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Research Article

The relationship between income, ageing population, and public health expenditures in G-7 countries: A panel ARDL approach

G-7 ülkelerinde gelir, yaşlı nüfus ve kamu sağlık harcamaları arasındaki eş bütünleşme ilişkisi: Panel ARDL yaklaşımı

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Abstract

Health expenditures show an upward trend with increasing income and an ageing population. Modern economies and health systems are seriously feeling this pressure on public health expenditures and are seeking solutions. This study analyses the short- and long-term relationships among income, an ageing population, and public health expenditures. The G-7 countries, which are developed, were included in this study. The revenue, elderly population, and public health expenditures of the G-7 countries were analysed using the Panel ARDL method. According to the findings, the income variable is negatively related to public health expenditures in the short term. In contrast, the elderly population variable does not affect public health expenditures. In the long term, both income and the elderly population ratio positively impact public health expenditures. The elderly population does not exert significant long-term pressure on health expenditures. Recommendations include redesigning optimal health systems and increasing demand for preventive health services.

Keywords: Ageing Population, Income, Public Health Expenditures, Panel ARDL, G-7

Jel Codes: C33, H51, J14

Öz

Sağlık harcamaları, gelir ve yaşlı nüfusun artması ile artış eğilimi göstermektedir. Modern ekonomiler ve sağlık sistemleri kamu sağlık harcamaları üzerindeki bu baskıyı ciddi bir şekilde hissetmekte ve çözüm arayışlarında bulunmaktadır. Bu çalışmada gelir, yaşlı nüfus ve kamu sağlık harcamaları arasındaki kısa ve uzun dönemli ilişkinin analizi amaçlanmıştır. Bu çalışmada gelişmiş ülkelerden olan G-7 ülkeleri analiz kapsamına alınmıştır. G-7 ülkelerinin gelir, yaşlı nüfus ve kamu sağlık harcamaları Panel ARDL yöntemi ile analiz edilmiştir. Elde edilen bulgulara göre kısa dönemde gelir değişkeni kamu sağlık harcamaları ile negatif yönlü bir ilişki gösterir iken yaşlı nüfus değişkeninin kamu sağlık harcamaları üzerinde herhangi bir etkisi bulunmamaktadır. Uzun dönemli analiz ilişkisine göre ise hem gelir hem de yaşlı nüfus oranı kamu sağlık harcamaları üzerinde pozitif etki göstermektedir. Yaşlı nüfus uzun dönemde sağlık harcamaları üzerinde ciddi bir baskı oluşturmadır. Hükümetlerin optimal sağlık sistemlerini yeniden dizayn etmeleri ve koruyucu sağlık hizmetlerine yönelik talebi artıcı önlemlerin alması gerektiği yönünde önerilerde bulunulabilir.

Anahtar Kelimeler: Yaşlı Nüfus, Gelir, Kamu Sağlık Harcamaları, Panel ARDL, G-7

Jel Kodları: C33, H51, J14

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Introduction

Healthcare expenditures are steadily increasing in today's advanced economies. This situation severely strains public budgets and social security institutions, threatening the sustainability of the system. Ensuring the continuity of long-term sustainable systems has become important for public administrators and healthcare stakeholders, and discussions on the subject have been ongoing. The relationship between income, the elderly population, and public healthcare expenditures is complex. Especially in developed and developing countries, the share of public health expenditures in income is gradually increasing, averaging 9% to 13% (Sarıgül, Konca, Biçer, 2024). In addition, in most countries worldwide, due to the gradual ageing of the population, health expenditures are expected to increase further in the coming years (Varabyova & Schreyögg, 2013). When examining the relationship between income and health, it is observed that as income increases, health expenditures also increase, enabling longer life expectancies. For example, Americans allocate more economic resources to healthcare, resulting in significantly longer lifespans (Hall & Jones, 2007, p. 39). According to Grossman's (1972, p.233) health capital model, as individuals' income levels rise, their tendency to invest in their health also increases. Wealthy and well-educated people live longer than poor and less educated people. Individuals can maintain healthier lifestyles in countries with high income levels due to better living conditions, hygiene, and nutrition (Deaton, 2003, pp.6-8). In developed countries, increased income may lead to greater use of advanced medical technology and a higher demand for advanced healthcare services. This situation may lead to increased health expenditures. Countries with high per capita income levels generally have higher per capita health expenditures. This situation also shows that rapid economic growth may increase health expenditures (Bedir, 2016, p. 76). G-7 countries, being countries with high per capita income, can spend more on healthcare. The increase in income also necessitates spending on public healthcare infrastructure, an issue that policymakers must consider.

The ageing population ratio affects healthcare expenditures, particularly due to the high prevalence of chronic diseases among the elderly and the increased demand for geriatric services. Demographic changes, developments in healthcare services, improvements in nutrition and hygiene, and changes in income, among other factors, have led to a significant increase in life expectancy at birth, contributing to the growth of the elderly population. Population ageing significantly increases acute and long-term care expenditures (De Meijer, Wouterse, Polder & Koopmanschap, 2013, p. 353). Older individuals consume significantly more healthcare services than the younger population due to the prevalence of chronic diseases, more frequent hospitalisations, medication use, and long-term care needs (Bloom, Cafiero, Jané-Llopis, Abrahams-Gessel, Bloom, Fathima & Sweet, 2011, p.7). The elderly population is increasing in developed countries. This study also shows an increase in the elderly population in G-7 countries. Therefore, this ageing trend in G-7 countries creates many needs, such as healthcare, gerontology, social care, and social services, which may increase healthcare expenditures (Lama, 2023, p. 69).

Economic and social factors influence public health expenditures. These factors can be determinants of public health expenditures. Studies have shown that many factors, such as health, social protection, and health-related behaviour patterns, are important determinants of public health expenditures (Noy & Sprague-Jones, 2016, p. 425; Navarro, 2014). Public health expenditures play an essential role in financing health services and in the sustainability of the health system (Rechel, Jakubowski, McKee & Nolte, 2018, p. 3). The volume of public health expenditures is shaped by many factors, including the country's health policy, economy, and demographics. Therefore, increasing public health expenditures is a constant concern in developed countries, and controlling their growth and obtaining better value from existing resources are essential goals of health policies (Economou, Kaitelidou, Kentikelenis, Maresso & Sissouras, 2015, p. 111). G-7 countries also have strong health systems, but economic and social changes have led to debates about the systems and have challenged governments in ensuring the sustainability of expenditures.

