, including the exclusion of the COVID-19 years, the inclusion of a pandemic dummy variable, and the use of an alternative measure of healthcare expenditure. The reported statistics confirm that the core results remain stable across specifications.

Table 5. Robustness specifications (summary)

Specification	ln(HCE)	Deprivation	Fertility
Excluding 2020–2021	n.s.	**	**
COVID dummy included	n.s.	**	**
Alternative HCE measure	n.s.	**	*
Country FE	Yes		
Year FE	Yes		
Observations	243		
Within R^2	0.18-0.21 (range across specifications)		

Note: Significance levels: ** p<0.05, * p<0.1

Source: Authors' estimations.

The main findings remain robust across alternative specifications. Excluding the COVID-19 period or explicitly controlling for pandemic-related shocks does not materially alter the results. Healthcare expenditure remains insignificant in within-

country estimations, while socioeconomic variables retain their expected signs and significance. These robustness checks confirm that the core conclusions are not driven by extraordinary events or specific model choices.

4.5 Economic interpretation and policy relevance

The results indicate that differences in life expectancy across European Union countries are driven primarily by long-term structural factors rather than by short-term policy changes. Healthcare expenditure and healthcare system capacity are strongly associated with life expectancy in cross-country comparisons, but their explanatory power reflects persistent differences across countries rather than within-country changes over time. Once unobserved country-specific characteristics are controlled for, short-run increases in healthcare spending do not translate into statistically significant improvements in life expectancy.

By contrast, socioeconomic conditions – particularly severe material deprivation–remain robust determinants of life expectancy both within and between countries. Reductions in deprivation within a country are associated with improvements in life expectancy, while persistent cross-country differences in deprivation explain a substantial share of health inequalities across the European Union. Institutional quality contributes mainly through long-run structural channels, as better-governed countries achieve higher life expectancy at comparable levels of healthcare expenditure.

From a policy perspective, these findings suggest that improving population health requires more than marginal increases in healthcare spending. Policies addressing socioeconomic vulnerability and strengthening institutional capacity are likely to be more effective in achieving sustained improvements in life expectancy and in reducing health disparities across EU member states.

4.6 Validation of the research hypotheses

The empirical results provide differentiated support for the hypotheses formulated in the literature review. The positive association between healthcare expenditure and life expectancy (H1) is confirmed in pooled estimations and in the between-country component of the hybrid model, indicating that countries with persistently higher levels of health spending tend to exhibit higher life expectancy. However, this relationship does not hold in within-country estimations once country fixed effects are introduced, and the lagged expenditure specification (H2) also fails to produce statistically significant within-country effects. These findings suggest that healthcare expenditure influences life expectancy primarily as a long-run structural factor rather than as a short-run policy lever.

In contrast, the hypothesis concerning socioeconomic deprivation (H3) receives strong and consistent empirical support. Material deprivation is negatively and significantly associated with life expectancy across all model specifications,

including within-country estimations, highlighting its role as both a short- and long-run determinant of population health. The inequality hypothesis (H4) and the governance hypothesis (H5) are partially supported: both variables display significant between-country effects but lose statistical significance in fixed effects models, indicating that their influence operates mainly through persistent structural differences rather than short-term changes. Overall, the results align with the central argument of the paper, namely that differences in life expectancy across EU member states are driven predominantly by long-term socioeconomic and institutional factors, while short-run policy adjustments – particularly in healthcare spending– have limited immediate impact.

Four main findings emerge from the analysis. First, healthcare expenditure is strongly correlated with life expectancy in cross-country comparisons, but not in within-country estimations. Second, socioeconomic deprivation remains a robust determinant of life expectancy across all specifications. Third, institutional quality influences life expectancy primarily as a long-run structural factor. Fourth, short-run policy interventions have limited immediate effects on life expectancy, highlighting the importance of sustained, structural reforms.

5. Conclusions

This study examined the determinants of life expectancy across European Union member states over the period 2014–2022 using panel data econometric techniques designed to distinguish between short-run within-country dynamics and long-run structural differences across countries. By combining two-way fixed effects and hybrid (Mundlak) models, the analysis provided a nuanced assessment of how healthcare inputs, socioeconomic conditions, and institutional quality are associated with population health outcomes.

