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ORIGINAL RESEARCH ARTICLE

Evaluation of long-term care expenditures from the silver economy perspective

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Abstract

Silver economics is a field of science that evaluates the long-term care needs that develop because of aging from the economics perspective within the supply and demand framework. The expenditures and investments made to meet long-term care needs constitute the main subject of long-term care expenditures. This study empirically tested the relationship between long-term care expenditures and life expectancy. Expenditures on long-term care facilities (LTCFE) were taken as the dependent variable, and life expectancy at birth (LEAB) and life expectancy at 65 years and over (LEO65) were taken as independent variables. The analysis included data from 25 countries with regular LTCFE from 2004 to 2020. The variables were analyzed using the econometric model established within the framework of panel data analysis. According to the least squares analysis results, a 1% increase in LEAB increased LTCFE by 2.1%, while a 1% increase in LEO65 decreased LTCFE by 0.54%. Moreover, a unidirectional causality relationship was found between LTCFE and LEAB and LEO65. The empirical evidence suggests that life expectancy impacted LTCFE. According to the findings, they emphasize the importance of aligning policy frameworks with demographic changes to ensure sustainable long-term care systems in aging societies.

Keywords: Econometric evaluation; Silver economy; Expenditures on long-term care facilities; Life expectancy; Aging population

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1. Introduction

The "silver economy" is defined as the economic opportunities arising from increased public and consumer spending of the aging population and the unique needs of people aged over 50 years (EC, 2015). Silver economies prioritize the quality of life of older persons from a holistic perspective, addressing issues such as employment of persons aged over 50 years, policies, such as lifelong learning for older persons, preventive health services, and creating a sustainable society (EC, 2015). Silver economics is a field of science that evaluates the long-term care needs that develop because of aging within a supply and demand framework from an economic perspective. The silver economy has significant socioeconomic and health impacts. From a socioeconomic perspective, the aging population may cause employment difficulties for younger generations as the retirement age increases or the aging population may face employment loss due to retirement, illness, etc. In addition, it may cause difficulties in the financial sustainability

of social security systems due to the decrease in the contribution to social system revenues and the increase in payments for retirement and social services due to various reasons, such as unemployment, informal employment, low wages, aging population, early retirement, economic instability, and migration.

With regard to social services, an aging population can cause significant changes in economies with the increased demand for health services, nursing homes, and other social services. This situation may require governments to rethink social and health service budgets and policies. The consumption habits of older individuals often differ. Difficulties in adapting to new technology and changing daily habits may also result in negative impacts on the quality of life of elderly individuals. The health effects of the silver economy include the risk of aging and chronic diseases, which may require healthcare systems to cope with chronic diseases. Increased demand for health services and healthcare costs may impose significant burdens on health systems. Nonetheless, the aging population's demand for health and social services may create new opportunities in these sectors, and economies may be positively affected by this demographic change (Streicher *et al*., 2022; Costa-Font & Vilaplana-Prieto, 2023; Spitzer & Reiter, 2024.). Therefore, governments must evaluate their economies from a sustainability perspective within the aging framework and the needs that will develop due to aging and make investments in this field. The most decisive feature of the silver economy is the needs arising from aging because of prolonged life expectancy. Aging and the accompanying chronic diseases create the need for long-term care, bringing healthcare to the forefront in this respect. In fact literature stated that long-term care services are considered as an important sector in the care economy after child care/education (Ilkkaracan & Kim, 2019; Norouzi & Angel, 2023).

The increase in life expectancy at birth (LEAB); the slowdown in the fertility rate; social, cultural, economic, and technological transformations; and developments in the field of health have led to an increase in the elderly population. Furthermore, health services provided to elderly individuals are more expensive than those provided to younger individuals (Demirci *et al*., 2019). Due to the high incidence of chronic diseases in elderly adults, they benefit more from long-term care services. According to the World Health Organization data, 1 out of every 6 people in the world will be 60 years of age or older in 2030, and the number of individuals aged 60 years and older is expected to double in 2050 (2.1 billion). Furthermore, individuals aged 80 years and older are expected to triple between 2020 and 2050, reaching 426 million (WHO, 2021). Changes in the age distribution of populations are observed in high-income countries (for example, in Japan, the number of people over the age of 60 years comprises 30% of the population); however, significant changes will also occur in low- and middle-income countries in the coming years. By 2050, many Organization for Economic Co-operation and Development (OECD) countries are expected to be aging, increasing the demand for long-term care services. Even Turkey, which has the youngest population among OECD countries, is projected to have 17.6% of its population aged 65 years and over in 2050 (Bal, 2016). Therefore, a sustainable method for financing long-term care services must be established.