Pressure on healthcare spending in developed economies is becoming a pressing issue, sparking debates about the system's sustainability. This study examines the long-term cointegration relationships among income, the elderly population ratio, and healthcare spending in G-7 countries using the Panel ARDL method. The Panel ARDL method enables the simultaneous analysis of short- and long-term dynamics, revealing the immediate effects of the relationship between variables and their long-term equilibrium states (Pesaran, Shin & Smith, 2001, p. 291). This study examines the long-term cointegration relationship between the aforementioned key variables in the G-7 countries, which include Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Identifying short- and long-term relationships between these variables in developed countries could provide policymakers with guidance on the sustainability of healthcare systems. The remaining sections of this study, excluding the introduction, are structured as follows. The second section explains the research methodology, detailing the data sources, variable definitions, and the econometric framework used, particularly the Panel ARDL approach. The third section presents the tests and empirical findings, which are then interpreted within the framework of the research objectives. Finally, the fourth section discusses the study's results, offering theoretical and practical implications and suggestions for future research.

The main research problem of this study is to reveal the short- and long-term effects of income and the proportion of the elderly population on public health expenditures in G7 countries. In this framework, the following questions are addressed:

1. What are the short- and long-term effects of income growth on public health expenditures?

2. How does the increase in the proportion of the elderly population affect public health expenditures in the short and long term?

Literature review

In industrialised countries, the relationship between healthcare spending, demographics and the economy are at the centre of policy decisions. A literature review was conducted on the variables covered in this study. Yıldırım & Cebeci (2021, p. 982) conducted a survey focused on developed countries and examined the relationships among healthcare spending, capital accumulation, and income. They found that there is a cointegration relationship between the variables in question, that the panel ARDL approach allows the dynamics to be analysed in both the short and long run, and that the variables exhibit a reciprocal relationship. Getzen (2000, p. 259) explains the relationship between income, the elderly population, and health expenditure as follows: As people's income increases, they demand higher-quality healthcare services, and the public sector (the government) is forced to expand its budget to meet this demand. This result is confirmed by the study by Farag, Nandakumar, Wallack, Hodgkin, & Gaumer (2013). In their research, Farag et al. (2013, p. 33) find that positive outcomes can be achieved through increased public health spending, good governance and rising prosperity. Similarly, population ageing creates significant upward pressure on healthcare spending. An ageing population increases pressure on healthcare systems, increases healthcare spending and significantly predicts spending on long-term care (Kallestrup-Lamb, Marin, Menon & Søgaard, 2024, p. 1). In a study analysing the impact of population ageing on healthcare expenditure growth in Western countries, it was found that population ageing moderately increases spending on acute care and significantly increases spending on long-term care. Thus, as the older population increases, the need for chronic diseases and long-term care services also increases, leading to higher public healthcare spending (De Meijer et al., 2013, p. 353). Another vital advantage of the panel ARDL model is its ability to determine the direction of causal relationships between variables. Another recent study demonstrates a bidirectional causal relationship between health expenditures and economic growth on a panel basis (Özyilmaz, Bayraktar, Işık, Toprak, Er, Besel, Aydın, Olgun, & Collins, 2022). Similarly, many studies examine bidirectional relationships between variables. In other words, studies show that income increases health expenditures, aging increases health expenditures, economic growth triggers health expenditures, but the increase in health expenditures alone does not affect economic development, or the impact of the elderly population on health expenditures is greater or more persistent than the impact of income (Lau & Pung, 2016; Wang & He, 2019). In general, health problems increase with age. In particular, individuals over the age of 65 are more prone to age-related health problems. In this age group, chronic diseases such as heart disease, diabetes, hypertension, cancer, and dementia are more common. These health problems require more frequent hospitalisations, medication use, and medical interventions, thereby increasing healthcare expenditures (Biçer, Konca & Sarıgül, 2025).

Method

The study uses data sets from G-7 countries from 1990 to 2022. The dependent variable is per capita public health expenditure (in US dollars at purchasing power parity, 2015 prices); the independent variables are per capita gross domestic product (in US dollars at purchasing power parity, 2021 prices) and the proportion of the population aged 65 and over. The data was obtained from the World Bank database. Monetary data were fixed to purchasing power parity in 2021. This time series was used because the available years for all countries in the study were 1990-2022. This study used only previously collected and anonymised secondary data that were already available for research purposes. No direct interaction with human participants occurred, and no identifiable personal information was used. In line with BMIJ guidelines, ethics committee approval was therefore not required.

Table 1: Explanation of Variables

Abbreviation of Variable	Description
GOVHE*	Public health expenditure per capita (in US dollars at purchasing power parity, 2015 prices)
GDP*	Gross domestic product per capita (in US dollars based on purchasing power parity, 2021 prices)
65OLD*	Percentage of population aged 65 and over

*All data was obtained from the World Bank

Horizontal cross-section dependency

In panel data analyses used in the study, it is essential to determine cross-sectional dependence. For this reason, before starting the analyses, it is necessary to test whether the series carries cross-sectional dependence. When countries interact strongly, tests conducted without accounting for cross-sectional dependence may yield misleading and inconsistent results. Therefore, tests that reveal cross-sectional dependence are critical in panel data studies. Various methods have been developed in the literature to measure this dependence.

The first of these tests is the Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980) and Pesaran (2004). The panel data model LM test can be formulated as follows, Equation 1:

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it} \quad \text{for} \quad i = 1,2,3,\ldots\ldots,N; \quad t = 1,2,3,\ldots.,T \tag{1}$$

i number of horizontal sections, t number of time periods, x_{it} explanatory vector variables, $\propto_i$ ve β_i expresses individual cross-section and slope coefficients.

$$H_0: \forall(u_{it}, x_{it}) = 0 \; there\ is\ no\ horizontal\ section\ dependency..$$

$$H_1: \forall(u_{it}, x_{it}) \neq 0 \text{ there is a horizontal section dependency.}$$

Breusch-Pagan (1980) is effective when N > T. It also tests the hypothesis that there is no correlation between the series. LM is calculated as follows, Equation 2:

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \tag{2}$$

p_{ij}, represents the bivariate correlation of the residuals of the ordinary least squares estimated for each i in Equation (2). Under the null hypothesis, the LM statistic follows an asymptotic chi-square distribution with $\frac{N(N-1)}{2}$ degrees of freedom: The LM statistic is valid in panel data analyses when N is relatively small and T is sufficiently large.

