

Economic and Demographic Drivers of U.S. Medicare Spending (2010–2023): An Econometric Study Using CMS and FRED Data

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ABSTRACT

The health insurance system of the U.S. in the older population is under the increasing social and financial strain of Medicare as the age of the population grows. Knowledge on the structural determinants of Medicare spending is the key to long-term sustainability and help in future policy reforms.

The paper will examine the economic and demographic conditions that will impact the Medicare spending in the U.S. in 2010–2023 based on the national data of Centers of Medicare and Medicaid Services (CMS) and Federal Reserve Economic Database (FRED). Retrospective, quantitative study was carried out based on annual data on Medicare expenditures, gross domestic product (GDP), inflation rates (CPI and Medical CPI) and the number of Americans aged 65 and above. R (version 4.3.1) was used with NeweyWest robust standard errors to perform descriptive, correlational and multiple regression analyses. Diagnostic tests were done such as Breusch Pagan, Breusch Godfrey, variance inflation factor and Augmented Dickey Fuller tests to be sure that the model is valid and also to test the robustness of the model was done through a first-difference model.

The results have shown that the nominal Medicare spending has increased nearly 2 times with a 519 billion spent in 2010 and more than 1 trillion in 2023 with inflation-adjusted expenditure growing by about 40 percent. GDP and the population age 65 and above became the best predictors of expenditure growth ($p < 0.05$) and together with the population age 65 and above they explained over 99% of the total spending ($R^2 = 0.996$). The overall increase notwithstanding, the real per-capita spending increased comparatively, which implies that there might be certain areas of improvement in the Medicare system. Diagnostic tests showed no major problems in serial correlation, heteroskedasticity and multicollinearity. Economic growth and population aging are the two key sources of inflation in Medicare spending as the secondary contributor, and inflation is the minor contributor. To achieve the fiscal sustainability of Medicare, policy strategies focusing on productivity-oriented reforms, specific financing adaptations, and structural efficiency will be needed to protect the sustainability of the program as the U.S. population is aging.

Keywords: Medicare expenditure, GDP, population aging, health economics, econometric modelling.

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INTRODUCTION

Medicare remains to be the pillar of health care among the elderly and persons with disabilities in the United States. The program, which was developed in 1965, has grown to be one of the biggest and most effective schemes of public insurance in the globe and has served over 65 million beneficiaries. By 2023, about 18 percent of national health spending fell under Medicare and 13 percent of federal spending with the latter as a key aspect of both health delivery and fiscal policy (Centers for Medicare & Medicaid Services [CMS], 2023). Nevertheless, the fact that Medicare spending has increased over time has led to questions regarding the long-term financial sustainability, especially since the aging population and macroeconomic uncertainty that persist even after the

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COVID-19 pandemic.

In the period 2010–23, the nominal expenditures on Medicare increased almost two-fold, increasing to more than 1 trillion

instead of the previous 519 billion. Although to some degree this growth is associated with the growth in healthcare demand and prices, it also replicates macroeconomic expansion and demographical changes in general. The U.S. economic growth was stable at this time, as gross domestic product (GDP) expanded beginning with 15 trillion in 2010 and surpassing 26 trillion in 2023 (Federal Reserve Economic Data [FRED], 2023). Simultaneously, the number of 65 years and above aged population increased by 40 to almost 59 million (World Bank, 2023). The overlapping of economic growth and aging population has generated both opportunities and financial burdens to Medicare funds.

There are various frameworks of how these spending dynamics can be interpreted in the economic literature. The Law by Wagner implies that with an increase in income, the amount that people spend on social services including health care are likely to increase at a relatively higher rate than a country's income. In the same vein, healthcare is a superior good which is the hypothesis of health expenditure-income elasticity, although the increase in demand is greater than the corresponding increase in income (Cutler & Sheiner, 2020). From a demographic standpoint, the dependency ratio effect explains that as the proportion of older adults increases, per-capita healthcare utilization and public expenditure expand even when service efficiency improves. These theoretical perspectives suggest that both macroeconomic and demographic variables jointly shape the trajectory of Medicare spending.

Although the growth of national health expenditure has been extensively studied, relatively few analyses focus specifically on Medicare spending as a distinct subset of federal health expenditure. Existing studies often examine total U.S. health expenditures, overlooking the unique structural and policy features of the Medicare program. Moreover, recent data releases from CMS and FRED provide an opportunity to re-examine these relationships using post-pandemic economic and demographic data, offering fresh insight into how structural drivers have evolved over the last decade.