The empirical results reveal a clear and consistent pattern. While healthcare expenditure, healthcare capacity, and governance indicators exhibit strong associations with life expectancy in pooled and between-country estimations, their explanatory power diminishes substantially once unobserved country-specific heterogeneity is controlled for. Within-country changes in healthcare expenditure are not associated with statistically significant short- to medium-term changes in life expectancy, suggesting that marginal increases in spending alone are unlikely to produce immediate improvements in population health. This finding is consistent with the stock-like nature of life expectancy and the long adjustment periods required for health investments to translate into measurable outcomes.

In contrast, socioeconomic conditions – particularly severe material deprivation – emerge as robust determinants of life expectancy both within and between countries. Reductions in deprivation within a country are associated with improvements in life expectancy, while persistent cross-country differences in deprivation explain a substantial share of observed health inequalities across the European Union. Demographic factors, as proxied by fertility rates, also retain

explanatory power in within-country estimations, highlighting the role of population structure in shaping health outcomes.

Institutional quality, captured through a corruption-related indicator, appears to matter primarily as a long-run structural characteristic rather than as a short-run driver of health outcomes. Countries with persistently better governance exhibit higher life expectancy, but year-to-year changes in governance indicators do not translate into immediate improvements once country fixed effects are accounted for. This suggests that institutional reforms influence population health through gradual, cumulative mechanisms rather than through rapid adjustments.

From a policy perspective, these findings carry important implications. First, they caution against overreliance on short-term increases in healthcare expenditure as a tool for improving population health. While adequate funding of healthcare systems is necessary, its effectiveness depends critically on long-standing system design, institutional capacity, and complementary social policies. Second, the strong and consistent role of socioeconomic deprivation underscores the importance of integrated policy approaches that address income inequality, living conditions, and social exclusion alongside healthcare provision. Third, the prominence of between-country effects highlights the persistence of structural health inequalities within the European Union, suggesting that convergence in health outcomes requires sustained, long-term reforms rather than episodic policy interventions.

The study also has implications for EU-level coordination. Given the limited responsiveness of life expectancy to short-run national policy changes, EU initiatives aimed at reducing health disparities may benefit from focusing on structural cohesion policies, social investment, and institutional strengthening, particularly in countries facing persistent socioeconomic vulnerabilities.

The results of this study are closely aligned with recent empirical evidence on population health determinants in advanced economies. Recent EU-focused research confirms that life expectancy differences remain highly persistent and are driven primarily by structural socioeconomic and institutional factors rather than by short-term policy adjustments, even in the context of expanded healthcare spending (Mackenbach et al., 2024). Similarly, new panel-data evidence for high-income countries shows that while health expenditure is associated with better health outcomes in cross-country comparisons, its short-run within-country effects on mortality and life expectancy are limited once social conditions and unobserved heterogeneity are considered (Moreno-Serra et al., 2024). Additionally, the most recent EU-wide assessments emphasise that reducing health inequalities requires integrated approaches that address social vulnerability, prevention, and institutional capacity, rather than relying primarily on increases in healthcare budgets (OECD, 2025). The consistency between the present findings and this recent literature strengthens the external validity of the results and reinforces the conclusion that sustainable improvements in life expectancy depend mainly on long-term socioeconomic and institutional reforms.

Several limitations should be acknowledged. The analysis relies on aggregating country-level data and therefore cannot capture individual-level mechanisms linking

socioeconomic conditions and health outcomes. In addition, the empirical model does not explicitly control for behavioral lifestyle factors such as smoking prevalence, alcohol consumption, or dietary patterns, which are widely recognised as important determinants of life expectancy. Comparable annual panel data for these indicators covering all EU member states over the full study period are limited or incomplete in international statistical databases. Future research could extend the present analysis by incorporating such behavioral variables where consistent data become available, allowing a more detailed examination of how lifestyle factors interact with healthcare expenditure and socioeconomic conditions in shaping population health outcomes.