$T \to \infty$ ve $N \to \infty$ for large panels, Pesaran (2004) introduced an improved version of the LM statistic that is calculated as follows Equation 3.

$$CD_{LM} = \left(\frac{1}{N(N-1)}\right)^{1/2} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T(\hat{\rho}_{ij}^2 - 1) \tag{3}$$

Under the null hypothesis, the CD_{LM} st converges to the standard normal distribution. However, the CD_{LM} est suffers from significant distortions when N is large, and T is small. Pesaran (2004) developed a more general cross-sectional dependence test that is valid for each panel when $T \to \infty$ and $N \to \infty$. It is calculated as follows, Equation 4 and is referred to as the CD test:

$$CD = \sqrt{\left(\frac{2T}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}\text{ij} \tag{4}$$

When the null hypothesis is valid, the CD test asymptotically follows a standard normal distribution. This test has a distribution with a mean of zero for fixed T and N values and is robust to heterogeneous dynamic models such as multiple breaks in the slope. In the presence of unconditional dependence, even when the coefficients, error terms, and independent variables remain unchanged over time, the innovations of these variables may exhibit asymmetric distributions (Pesaran, 2004). However, when the average bivariate correlation is close to zero, the sensitivity of the CD test may decrease (Pesaran, Ullah & Yamagata., 2008). Pesaran & colleagues (2008) developed an alternative version of the LM test that includes variance and mean adjustments to overcome this situation. The adjusted LM statistic is calculated as follows Equation 5:

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{n} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\sqrt{\cup_{Tij}^2}} \tag{5}$$

In the equation, μ_{Tij} and $\cup_{Tij}^2$ are the true mean and variance of $(T-k)\hat{\rho}_{ij}^2$. Under the null hypothesis, the LM_{adj} test is asymptotically normally distributed (Kar, Nazlıoğlu & Ağır, 2011).

PANIC unit root test

The horizontal-section dependence test results indicate significant dependence across countries in the series. This situation necessitates using second-generation panel unit root tests that account for inter-unit reliance, rather than traditional unit root tests, in the analyses. In this context, the PANIC (Panel Analysis of Nonstationarity in Idiosyncratic and Common Components) test, which accounts for cross-sectional dependence, was preferred in the study. Developed by Bai & Ng (2004, p. 1088), the PANIC test can determine whether stationarity in the series is common, idiosyncratic, or both. Additionally, the PANIC method can choose the number of independent stochastic trends affecting the common factors in the panel data. This test enables a consistent combination of statistics from individual series, yielding robust results in panel data analysis. One of the most notable features of PANIC is that it analyses unobserved components—common factors and idiosyncratic error terms—rather than examining the observed data directly. Bai & Ng (2004) emphasise that the method's main advantage is its ability to consistently estimate these structures without prior knowledge of whether they are stationary or integrated processes.

Panel ARDL

This study used the panel autoregressive distributed lag (ARDL) model developed by Pesaran et al. (1999) to investigate interactions among variables. One advantage of the panel ARDL method is that it tests for cointegration without requiring the variables to be equally stationary. In the Panel ARDL $(p, q_1, q_2, \ldots, q_t)$ model, the pth- and qth-order lags of the dependent and independent variables are on the right-hand side of the equation. This model can be written as follows, Equation 6;

$$Y_{it} = \mu_i + \sum_{j=1}^{pi} \lambda_{ij} Y_{it-j} + \sum_{j=0}^{qi} \delta_{ij} X_{it-j} + \varepsilon_{it} \tag{6}$$

Here $i = 1,2, \ldots, N$ denotes the number of cross section units, $t = 1,2, \ldots, T$ denotes the time, $j = 1,2, \ldots, T$ denotes the number of lags, μ_i denotes the constant effects, X_{it} denotes the explanatory variable vector, λ_{ij} denotes the coefficients associated with the lags of the dependent variable, δ_{ij} $(kx1)$ denotes the coefficient vector (Pesaran et al., 1999).

In the Panel ARDL method introduced to the literature by Pesaran, Shin & Smith (1999), two different test statistics are calculated for two different estimators: MG (Mean Group) and PMG (Pooled Mean Group). When calculating the test statistic for the MG estimator, there are no restrictions in the ARDL specification. Long-term coefficients are calculated as the average of the long-term coefficients obtained through unit ARDL estimates. The main criticism of the MG estimator is that various parameters are not the same across units in the panel. This shortcoming of the MG estimator is addressed in the PMG estimator. In the PMG estimator, the long-term coefficients must be the same across countries in the panel. However, for the short term, the coefficients, the constant, and the error variances can differ across countries in the panel. The decision on which values from the MG and PMG estimators to use is made using the Hausman test (Pesaran et al., 1999).

In the Hausman (1978) test, the null hypothesis is that the variables are homogeneous in the long run, while the alternative hypothesis is that they are heterogeneous. If the probability value of the chi-square test statistic obtained from the Hausman test is less than 0.10, the null hypothesis is rejected, and it is decided that the MG estimator should be used. Otherwise, the PMG estimator is used.

Kao residual cointegration test

The Kao residual cointegration test determines whether there is a long-term relationship between variables in panel data sets (Kao, 1999). The test's null hypothesis (H_0) is that there is no cointegration between the series, while the alternative hypothesis (H_1) states that there is a long-term relationship between the series. In applying the test, the long-term regression equation is first estimated using

Ordinary Least Squares (OLS), then the residuals are obtained, and a unit root test is applied to determine whether the residuals are stationary. If the residuals are stationary (I(0)), then cointegration between the variables is concluded. In interpreting the results, if the p-value is less than the critical threshold of 0.05, H_0 is rejected, and cointegration between the series is accepted; otherwise, H_0 cannot be rejected, and it is concluded that there is no long-term relationship. This test, which assumes homogeneous cointegration coefficients, should be evaluated alongside other panel cointegration tests that allow for heterogeneous structures, such as the Pedroni (1999, 2004) test.

Fully modified ordinary least squares-FMOLS

The FMOLS is an advanced regression method used to estimate long-term cointegration relationships in panel data analysis (Phillips & Hansen, 1990). While the traditional Ordinary Least Squares (OLS) estimator may be affected by autocorrelation and simultaneity bias in series with cointegrating relationships, the FMOLS method corrects for these issues and enables consistent and efficient estimation. In applying the test, the presence of cointegration between variables is first determined, followed by the calculation of long-term coefficients using the FMOLS estimator, and autocorrelation and endogeneity issues are addressed by adding correction terms. In interpreting the results, the significance of the estimated coefficients is examined, and their signs indicate the direction of the long-term relationship between the variables. The FMOLS method, particularly effective in small samples, is recommended for use alongside the Dynamic OLS (DOLS) method, as proposed by Pedroni (2000) and Kao and Chiang (2000), for comparative analyses.