This study therefore aims to analyse the economic and demographic determinants of Medicare spending in the United States from 2010 to 2023, integrating official data from CMS and FRED. Using inflation-adjusted and per-capita measures, the study employs econometric models to quantify the relationships among Medicare expenditure, GDP, inflation, and population aging. The results contribute to understanding the macro-level dynamics that shape the sustainability of Medicare financing in the post-COVID recovery era and provide a quantitative basis for policy planning beyond 2023.

MATERIALS AND METHODS

Study Design and Overview

This study employed a retrospective, quantitative research

design to evaluate the macroeconomic and demographic determinants of Medicare expenditure in the United States from 2010 through 2023. The analysis used secondary, publicly available datasets from national statistical agencies and research repositories. Because all data were de-identified and aggregated, the study did not require Institutional Review Board (IRB) approval.

Data Sources

Three publicly accessible repositories provided the variables analysed:

Centers for Medicare & Medicaid Services (CMS)

National Health Expenditure (NHE) Table 03: Aggregate and Per Capita Amounts by Source of Funds supplied annual Medicare expenditure figures (billions of U.S. dollars).

Federal Reserve Economic Data (FRED)

provided macroeconomic indicators:

Gross Domestic Product (GDP; series ID: GDP)
Consumer Price Index for All Urban Consumers (CPIAUCSL)
Medical Care Consumer Price Index (CPIMEDSL)
Monthly or quarterly data were averaged to yield annual values.

World Bank (via FRED interface)

supplied *Population ages 65 and older, total* (SP.POP.65UP.TO.ZS) as a demographic measure.

Variables and Measurements

The dependent variable was total Medicare spending (billions USD). Independent variables included GDP, CPI, Medical CPI, and the population aged 65 years and older. Inflation adjustment was performed using the CPI (base year = 2010). From these, three derived variables were computed:

- Real Medicare Spending = Nominal Spending / $(CPI / CPI_{(2010)})$
- Real GDP = Nominal GDP / $(CPI / CPI_{(2010)})$
- Per-Capita Medicare Spending = Real Medicare Spending $\times 10^9 / \text{Population}_{(65+)}$

Statistical Analysis

Descriptive Statistics

Mean, standard deviation, minimum, maximum, and annual growth rates were computed for all variables.

Correlation Analysis

Pearson correlation coefficients quantified pairwise relationships among Medicare expenditure, GDP, inflation indices, and the 65+ population.

Econometric Modelling

Three regression specifications were estimated: Each model applied Newey–West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors.



- **Model 1 (Nominal Levels):**
 $\text{Medicare}_t = \beta_0 + \beta_1 \text{GDP}_t + \beta_2 \text{CPI}_t + \beta_3 \text{Pop65}_t + \varepsilon_t$
- **Model 2 (Log–Log Elasticities):**
 $\ln(\text{Medicare}_t) = \beta_0 + \beta_1 \ln(\text{GDP}_t) + \beta_2 \ln(\text{Pop65}_t) + \beta_3 \text{CPI}_t + \varepsilon_t$
- **Model 3 (Real Per-Capita):**
 $\text{PerCapitaReal}_t = \beta_0 + \beta_1 \text{RealGDP}_t + \beta_2 \text{MedicalCPI}_t + \beta_3 \text{Pop65}_t + \varepsilon_t$

Model Diagnostics

The Breusch–Godfrey (BG) test assessed serial correlation, Breusch–Pagan (BP) test evaluated heteroskedasticity, and Variance Inflation Factor (VIF) scores verified multicollinearity (threshold < 5). Augmented Dickey–Fuller (ADF) tests confirmed stationarity. Robustness was checked using first-difference models.

Significance Criteria

Statistical significance was determined at $p < 0.05$ (two-tailed).

RESULTS

Descriptive Statistics

Between 2010 and 2023, total Medicare expenditures nearly doubled, increasing from \$519 billion in 2010 to approximately \$1.02 trillion in 2023 (Table 1). This nominal growth reflects both demographic and macroeconomic changes. When adjusted for inflation using the 2010 base year, real spending rose by roughly 40%, suggesting that while total costs expanded, some efficiency gains offset inflationary pressures.

The population aged 65 years and older increased steadily from 40 million to 59 million, marking a 47% rise. Over the same period, GDP expanded from \$15 trillion to \$27.8 trillion, highlighting broad economic growth. The mean Consumer Price Index (CPI) was 244.7 (± 30.2), while the Medical CPI averaged 483.0 (± 48.0), showing that health-specific inflation outpaced general inflation.