Long-term care services are provided to people with reduced physical or cognitive capacity, including health and social care activities, and people dependent on external assistance to perform basic daily activities for an extended period (Bal, 2016). In general, long-term care services are provided by professional caregivers, paid caregivers, or family members (usually women) in the home of the person receiving the service, in an institution providing daytime services to elderly adults, or in living spaces such as supervised nursing homes. The need for long-term care arises due to illness, disability, chronic diseases, or problems arising from old age, and the duration of the need for long-term care varies depending on the cause for the same. As a natural consequence of aging, the demand for long-term services is increasing, and expenditures in this area are steadily rising, threatening the financial sustainability of society as the number of elderly individuals who need professional medical care or support in activities of daily living because of illness increases. Long-term care is labor-intensive, expensive under all circumstances, and requires more dedication and professionalism than other care services with unique emotional aspects (Bal, 2016). In 2021, approximately $467.4 billion was spent on long-term services and supports, representing 13.2% of the $3.6 trillion spent on personal healthcare in U.S.(Congressional Research Service, 2023).

Regarding financial sustainability, long-term care expenditures have become a priority policy issue in many countries with aging populations, such as the OECD nations. Studies emphasize that the aging population will put pressure on the healthcare system and the social security system (Aina *et al*., 2021; Cristea *et al*., 2020; Vlad & Mădălina, 2012). Moreover, solutions to be implemented through high premium taxes will put pressure on the economy. Research shows different and contradictory results on this relationship, and how and why long-term care expenditures affect life expectancy remains unclear (Spielauer, 2001). The ambiguity of the relationship

between long-term care expenditures and life expectancy is expressed in the fact that the causal link between them remains unproven. Without such evidence, the effects of an increase/decrease in long-term care expenditures on life expectancy may not be accurately estimated. There is no detailed study on this issue using one-to-one parametric methods; therefore, this study empirically analyzes the relationship between long-term care expenditures and life expectancy. Econometric analyses allow us to empirically reveal the causal relationship between two or more variables. Econometric forecasting models are one method to investigate future trends in spending and demand for long-term care based on demographic data (Spielauer, 2001; Spielauer, 2011; Schneider & Buchinger, 2009; Olivares-Tirado *et al*., 2011). To empirically test the relationship between long-term care expenditures and life expectancy, this study's research question was determined as follows:

Q_1: Is there a relationship between life expectancy and long-term care expenditures? If so, to what extent and in what direction does life expectancy affect long-term care expenditures?

2. Methods

This study used panel data analysis to investigate the relationship between life expectancy and long-term care expenditures. LEAB and life expectancy at 65 years and over (LEO65) were considered independent variables representing the silver economy. Expenditures on long-term care facilities (LTCFE) were considered the dependent variable for long-term care expenditures. The panel data method allows us to test many countries and multi-temporal data together. In this context, the analysis was conducted in three stages. In the first stage, descriptive information about the variables subject to the research was given, and the significance tests of the econometric model were carried out using the least squares method. In the second stage, unit root tests were performed to determine the degree of stationarity of the variables. In the third stage, the lag length of the model was determined, and the causality relationship between the variables was analyzed with the Dumitrescu Hurlin (DH) panel causality test.

2.1. Variables

In this study, LEAB and LEO65 were determined as independent variables, and LTCFE (per capita, current prices, and current public-private partnerships [PPPs]) was determined as the dependent variable within the scope of long-term care expenditures in health. Data on health expenditures were generally recorded as total health expenditures at the country level. A few countries follow classifications by health expenditure functions, such as preventive, curative, and long-term care expenditures; these countries are in the high-income group. The year range was 2004 – 2020, and 25 countries with regular data on long-term care facility expenditures were identified: Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Japan, South Korea, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Switzerland, and the United States.

2.2. Statistical analysis

EViews 10 software (EViews 10, IHS Global Inc., 4521 Campus Drive, #336, Irvine, CA 92612) was used for statistical analysis.

3. Results

The average LEAB was 79.75 ± 2.94 years (min: 70.60; max: 84.60), LEO65 was 14.75 ± 2.94 (min: 19.60; max: 5.60), and LTCFE was 350.37 ± 325.96 per capita/PPP (min: 1.37; max: 1,669.19) (Figure 1).