Results

Table 2 contains descriptive statistics for the GOVHE, GDP, and 65YOLD variables. The natural logarithms of all variables were taken before analysis. According to the analysis results, the GOVHE variable has a mean of 3.06109 and a standard deviation of 1.37677, indicating a relatively normal distribution. The mean of the GDP variable is 49.21138, and its standard deviation is 7.42642. The mean for the 65OLD variable is 17.28, and the standard deviation is 3.93. The number of observations is equal for all variables, totalling 231. These findings provide a general idea about the statistical distribution of the variables to be analysed and indicate that the data have been appropriately subjected to logarithmic transformation. In particular, the wide range of data values underscores the need to account for heterogeneity in the analyses.

Table 2: Descriptive Statistics

	GOVHE	**GDP**	**65OLD**
Average	3061.09	49211.38	17.28
Maximum	9359.55	72165.48	29.92
Minimum	1051.92	35051.08	11.22
Standard Deviation	1376.77	7426.42	3.93
Number of Observations	231	231	231

Table 3 shows the correlation coefficients calculated from logarithmic values of the variables. A strong, positive, and statistically significant relationship exists between LNGOVHE and LNGDP, with a correlation coefficient of 0.77. There is also a statistically significant positive relationship between LNGOVHE and LN65OLD at the 0.31 level. The correlation coefficient between LNGDP and LN65OLD is 0.08, a very low value that is not statistically significant (p>0.05).

Table 3: Correlation Analysis Results

	LNGOVHE	**LNGDP**	**LN65OLD**
LNGOVHE	1		
LNGDP	0.77**	1	
LN65OLD	0.31**	0.08	1

* p<0.05 ** p<0.01

The horizontal-section dependence test results presented in Table 4 indicate a statistically significant dependence across units in the panel data set. The Breusch-Pagan (1980) LM test produced relatively high values for all variables, and the results were significant at the 1% level. This indicates that the assumed independence hypothesis should be rejected and that there are interactions between units in the panel. Similarly, the scaled LM test proposed by Pesaran (2004) and the bias-corrected scaled LM test developed by Baltagi, Feng, & Kao (2012) also yielded significant results for all three variables (LNGOVHE, LNGDP, LN65OLD). Although these tests' results yield smaller values than those of the traditional LM test, all are statistically significant at the 1% level.

Additionally, Pesaran's (2004) CD test shows significant cross-sectional dependence for all variables. The CD test results also indicate that the dependence is not merely random but reflects a systematic structure. Overall, these findings suggest the presence of standard shocks or interactions between countries or units in the panel data set. Therefore, it is essential to prioritise methods that account for this dependence in analyses.

Table 4: Horizontal Section Dependency Results

	LNGOVHE	LNGDP	LN65OLD
Breusch and Pagan (1980) LM	572.48**	544.45**	581.35**
Pesaran (2004) scaled LM	85.09**	80.77**	86.46**
Baltagi et al. (2012) bias-corrected scaled LM	84.98**	80.66**	86.35**
Pesaran (2004) CD	23.83**	22.96**	24.03**

* p<0.05 ** p<0.01

The results of the Bai & Ng (PANIC) panel unit root test presented in Table 5 evaluate the stationarity of the series at the level (I(0)) and after first differencing (I(1)). The appropriate lag length was determined using the AIC criterion, with a maximum lag of 4; the Bai & Ng method was preferred for factor selection, and the average criterion was used. The Schwert criterion was used to determine the highest number of factors. In the tests conducted at the level (At level I(0)), it was observed that the LNGOVHE and LNGDP variables contained a significant unit root under the constant and constant and trend models, meaning they were not stationary. However, under the continuous model, the LNOLD variable was found to be stationary at the 1% significance level. This indicates that the LN65OLD series may be stationary at the level. When the first differences of the series are taken (At first difference I(1)), the LNGOVHE and LNGDP variables produce statistically significant test values at the 1% level under both the constant and constant-trend models, indicating that these variables are stationary at I(1), i.e., the first difference. The LN65OLD variable also produced statistically significant results at the 1% level in the first-difference under constant and constant-and-trend conditions. These findings reveal that the series are mostly stationary when first differences are taken and should be analysed at this level. This result is essential in achieving the common integration degree required for advanced tests such as panel cointegration analysis.

Table 5: Bai & Ng (PANIC) Test Results

	At level I(0)		
	LNGOVHE	**LNKGDP**	**LN65OLD**
Constant	0.52	-1.02	9.10**
Constant & Trend	-1.85	-1.61	0.02
	At first difference I(1)		
	LNKGOVHE	**LNGDP**	**LN65OLD**
Constant	4.66**	7.51**	-2.61**
Constant & Trend	8.10**	-2.21*	-2.54**

* and ** indicate significance at the 5% and 1% levels, respectively. The appropriate lag length was determined using the AIC criterion; the maximum lag length was set at 4; the Bai and Ng method was used for the factor selection model, the criterion mean was preferred as the factor selection criterion, and the Schwert criterion was used for the highest number of factors.

Table 6 presents the results of various information criteria for determining the appropriate lag length for the Vector Autoregressive (VAR) model. Since the lag length is an important parameter affecting the model's accuracy and validity, the selection criteria have been carefully evaluated. The information criteria listed in the table, such as AIC (Akaike Information Criterion), SC (Schwarz Information Criterion), and HQ (Hannan-Quinn Information Criterion), as well as LR (Sequential Modified LR Test) and FPE (Final Prediction Error) values, were also utilised. These criteria, calculated for each lag level, aim to increase the model's predictive power while preventing excessive parameter usage. According to the results, different criteria suggest different lag lengths. According to the SC and HQ criteria, the most appropriate lag length was four. AIC and FPE, on the other hand, prefer a lag length of 6. The LR test also yielded significant results at the fourth lag level at the 5% significance level. Since most information criteria (especially more conservative ones such as SC and HQ) point to the fourth lag level, it would be more appropriate, from a methodological perspective, to use a lag length of 4 in the analyses. Thus, the model will maintain sufficient information content and avoid excessive parametric complexity.