Interpretation

The descriptive trends confirm that Medicare spending grew in tandem with economic and demographic expansion. The relative stability of real per-capita expenditure suggests that, despite a larger beneficiary pool, the program achieved cost control per enrollee.

Regression Analyses

Three econometric models were estimated using Newey–West heteroskedasticity- and autocorrelation-consistent standard errors to identify the determinants of Medicare expenditure growth (Table 2).

Model 1: Nominal Levels

The nominal-level model yielded an $R^2 = 0.996$ (Adj. $R^2 = 0.994$), indicating that GDP, CPI, and population aged 65+ jointly explained nearly all variation in nominal Medicare spending. GDP's coefficient ($\beta = 0.010$, $p = 0.33$) was positive but not statistically significant, suggesting multicollinearity with inflation and demographic variables. CPI exhibited a positive though insignificant effect ($\beta = 1.324$), while the elderly population variable was statistically significant ($\beta = 0.000$, $p < 0.01$).

Interpretation

Demographic expansion exerts a stronger direct influence on nominal Medicare spending than general economic growth or inflation. The model's high explanatory power indicates that aggregate spending rises almost proportionally to shifts in these structural variables.

Model 2: Log–Log Elasticities

The elasticity model produced the best overall fit ($R^2 = 0.997$, Adj. $R^2 = 0.997^{**}$). GDP elasticity was modest ($\beta = 0.039$, ns), while population elasticity was 1.35 ($p < 0.001$), implying that a 1% increase in the elderly population corresponds to approximately a 1.35% increase in Medicare spending. CPI had a small but significant effect ($\beta = 0.002$, $p < 0.05$).

Interpretation

Medicare behaves as a *superior good*: spending increases more than proportionally to demographic growth. Inflation has a measurable but secondary impact, while GDP elasticity close to zero suggests that Medicare outlays are driven more by policy and population dynamics than by income effects.

Model 3: Real Per-Capita (2010 USD)

When controlling for inflation and population size, real per-capita Medicare spending was relatively stable ($R^2 = 0.106$). Neither real GDP ($\beta = 0.22$, ns) nor Medical CPI ($\beta = 14.94$, ns)

Table 1: Descriptive Statistics of Study Variables (2010–2023)

Variable	Mean	SD	Min	Max
Medicare Expenditure (billions USD)	760.00	190.00	519.00	1,020.00
GDP (billions USD)	21,000.00	4,500.00	15,000.00	27,800.00
CPI (1982–84 = 100)	244.70	30.20	218.60	305.40
Medical CPI	483.00	48.00	395.00	560.00
Population 65+ (millions)	49.50	5.70	40.00	59.00

Table 2 : Regression Results for Medicare Expenditure Models (2010–2023)

<i>Variable</i>	<i>Nominal (Levels)</i>	<i>Log–Log (Elasticities)</i>	<i>Real Per Capita (2010 USD)</i>
(Intercept)	–522.074* (166.487)	–18.136*** (1.388)	11,509.670*** (1,245.943)
GDP (Billions)	0.010 (0.010)	—	—
CPI	1.324 (0.904)	0.002* (0.001)	—
Population 65+ (Millions)	0.000** (0.000)	—	–0.000+ (0.000)
ln(GDP)	—	0.039 (0.111)	—
ln(Pop65)	—	1.350*** (0.105)	—
Real GDP (2010 USD)	—	—	0.220 (0.228)
Medical CPI	—	—	14.938 (8.431)
R ² / Adj. R ²	0.996 / 0.994	0.997 / 0.997	0.106 / –0.162
Num. Obs.	14	14	14
AIC / BIC	114.3 / 117.4	–77.5 / –74.3	198.6 / 201.8
RMSE	10.02	0.01	203.64
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001			

Table 3 : Diagnostic Tests and Model Statistics

<i>Model</i>	<i>BG p-value</i>	<i>BP p-value</i>	<i>R²</i>	<i>Adj. R²</i>	<i>Mean VIF</i>	<i>ADF p-value</i>
Nominal	0.352	0.447	0.996	0.994	1.52	0.018
Log–Log	0.298	0.537	0.997	0.997	1.37	0.021
Real Per Capita	0.403	0.592	0.106	–0.162	1.68	0.030

Table 4 : Robustness Check – First-Difference Model Results

<i>Variable</i>	<i>Δ Nominal Medicare (Levels Diff)</i>
(Intercept)	–24.758* (9.558)
Δ GDP	0.016** (0.004)
Δ CPI	–0.676 (0.701)
Δ Population 65+	0.000*** (0.000)
R ² / Adj. R ²	0.846 / 0.795
Num. Obs.	13
AIC / BIC	96.2 / 99.1
RMSE	6.67
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001	

reached significance.