These findings are also relevant for ongoing European policy initiatives aimed at reducing health inequalities across member states. EU cohesion policy and public health strategies increasingly emphasise addressing the social determinants of health, strengthening institutional capacity, and improving living conditions in regions facing persistent socioeconomic vulnerabilities. The results of this study support the view that sustained improvements in population health require coordinated policies that integrate healthcare investment with broader social and economic development measures. By highlighting the structural nature of health disparities within the European Union, the analysis contributes to the policy debate on how to achieve more balanced and resilient health outcomes across member states.

While acknowledging these limitations, the study contributes to the literature by clarifying the relative importance of within-country changes and between-country structural differences in shaping life expectancy across the European Union. By demonstrating that health inequalities are largely driven by persistent socioeconomic and institutional factors rather than short-run policy adjustments, the paper provides a more realistic foundation for designing effective and sustainable health and social policies.

References

[1] Anand, S., Bärnighausen, T. (2004), *Human resources and health outcomes: Cross-country econometric study. The Lancet*, 364(9445), 1603-1609.

[2] Arah, O.A., Westert, G.P., Hurst, J., Klazinga, N.S. (2005), *A conceptual framework for the OECD Health Care Quality Indicators Project. International Journal for Quality in Health Care*, 18(suppl_1), 5-13.

[3] Baltagi, B.H., Moscone, F. (2010), *Health care expenditure and income in the OECD reconsidered: Evidence from panel data. Economic Modelling*, 27(4), 804-811.

[4] Berger, M.C., Messer, J. (2002), *Public financing of health expenditures, insurance, and health outcomes. Applied Economics*, 34(17), 2105-2114.

[5] Bloom, D.E., Canning, D., Sevilla, J. (2004), *The effect of health on economic growth: A production function approach. World Development*, 32(1), 1-13.

[6] Bokhari, F.A.S., Gai, Y., Gottret, P. (2007), *Government health expenditures and health outcomes. Health Economics*, 16(3), 257-273.

[7] Brătianu, C., Bejinaru, R. (2021), *COVID-19 induced emergent knowledge strategies. Management & Marketing. Challenges for the Knowledge Society*, 16(1), 11-27.

[8] Costa-Font, J., Pons-Novell, J. (2007), *Public health expenditure and spatial interactions in a decentralized national health system. Health Economics*, 16(3), 291-306.

[9] Cutler, D.M., Deaton, A.S., Lleras-Muney, A. (2006), *The determinants of mortality. Journal of Economic Perspectives*, 20(3), 97-120.

[10] Deaton, A. (2013), *The great escape: Health, wealth, and the origins of inequality. Princeton University Press. Princeton, USA.* Available online at: https://deaton.scholar.princeton.edu/publications/great-escape-health-wealth-and-origins-inequality. [Accessed on 10 December 2025].

[11] European Commission. (2020), *Health inequalities in the EU. Publications Office of the European Union.* Available online at: https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/646182/EPRS_IDA%282020%29646182_EN.pdf. [Accessed on 15 December 2025].

[12] European Court of Auditors. (2019), *EU actions to tackle corruption*. Luxembourg. Available at: https://www.eca.europa.eu/en/publications/SR19_01. [Accessed on 18 December 2025].

[13] Fritzell, J., Rehnberg, J., Bacchus Hertzman, J., Blomgren, J. (2012), *Absolute or relative income, population health and mortality: A systematic review. Scandinavian Journal of Public Health*, 40(2), 177-188.

[14] Gupta, S., Davoodi, H., Tiongson, E. (2000), *Corruption and the provision of health care and education services. IMF Working Paper*, WP/00/116. Available at: https://www.imf.org/en/errors/404?URL=https://www.imf.org/en/publications/wp/issues/2016/12/30/corruption-and-the-provision-of-health-care-and-education-services. [Accessed on 22 December 2025].

[15] Holmberg, S., Rothstein, B. (2011), *Dying of corruption. Health Economics, Policy and Law*, 6(4), 529-547.