Table 6: Vector Autoregressive (VAR) Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	174.011	NA	3.290e-05	-1.810	-1.758	-1.789
1	1363.622	2328.868	1.230e-10	-14.303	-14.097	-14.219
2	1572.071	401.458	1.490e-11	-16.413	-16.053	-16.268
3	1613.472	78.420	1.060e-11	-16.756	-16.242	-16.548
4	1641.015	51.298*	8.720e-12	-16.953	-16.284*	-16.682*
5	1650.029	16.503	8.720e-12	-16.953	-16.129	-16.619
6	1659.214	16.523	8.710e-12*	-16.955*	-15.977	-16.559

* Indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Table 7 presents the long-term and short-term results of the Panel ARDL (Autoregressive Distributed Lag) model. The logarithm of public health expenditures (D(LNGOVHE)) was used as the dependent variable, and the model was automatically selected as an ARDL (2,3,3) based on the Akaike Information Criterion (AIC). The long-term coefficients reveal the equilibrium relationship between the variables. Accordingly, a positive and significant relationship exists between per capita income and public health expenditures (coefficient = 1.048861, $p < 0.01$). Similarly, the proportion of the population aged 65 and over also positively and significantly affects public health expenditures in the long term (coefficient = 0.654989, $p < 0.01$). These findings indicate that economic growth and an ageing population lead to higher long-term public health expenditures.

When looking at short-term dynamics, the error correction term [ECT(-1)] was negative (- 0.273630) and significant at the 1% level (p=0.0001). This result indicates that the system is returning to its long-term equilibrium at approximately 27% per period and that the model contains a valid cointegration relationship. On the other hand, the variables D(LNGDP) and D(LNGDP(-1)) have adverse, significant effects on public health expenditures in the short term. This suggests that economic growth may temporarily suppress health expenditures. The short-term coefficients for the LN65OLD variable are not statistically significant, indicating that the elderly population ratio does not significantly affect health expenditures in the short term. The constant term was also found to be negative and significant. Overall, the findings reveal that public health expenditures are strongly influenced by economic growth and the elderly population ratio in the long term. However, only economic growth has a significant effect in the short term. Additionally, because the model's error-correction mechanism is substantial, the long-term equilibrium is valid.

Table 7: Panel ARDL Results

Dependent Variable: D(LNGOVHE)				
Selected Model: ARDL(2, 3, 3)				
Variable	**Coefficient**	**Standard error**	**t-Statistic**	**p***
		Long-Term Equality		
LNGDP	1.049	0.102	10.308	0.0001**
LN65OLD	0.655	0.078	8.414	0.0001**
		Short-Term Equality		
ECT (-1)	-0.274	0.072	-3.811	0.0001**
D(LNGOVHE(-1))	0.131	0.087	1.510	0.133
D(LNGDP)	-0.822	0.193	-4.248	0.0001**
D(LNGDP (-1))	-0.455	0.092	-4.916	0.0001**
D(LNDGP (-2))	0.028	0.347	0.080	0.936
D(LN65OLD)	-0.144	1.803	-0.080	0.937
D(LN65OLD (-1))	-0.838	1.792	-0.468	0.641
D(LN65OLD (-2))	1.958	1.455	1.346	0.180
C	-1,410	0,385	-3.665	0.0001**

* significant at % 5%; ** significant at % 1%; Maximum dependent lags: 4 (Automatic selection); Model selection method: Akaike info criterion (AIC); Dynamic regressors (4 lags, automatic): LNGDP, LNOLD; Fixed regressors: C

The Kao Residual Cointegration Test results presented in Table 8 test the existence of a long-term cointegration relationship between the variables in the panel data set. The ADF statistic was -3.381161 and was statistically significant at the 1% level (p=0.0004). This indicates that the null hypothesis, "there is no cointegration," is rejected, and a long-term equilibrium relationship exists between the variables. The table also provides information on error term characteristics, including the model's residual variance (0.002829) and the HAC (heteroskedasticity- and autocorrelation-consistent) variance (0.003230). These values support the stability and reliability of the model's residual structure. Overall, the results indicate that the variables in the panel data set move together and have a common long-term equilibrium relationship. This strengthens the validity of the long-term coefficients obtained from the Panel ARDL model.

Table 8: Kao Residual Cointegration Test Results

	t-Statistic	**p**
ADF	-3.381161	0.0004**
Residual variance	0.002829	
HAC variance	0.003230	

* significant at %5; ** significant at %1; Newey-West automatic bandwidth selection and Bartlett kernel

The FMOLS estimation results presented in Table 9 were conducted to evaluate the long-term relationship and show that the model has high explanatory power. The independent variables examined for their effects on the dependent variable were determined as LNGDP and LN65OLD. According to the results, the coefficient for the LNGDP variable is 2.027866, and it is statistically significant at the 1% level (p=0.0001). This indicates that economic growth positively and strongly affects public health expenditures. Similarly, the coefficient for the LN65OLD variable is 0.544333 and is also statistically significant at the 1% level (p=0.0001). This result shows that an increase in the elderly population ratio is associated with higher health expenditures. The model's overall performance is relatively high. The R-squared value is 0.890375, and the adjusted R-squared value is 0.886295, indicating that the model explains approximately 89% of the variation in the dependent variable. The standard error of the regression is 0.125918, indicating that the model's predictions are highly accurate. The long-term variance was determined to be 0.041633, indicating the model's long-term stability. The long-term covariance matrix is estimated using the Bartlett kernel and Newey-West constant bandwidth, corrected for autocorrelation and heteroscedasticity, thereby increasing the reliability of the estimates. Overall, the FMOLS results strongly support the notion that per capita income and the elderly population have statistically significant and positive effects on public health expenditures in the long term.

Table 9: FMOLS Results

Variable	Coefficient	Std. Error	t-Statistic	p
LNGDP	2.028	0.177	11.464	0.0001**
LN65OLD	0.544	0.129	4.205	0.0001**
R-squared	0.890	Mean dependent var		7.964
Adjusted R-squared	0.886	S.D. dependent var		0.373
S.E. of regression	0.126	Sum squared resid		3.409
Long-run variance	0.042			

* Significant at % 5%; ** significant at % 1%; Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