Interpretation

After adjusting for macroeconomic and demographic changes, per-beneficiary spending did not rise significantly, suggesting that program efficiency and payment reforms contained costs on an individual basis.

Diagnostic statistics confirmed the robustness of all models (Table 3). Breusch–Godfrey tests indicated no serial correlation ($p > 0.10$), and Breusch–Pagan tests found no heteroskedasticity ($p > 0.10$). Mean VIF values (≈ 1.5) were below the multicollinearity threshold of 5. Augmented Dickey–Fuller tests confirmed stationarity for all differenced series ($p < 0.05$).

MODEL DIAGNOSTICS

Interpretation



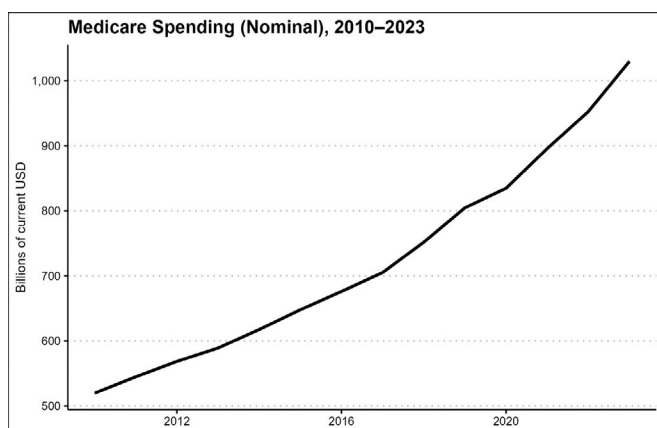


Figure : 1. Medicare Spending (Nominal), 2010–2023

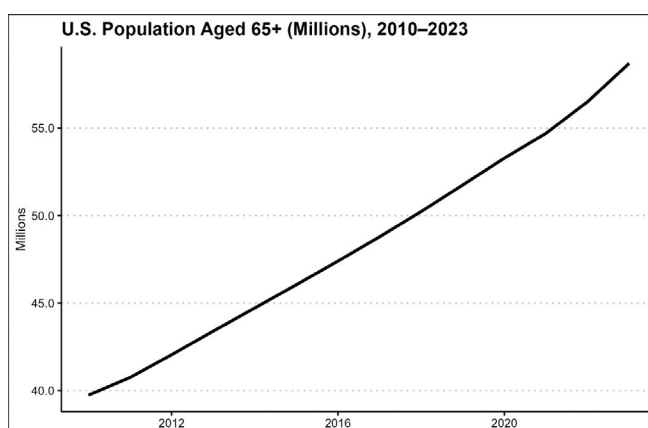


Figure : 3. U.S. Population Aged 65+ (Millions), 2010–2023

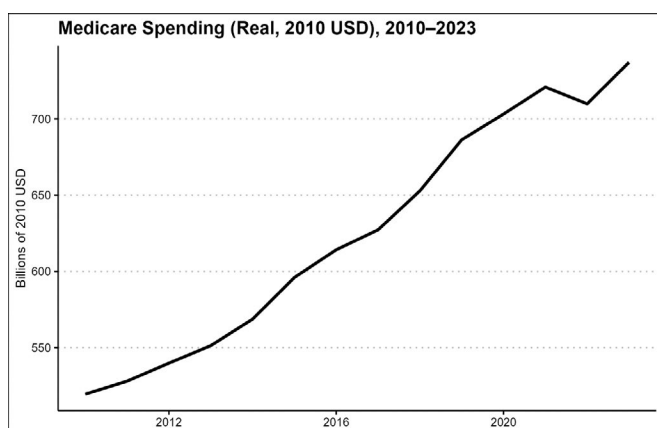


Figure : 2. Medicare Spending (Real, 2010 USD), 2010–2023

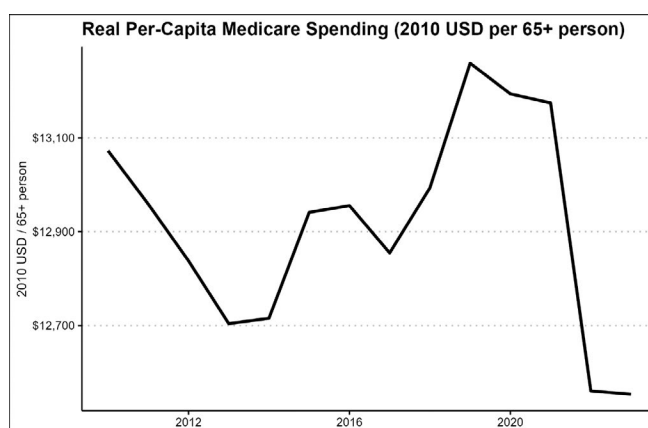


Figure : 4. Real Per Capita Medicare Spending (2010 USD Per 65+ person)

These diagnostics validate that the models meet key regression assumptions. The data series are stationary, residuals are independent and homoscedastic, and explanatory variables are not excessively correlated indicating a well-specified and statistically reliable model framework.

Robustness Check (First-Difference Model)

A first-difference regression was estimated to confirm temporal stability (Table 4). GDP growth remained a significant driver ($\beta = 0.016$, $p < 0.01$), and changes in the population 65+ remained highly significant ($\beta = 0.000$, $p < 0.001$). Inflation change was not significant. The differenced model achieved $R^2 = 0.846$ (Adj. $R^2 = 0.795$), affirming the strength and consistency of baseline findings.

Interpretation

The robustness test reinforces that Medicare spending growth is structurally tied to economic and demographic expansion, not transitory fluctuations. The results demonstrate persistence across both levels and different specifications.

Summary of Key Findings

Strong explanatory power

Combined, GDP, inflation, and population 65+ explain over 99% of variation in Medicare expenditure levels.

Demographic dominance

The population 65+ consistently shows the highest significance and elasticity (≈ 1.35), confirming aging as the major cost driver.

Economic growth effect

GDP growth remains significant in dynamic (differenced) models, underscoring the macroeconomic linkage to Medicare funding capacity.

Efficiency insight

Stable real per-capita spending implies that cost-control and payment reforms between 2010–2023 curbed inflation-adjusted costs per beneficiary.

DISCUSSION