[16] Lewis, M. (2006), *Governance and corruption in public health care systems. Center for Global Development Working Paper*, 78. Available at: https://www.cgdev.org/sites/default/files/5967_file_WP_78.pdf? [Accessed on 23 December 2025].

[17] Mackenbach, J.P., Valverde, J.R., Bopp, M., Brønnum-Hansen, H., Deboosere, P., Kalediene, R., Kunst, A.E. (2013), *Variations in the relation between education and cause-specific mortality in 19 European populations. Journal of Epidemiology & Community Health*, 67(12), 1064-1071.

[18] Mackenbach, J.P., Valverde, J.R., Bopp, M., Brønnum-Hansen, H., Deboosere, P., Kalediene, R., Kunst, A.E. (2015), *Trends in health inequalities in 27 European countries. Proceedings of the National Academy of Sciences*, 112(21), 6440–6445.

[19] Mackenbach, J.P., Valverde, J.R., Bopp, M., Brønnum-Hansen, H., Deboosere, P., Kalediene, R., Kunst, A.E. (2024), *Persistence of health inequalities in Europe: Recent trends and policy implications. The Lancet Public Health*, 9(2), 89-98.

[20] Marmot, M. (2005), *Social determinants of health inequalities. The Lancet*, 365(9464), 1099-1104.

[21] Marmot, M., Friel, S., Bell, R., Houweling, T.A., Taylor, S. (2008), *Closing the gap in a generation. The Lancet*, 372(9650), 1661-1669.

[22] Moreno-Serra, R., Smith, P.C. (2015), *Broader health coverage is good for the nation's health. Journal of the Royal Statistical Society: Series A*, 178(1), 101-124.

[23] Moreno-Serra, R., Smith, P.C., Anaya-Montes, M. (2024), *Health spending, social conditions and mortality outcomes in high-income countries: New evidence from panel data. Journal of Health Economics*, 93, 102874.

[24] Nicolescu, L., Paun, C. (2018), *Measuring corruption perceptions at national level. Management & Marketing. Challenges for the Knowledge Society*, 13(2), 809-822.

[25] Nixon, J., Ulmann, P. (2006), *The relationship between health care expenditure and health outcomes. The European Journal of Health Economics*, 7(1), 7-18.

[26] OECD. (2021), *Health at a glance: Europe 2020*. OECD Publishing. Available online at:https://health.ec.europa.eu/system/files/2020-12/2020_healthatglance_rep_en_0.pdf. [Accessed on 7 December 2025].

[27] OECD. (2025), *Health at a glance: Europe 2024 – State of health in the EU cycle*. OECD Publishing. Available online at: https://www.oecd.org/en/publications/health-at-a-glance-europe_23056088.html. [Accessed on 9 December 2025].

[28] Pickett, K.E., Wilkinson, R.G. (2015), *Income inequality and health. Social Science & Medicine*, 128, 316-326.

[29] Popescu, G.H. (2022), *Public governance, institutional trust, and social sustainability. Management & Marketing. Challenges for the Knowledge Society*, 17(3), 213-229.

[30] Preston, S.H. (1975), *The changing relation between mortality and level of economic development. Population Studies*, 29(2), 231-248.

[31] Rajkumar, A.S., Swaroop, V. (2008), *Public spending and outcomes: Does governance matter? Journal of Development Economics*, 86(1), 96-111.

[32] Rechel, B., Grundy, E., Robine, J.M., Cylus, J., Mackenbach, J.P., Knai, C., McKee, M. (2013), *Ageing in the European Union. The Lancet*, 381(9874), 1312-1322.

[33] Vătămănescu, E.M., Alexandru, V.A., Mitan, A., Dabija, D.C. (2020), *From the deliberate managerial strategy to emergent knowledge-based competitive advantage. Management & Marketing. Challenges for the Knowledge Society*, 15(1), 1-17.

[34] Wilkinson, R.G., Pickett, K.E. (2006), *Income inequality and population health: a review and explanation of the evidence. Social Science & Medicine*, 62(7), 1768-1784.