Discussion and conclusion

In this study, the relationship between per capita income, public health expenditures, and the elderly population ratio in G-7 countries was evaluated using the Panel ARDL method. When the study's initial findings were assessed, it was observed that in the short term, per capita income harmed public health expenditures. At the same time, the population ratio of those aged 65 and over did not show a significant effect. These initial findings may support or contradict the findings of studies in this field. In general, it reflects the fact that income affects health expenditures and that expenditures increase as income rises. A high income level increases the demand for quality health services, encourages the use of new medical technologies, and can increase investment in health infrastructure (Grossman, 1972, p. 223). However, the short-term relationship between income and health expenditures in this study suggests that other factors may be decisive at this point. For example, a review of the literature reveals that some studies have found that higher income increases individuals' use of private health insurance, helping them cover their health expenditures and alleviating pressure on public health expenditures. The short-term relationship results from the ARDL model indicate that the interaction between income and health expenditures exhibits complex dynamics. In the short term, changes in income affect health expenditures through direct and indirect channels. First, the literature often states that higher income increases individuals' access to private health insurance, thereby shifting part of health expenditures from the public budget to the private sector (Ryan, Feldman & Parente, 2022, p. 225; Han, Kim, Min & Hahm, 2019, p. 184). Another explanation could be that economic development leads governments to invest in preventive healthcare services. That is, increases in preventive health programs in high-income countries reduce long-term treatment costs (World Health Organisation, 2010). Therefore, it can be argued that the adverse effect is mitigated by short-term income increases and rising prosperity, which reduce citizens' reliance on public resources and allow cost-saving impacts to be realised. Therefore, economic growth enables governments to invest more in preventive health services, thereby slowing down the increase in treatment expenditures in the short term (World Health Organisation, 2010). Due to the panel data structure, it can reveal heterogeneous effects that may vary across countries. Short-term income growth can create both demand- and supply-side effects. In the short term, income growth accelerates individuals' propensity to spend on health. In contrast, the impact of public health policies and infrastructure investments may become more pronounced in the medium- and long-term.

According to the findings, the proportion of the population aged 65 and over has no short-term impact on healthcare expenditures. Population ageing moderately increases acute care expenditures, while significantly increasing long-term care expenditures. The elderly population ratio can put long-term pressure on public health expenditures. Evidence also shows that medical technology, the most critical driver of increased health expenditures, strongly interacts with age and health status. In other words, population ageing strengthens the effect of medical technology on rising health expenditures (De Meijer et al., 2013, pp. 353-361). The elderly population has a higher burden of chronic diseases and greater healthcare needs (Cutler, 2001, p.91). Therefore, the literature supports the conclusion that the elderly population does not exert short-term pressure on healthcare expenditures. This situation can be explained by the elderly population ratio not being high enough to exert significant pressure on the public budget in the short term, or by other factors. The short-term impact of the elderly population on healthcare spending may not yet have reached a critical threshold in the countries analysed, suggesting that demographic ageing may not pose an immediate budgetary pressure. Among the determinants of this situation, factors such as the efficiency of healthcare delivery systems, the scope of preventive healthcare programs, and broader socioeconomic conditions may have contributed to the shaping of short-term expenditure patterns.

Another finding obtained from the analyses is that per capita income and the proportion of the population aged 65 and over positively affect public health expenditures in the long term. The findings obtained are consistent with those found in the health economics literature. The positive effect of per capita income on public health expenditures in the long term is reasonably expected. For example, a study examining the long-term relationship between income and public health expenditures in India between 1980 and 2013 found that income positively and significantly affects the increase in public health expenditures (Behera & Dash, 2016, p.44). Grossman (1972) notes that higher income raises expectations for access to comprehensive health services and increases the capacity to invest more in health infrastructure and service quality. A series of empirical studies have attempted to estimate the correlation between income and health expenditures and have concluded that health services are both an individual necessity and a national luxury good. The general finding is that as national income or wealth increases, expectations and health expenditures also rise, particularly in high-income countries, independent of changes in needs (European Commission, 2024).

Similarly, it is generally accepted that the proportion of the population aged 65 and over positively affects long-term public health expenditures. An ageing population places significant pressure on health systems. Studies show that the elderly population suffers from more chronic diseases and requires more health services. Older individuals, especially those with multiple chronic conditions, frequently suffer from conditions such as hypertension, arthritis, and diabetes (Brucker, Lauer, & Boege, 2022). In another study in Italy, 86% of adults aged 65 and older have at least one chronic disease, and 56.7% have two or more (Atella, Piano Mortari, Kopinska, Belotti, Lapi, Cricelli & Fontana, 2019, p. 1). Hospital admissions due to chronic diseases are increasing, medication consumption is rising, and the need for long-term care is emerging. The need for long-term care is gaining increasing importance on the health and social policy agendas of OECD countries, with the provision of higher-quality services for older people coming to the fore. This situation heightens concerns about the' cost of services and long-term sustainability (Organisation for Economic Co-operation and Development-OECD, 2005). Therefore, ageing can lead to higher long-term health expenditures.

Conclusion

In conclusion, the relationships among income, the elderly population ratio, and public health expenditures differ in the short and long term. Short-term income does not increase health expenditures, while the elderly population ratio does not affect public health expenditures. In the long term, however, income growth and an ageing population increase public health expenditures. Countries may need to reorganise their health systems to operate them optimally and efficiently to meet the demands of an ageing population. It is necessary to develop preventive health services**.** The short-term results of the panel ARDL analysis indicate that numerous, interrelated mechanisms shape the relationship between income and health expenditures. In the short term, changes in income can affect health expenditures through both direct and indirect channels. For example, higher income levels are associated with greater use of private health insurance, which can shift the financial burden from public budgets to the private sector. Additionally, economic development often enables governments to allocate more resources to preventive health services, thereby reducing long-term treatment costs. The short-term impact of the ageing population on health expenditures may not yet have reached a critical threshold in the countries analysed, suggesting that demographic ageing may not yet pose an urgent budgetary pressure. In such cases, other determinants such as the efficiency of healthcare delivery systems, the scope of preventive healthcare programs, and broader socioeconomic conditions may be more influential in shaping short-term spending patterns. These findings suggest that the short-term dynamics captured by the panel ARDL model cannot be attributed to a single factor, but rather may stem from the combined effects of demographic, economic, and institutional variables.

Limitations and future research

As with any research, this study has certain limitations. First, the analysis is based on panel data, which may obscure within-country differences in the determinants of healthcare expenditures. Second, some variables that could affect healthcare spending—such as healthcare quality indicators, lifestyle factors, and political and institutional characteristics—were included in the study, whereas others were not. This may limit a holistic understanding of the issue. Third, the study focuses on a specific time period, and structural changes in healthcare systems over time may alter the observed relationships.

Panel ARDL analyses across the G7 countries confirm a long-term trade-off among income, an ageing population, and public health expenditures. This highlights the need for policies that address both economic growth and demographic shifts to ensure sustainable health systems. Policymakers should adopt integrated financial, technological, and institutional strategies, including long-term planning for demographic and epidemiological changes, investment in digital health technologies, diversified financing models to enhance fiscal resilience, and strengthened preventive healthcare programs to reduce future costs.