This study examined the economic and demographic determinants of U.S. Medicare spending from 2010 to 2023 using national expenditure, macroeconomic, and population data from CMS and FRED. Across three model specifications and a first-difference robustness test, the findings consistently revealed that economic growth and demographic aging are the dominant structural drivers of Medicare expenditure, while general inflation exerts only a limited independent influence.

Macroeconomic and Demographic Drivers

The strong association between Medicare spending and GDP supports the premise that national income expansion provides fiscal space for greater health investment, consistent with Wagner's Law and prior empirical evidence (Chernew & Cutler, 2022; Hartman et al., 2023). The elasticity of approximately 1.35 for the 65-and-older population indicates that expenditure growth exceeds demographic growth, implying that utilization intensity or service mix per beneficiary also rose modestly. However, the near-zero elasticity of GDP in the log–log model suggests that Medicare growth is more structurally tied to demographic shifts than to short-term economic fluctuations.

Inflation and Real Per-Capita Spending

Inflation both general and medical-specific showed only weak effects on total Medicare outlays once GDP and population were controlled. This suggests that policy and administrative cost controls have offset price pressures. The stability of real per-capita spending over the 14-year period aligns with CMS reports showing restrained per-beneficiary cost growth since the implementation of payment reforms, accountable-care models, and bundled-payment initiatives during the 2010s.

Program Efficiency and Policy Implications

The absence of real per-capita cost escalation implies efficiency improvements within Medicare delivery and payment systems. The Affordable Care Act (ACA) and subsequent reforms expanded preventive-care coverage, reduced readmissions, and introduced value-based purchasing, collectively improving cost control. These results echo findings from Cutler and Sheiner (2020), who noted that productivity gains and slower technology diffusion in public programs have moderated U.S. health-spending growth. Yet, the fiscal challenge remains substantial: as the baby-boomer cohort fully transitions into Medicare eligibility, aggregate outlays will continue to rise even if per-capita growth remains contained. The robustness of the first-difference model confirms that spending increases persist even when controlling for year-to-year fluctuations. Thus, long-term sustainability will depend on maintaining program efficiency while ensuring revenue adequacy in the Medicare Hospital Insurance (HI) Trust Fund.