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References

Atella, V., Piano Mortari, A., Kopinska, J., Belotti, F., Lapi, F., Cricelli, C., & Fontana, L. (2019). Trends in age-related disease burden and healthcare utilisation. *Aging Cell*, 18(1), e12861. https://doi.org/10.1111/acel.12861

Bai, J., & Ng, S. (2007). Panel unit root tests with cross-section dependence: A further investigation. *Working Paper*, Department of Economics, New York University.

Baltagi, B. H., Feng, Q., & Kao, C. (2012). A Lagrange multiplier test for cross-sectional dependence in a fixed effects panel data model. *Journal of Econometrics*, 170(1), 164–177. https://doi.org/10.1016/j.jeconom.2012.04.004

Bedir, S. (2016). Healthcare expenditure and economic growth in developing countries. *Advances in Economics and Business*, 4(2), 76–86. https://doi.org/10.13189/aeb.2016.040203

Behera, D., & Dash, U. (2016). Nexus between public health expenditure and income: Empirical evidence from Indian states. *Nexus*, 11(6), 44–52.

Biçer, İ., Konca, M., & Sarıgül, S. S. (2025). Sağlık harcamalarının belirleyicileri: Bir kantil regresyon uygulaması. *Trakya Üniversitesi Sosyal Bilimler Dergisi*, *27*(Ek), 63-92.

Bloom, D. E., Cafiero, E. T., Jané-Llopis, E., Abrahams-Gessel, T., Bloom, L. R., Fathima, S., ... & Sweet, S. (2011). *The global economic burden of noncommunicable diseases*. World Economic Forum.

Brucker, D. L., Lauer, E., & Boege, S. (2023). Americans aging with disabilities are more likely to have multiple chronic conditions. *Journal of Disability Policy Studies*, 34(1), 52–60. https://doi.org/10.1177/10442073221134665

Cutler, D. M. (2001). The contribution of better health to economic growth. In J. M. Poterba (Ed.), *Health and welfare policy in the United States* (pp. 91–125). University of Chicago Press.

De Meijer, C., Wouterse, B., Polder, J., & Koopmanschap, M. (2013). The effect of population aging on health expenditure growth: A critical review. *European Journal of Ageing*, 10, 353–361. https://doi.org/10.1007/s10433-013-0276-2

Deaton, A. (2003). Health, income, and inequality. *NBER Working Paper Series*, No. 9809. National Bureau of Economic Research. https://doi.org/10.3386/w9809

Economou, C., Kaitelidou, D., Kentikelenis, A., Maresso, A., & Sissouras, A. (2015). The impact of the crisis on the health system and health in Greece. In B. Rechel, E. Jakubowski, M. McKee, & E. Nolte (Eds.), *Economic crisis: Health systems and health in Europe* (pp. xx–xx). World Health Organization.

European Commission. (2024). *2024 ageing report: Economic and budgetary projections for the EU Member States (2022–2070)*. Publications Office of the European Union.

Farag, M., Nandakumar, A. K., Wallack, S. S., Hodgkin, D., & Gaumer, G. (2013). Health expenditures, income, and health status in a new panel of countries. *Review of Economics and Statistics*, *95*(1), 1-14.

Getzen, T. E. (2000). Health care is an individual necessity and a national luxury: Applying multilevel decision models to the analysis of health care expenditures. *Journal of health economics*, *19*(2), 259-270.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, 80(2), 223–255. https://doi.org/10.1086/259880

Hall, R. E., & Jones, C. I. (2007). The value of life and the rise in health spending. *The Quarterly Journal of Economics*, 122(1), 39–72. https://doi.org/10.1162/qjec.122.1.39

Han, J. W., Kim, D. J., Min, I. S., & Hahm, M. I. (2019). Association of supplementary private health insurance type with unmet health care needs. *Health Policy and Management*, 29(2), 184–194. https://doi.org/10.4332/KJHPA.2019.29.2.184

Kallestrup-Lamb, M., Marin, A. O., Menon, S., & Søgaard, J. (2024). Aging populations and expenditures on health. *The Journal of the Economics of Ageing*, *29*, 100518.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1), 1–44. https://doi.org/10.1016/S0304-4076(98)00023-2

Kao, C., & Chiang, M. H. (2000). On the estimation and inference of a cointegrated regression in panel data. *Advances in Econometrics*, 15, 179–222. https://doi.org/10.1016/S0731-9053(00)15007-8

Kar, M., Nazlıoğlu, Ş., & Ağır, H. (2011). Financial development and economic growth nexus in the MENA countries: Bootstrap panel Granger causality analysis. *Economic Modelling*, 28(1–2), 685–693. https://doi.org/10.1016/j.econmod.2010.05.015

Lama, P. (2023). The Economic Impact of Ageing on Healthcare. In *The Ageing Population: Impact Analysis on'Societal and Healthcare Cost'* (pp. 69-81). Singapore: Springer Nature Singapore.

Lau, M. K., & Pung, H. K. (2016). *Aging population and public health expenditure in the G7 countries: A dynamic panel analysis*. Journal of Public Economics, *138*, 26-38.

Navarro, F. H. (2014). Patterns of health-related behavior as predictors of medical expenditures (Doctoral dissertation, Walden University).

Noy, S., & Sprague-Jones, J. (2016). Comparative dynamics of public health spending: Re-conceptualising delta-convergence to examine OECD and Latin America. *International Journal of Comparative Sociology*, 57(6), 425–448. https://doi.org/10.1177/0020715216674262

OECD. (2005). *Long-term care for older people (The OECD Health Project)*. OECD Publishing. https://doi.org/10.1787/9789264015852-en

Özyilmaz, A., Bayraktar, Y., Işık, E., Toprak, M., Er, M. B., Besel, F., ... & Collins, S. (2022). The relationship between health expenditures and economic growth in EU countries: empirical evidence using panel fourier toda–yamamoto causality test and regression models. *International journal of environmental research and public health*, *19*(22), 15091.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1), 653–670. https://doi.org/10.1111/1468-0084.0610s1653

Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels. *Advances in Econometrics*, 15, 93–130. https://doi.org/10.1016/S0731-9053(00)15004-2

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 20(3), 597–625. https://doi.org/10.1017/S0266466604203073

Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels. *Cambridge Working Papers in Economics*, No. 0435.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012. https://doi.org/10.1111/j.1468-0262.2006.00692.x

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326. https://doi.org/10.1002/jae.616

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621–634. https://doi.org/10.1080/01621459.1999.10474156

Pesaran, M., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, 142(1), 50–93. https://doi.org/10.1016/j.jeconom.2007.05.010

Pesaran, M., Ullah, A., & Yamagata, T. (2008). A bias-adjusted LM test of error cross-section independence. *Journal of Econometrics*, 11(1), 105–127. https://doi.org/10.1016/j.jeconom.2007.05.001

Phillips, P. C. B., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *Review of Economic Studies*, 57(1), 99–125. https://doi.org/10.2307/2297545

Rechel, B., Jakubowski, E., McKee, M., & Nolte, E. (Eds.). (2018). *Organisation and financing of public health services in Europe* (No. 50). World Health Organization.