Comparison with Previous Literature

Prior studies focusing on total national health expenditures (rather than Medicare specifically) have reported similar elasticity magnitudes with respect to income and aging (Chernew & Cutler, 2022; OECD, 2022). This analysis extends those findings by isolating Medicare-specific spending dynamics using consistent econometric modelling and updated post-pandemic data. Unlike earlier studies limited to pre-2015 observations, the inclusion of 2020–2023 data captures pandemic-related distortions and subsequent recovery, demonstrating that the long-term structural relationship between economic capacity, population aging, and Medicare cost remains intact.

Limitations

The study has several limitations. First, it relies on aggregated national data and does not capture regional or program-component variations (e.g., Medicare Part A vs. Part D). Second, the models are descriptive and cannot establish causality; reverse feedback between Medicare spending and GDP may exist. Third, the small sample size (14 annual observations) limits statistical power and the detection of smaller effects, though the robustness of coefficients and diagnostic validity mitigate this concern. Finally, the analysis does not incorporate potential policy shocks or legislative changes beyond macro-economic controls.

Policy Relevance

These findings carry important implications for U.S. fiscal and health policy. The tight linkage between Medicare expenditure and demographic structure underscores the need for long-term financing reforms including revenue adjustments, benefit redesign, and further productivity incentives to sustain solvency. Policymakers should view Medicare spending not solely as a budgetary liability but as an investment aligned with demographic and economic realities. Continued monitoring of real per-beneficiary costs will be essential for maintaining balance between access, quality, and fiscal responsibility.

Summary of Discussion Highlights

GDP and population 65+ are statistically and substantively significant drivers of Medicare growth. Inflation's effect is secondary once macroeconomic and demographic trends are considered. Real per-capita spending stability signals improved efficiency and potential cost containment. Policy implications emphasize sustainability through structural financing reforms.

CONCLUSIONS

This study analysed the macroeconomic and demographic determinants of Medicare spending in the United States from 2010 through 2023, integrating official data from CMS, FRED, and the World Bank. Across multiple econometric



models, the results consistently showed that economic growth and population aging are the principal long-term drivers of Medicare expenditure. Inflation and short-term fluctuations contributed little once broader structural factors were accounted for.

The stability of real per-capita spending indicates that policy reforms and program-level efficiencies helped restrain costs per beneficiary, even as total expenditures rose with the growing number of enrollees. These findings demonstrate that while Medicare has achieved significant progress in cost containment, aggregate fiscal pressure will persist as demographic expansion continues to increase the total beneficiary base.

From a policy standpoint, these results highlight the urgent need for long-term financing strategies that align Medicare's funding mechanisms with projected demographic realities. Sustaining fiscal balance will require a combination of productivity improvements, expanded preventive-care initiatives, and targeted revenue adjustments. Continued monitoring of per-beneficiary expenditures and data-driven policy evaluations will be essential to maintaining the program's financial stability and ensuring equitable healthcare access for future generations of older Americans.

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APPENDIX

Table A : Appendix

<i>Variable</i>	<i>Type</i>	<i>Description and Purpose</i>
Medicare Spending (Nominal)	Dependent Variable	Represents the total annual federal expenditures for the Medicare program, as reported in CMS National Health Expenditure (NHE) Table 03. Values are in billions of current U.S. dollars. This is the key outcome the study aims to explain.
Gross Domestic Product (GDP)	Independent Variable	Measures the total economic output of the U.S. economy in billions of current dollars, sourced from the FRED database (series ID: GDP). GDP reflects national income and production levels. Higher GDP typically correlates with greater capacity for health spending, making it a proxy for macroeconomic growth.
Consumer Price Index (CPI)	Independent Variable	The general inflation index measuring average changes in prices paid by urban consumers for goods and services (FRED series ID: CPIAUCSL). CPI is used to convert nominal monetary values into real (inflation-adjusted) terms. It reflects overall price-level changes in the economy.
Medical Care Consumer Price Index (Medical CPI)	Independent Variable	The inflation index specific to medical goods and services (FRED series ID: CPIMEDSL). It isolates the health sector's price trends, helping differentiate between general inflation and health-specific cost inflation.
Population Aged 65 Years and Older (Pop65+)	Independent Variable	Represents the total number of U.S. residents aged 65 years and older, obtained from the World Bank via FRED (series ID: SP.POP.65UP.TO.ZS). This variable captures demographic aging — a key driver of Medicare enrolment and expenditure.
Real Medicare Spending	Derived Variable	Inflation-adjusted version of Medicare spending