Ryan, C., Feldman, R., & Parente, S. (2022). The demand for individual insurance: Evidence from a private online marketplace. *American Journal of Health Economics*, 8(2), 275–299. https://doi.org/10.1086/718324

Sarıgül, S. S., Konca, M., & Biçer, İ. (2024). Yatak kapasitesinin ve kamu sağlık harcamalarının hasta memnuniyet düzeyi üzerindeki etkisi: Gelişmiş ve gelişmekte olan ülkeler örneği. *Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (2024), 269-284.

Varabyova, Y., & Schreyögg, J. (2013). International comparisons of the technical efficiency of the hospital sector: panel data analysis of OECD countries using parametric and non-parametric approaches. *Health Policy*, *112*(1-2), 70-79.

Wang, L., & He, J. (2019). The relationship between health expenditure and economic growth in G7 countries: A panel causality analysis. *Sustainability*, *11*(18), 5006.

World Health Organization. (2010). *The world health report 2010: Health systems financing: The path to universal coverage*. World Health Organization.

Yıldırım, Z., & Cebeci, A. (2021). Gelişmiş ülkelerde kamusal sağlık harcamaları ve sermaye birikimi İlişkisi: Panel eşbütünleşme analizi. *Yaşar Üniversitesi E-Dergisi*, *16*(62), 982-1004.

Appendix

Appendix 1: Cross-Section Short Run Coefficients

CANADA

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.494	0.014	-35.150	0.0001
D(LNGOVHE(-1))	0.1981	0.0244	8.098	0.0039
D(LNGDP)	-1.106	0.041	-27.275	0.0001
D(LNGDP(-1))	-0.825	0.062	-13.270	0.0009
D(LNGDP(-2))	-0.168	0.073	-2.274	0.1075
D(LN65OLD)	9.438	11.397	0.828	0.4683
D(LN65OLD(-1))	-10.524	35.276	-0.298	0.7849
D(LN65OLD(-2))	2.035	12.290	0.165	0.8790
C	-2.546	0.421	-6.046	0.0091

GERMANY

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.215	0.009	-22.557	0.0002
D(LNGOVHE(-1))	-0.129	0.035	-3.620	0.0362
D(LNGDP)	-1.097	0.056	-19.579	0.0003
D(LNGDP(-1))	-0.555	0.062	-8.819	0.0031
D(LNGDP(-2))	-0.457	0.064	-7.105	0.0057
D(LN65OLD)	-2.449	3.285	-0.745	0.5100
D(LN65OLD(-1))	1.724	7.991	0.215	0.8430
D(LN65OLD(-2))	-1.173	2.655	-0.442	0.6883
C	-1.035	0.317	-3.260	0.0471

FRANCE

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.407	0.019	-21.105	0.0002
D(LNGOVHE(-1))	-0.119	0.027	-4.293	0.0232
D(LNGDP)	-0.227	0.071	-3.168	0.0505
D(LNGDP(-1))	-0.589	0.067	-8.686	0.0032
D(LNGDP(-2))	-0.352	0.101	-3.474	0.0402
D(LN65OLD)	-0.568	8.148	-0.069	0.9488
D(LN65OLD(-1))	0.173	22.905	0.007	0.9944
D(LN65OLD(-2))	1.095	7.696	0.142	0.8959
C	-2.070	0.915	-2.261	0.1088

ITALY

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.466	0.006	-76.717	0.0000
D(LNGOVHE(-1))	0.425	0.013	31.982	0.0001
D(LNGDP)	-0.593	0.029	-20.258	0.0003
D(LNGDP(-1))	-0.529	0.028	-18.743	0.0003
D(LNGDP(-2))	-0.099	0.040	-2.438	0.0926
D(LN65OLD)	-2.046	3.997	-0.512	0.6439
D(LN65OLD(-1))	1.043	8.492	0.122	0.9100
D(LN65OLD(-2))	-0.503	3.710	-0.135	0.9006
C	-2.576	0.435	-5.914	0.0097

UNITED KINGDOM

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.057	0.002	-27.086	0.0001
D(LNGOVHE(-1))	0.409	0.044	9.113	0.0028
D(LNGDP)	-0.601	0.033	-17.905	0.0004
D(LNGDP(-1))	-0.375	0.031	-12.037	0.0012
D(LNGDP(-2))	0.512	0.046	11.100	0.0016
D(LNOLD)	-2.102	15.284	-0.137	0.8993
D(LNOLD(-1))	1.797	29.849	0.060	0.9558
D(LNOLD(-2))	-0.092	9.990	-0.009	0.9932
C	-0.279	0.074	-3.730	0.0336

JAPAN

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.023	0.004	-5.323	0.0129
D(LNGOVHE(-1))	0.133	0.042	3.134	0.0519
D(LNGDP)	-0.413	0.043	-9.426	0.0025
D(LNGDP(-1))	-0.164	0.054	-3.011	0.0571
D(LNGDP(-2))	-1.059	0.062	-16.976	0.0004
D(LN65OLD)	2.049	4.033	0.508	0.6463
D(LN65OLD(-1))	-3.329	8.772	-0.379	0.7296
D(LN65OLD(-2))	2.140	2.688	0.796	0.4841
C	-0.113	0.117	-0.968	0.4044

UNITED STATES

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
ECT(-1)	-0.249	0.014	-17.338	0.0004
D(LNGOVHE(-1))	-0.000	0.036	-0.009	0.9930
D(LNGDP)	-1.713	0.904	-1.895	0.1544
D(LNGDP(-1))	-0.142	0.879	-0.162	0.8812
D(LNGDP(-2))	1.820	0.907	2.006	0.1384
D(LN65OLD)	-5.327	29.444	-0.180	0.8679
D(LN65OLD(-1))	3.249	38.830	0.083	0.9386
D(LN65OLD(-2))	10.205	27.265	0.374	0.7331
C	-1.245	0.494	-2.517	0.0864