LEAB increased by 2 – 9% over 16 years in the countries included in this study. In 16 years, the LEO65 increased from 10% to 20% in Austria, Belgium, Canada, France, Germany, Greece, Iceland, Japan, Netherlands, Poland, Portugal, Spain, and Switzerland. It increased by 21 – 50% in Czech Republic, Denmark, Finland, Hungary, South Korea, Lithuania, Luxembourg, Norway, and Slovenia and by 70 – 90% in Estonia and Latvia. In the United States, LEO65 decreased by 5%. LTCFE increased by 16 – 19 times in Czech Republic, Greece, and South Korea, whereas it decreased by 28% in Luxembourg. Table 1 shows the 16-year change in the variables subject to the research.

The equation to define the econometric model is as follows:

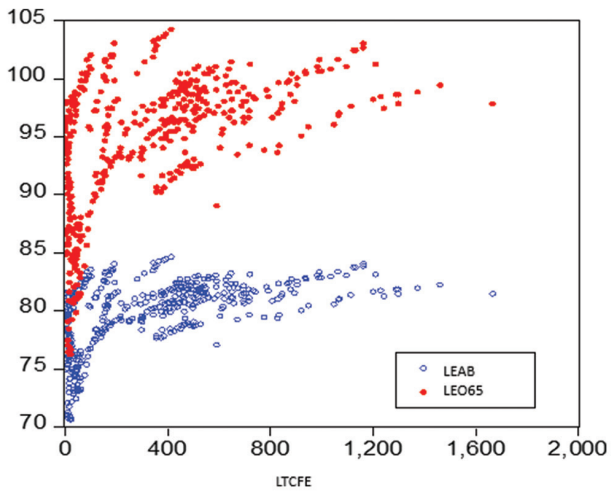

Figure 1. LTCFE, LEO65, and LEAB from 2004 to 2020

$$LTCFEit = \beta 0 + \beta 1LEABit + \beta 2LEO65it + uit.$$

Here, "β_0" represents the constant coefficient, "β_1" represents the LEAB, "β_2" represents LEO65, "u" represents the error term, "i" represents the countries in the cross-sectional dimension of the panel data, "t" represents the time dimension of 2004 – 2020, and "LTCFE" represents the dependent variable. Least squares analyses showed that the random effects (RE) model gave more consistent results in estimating the model established in the research according to the Hausman test result (*p*

Table 1. LTCFE, LEO65, and LEAB: Percentage change from 2004 to 2020

Countries	Year	LTCFE*	LEAB	LEO65	Countries	Year	LTCFE*	LEAB	LEO65
Austria	2004	214.12	79.30	14.30	S. Korea	2004	4.83	77.80	12.80
Austria	2020	474.84	81.30	16.30	S. Korea	2020	101.27	83.50	18.50
Austria	% change	1.22	0.03	0.14	S. Korea	% Change	19.96	0.07	0.45
Belgium	2004	303.52	79.00	14.00	Latvia	2004	21.00	70.90	5.90
Belgium	2020	642.44	80.80	15.80	Latvia	2020	61.44	75.50	10.50
Belgium	% change	1.12	0.,02	0.13	Latvia	% Change	1. 93	0.06	0.78
Canada	2004	342.51	80.10	15.10	Lithuania	2004	12.32	72.00	7.00
Canada	2020	736.05	81.70	16.70	Lithuania	2020	47.98	75.10	10.10
Canada	% change	1.15	0.02	0.11	Lithuania	% Change	2.89	0.04	0.44
Czech Republic	2004	16.92	75.90	10.90	Luxembourg	2004	674.59	79.20	14.20
Czech Republic	2020	300.69	78.0	13.30	Luxembourg	2020	486.13	82.20	17.20
Czech Republic	% change	16.77	0.03	0.22	Luxembourg	% Change	−0.28	0.04	0.21
Denmark	2004	358.83	77.80	12.80	Netherlands	2004	830.32	79.30	14.30
Denmark	2020	652.59	81.60	16.60	Netherlands	2020	1669.20	81.40	16.40
Denmark	% change	0.82	0.05	0.30	Netherlands	% Change	1.01	0.03	0.15
Estonia	2004	45.33	72.40	7.40	Norway	2004	613.78	80.10	15.10
Estonia	2020	184.66	78.90	13.90	Norway	2020	993.91	83.30	18.30
Estonia	% change	3.07	0.09	0.88	Norway	% Change	0.62	0.04	0.21
Finland	2004	251.76	79.00	14.00	Poland	2004	6.00	74.90	9.90
Finland	2020	534.90	82.00	17.00	Poland	2020	24.65	76.50	11.50
Finland	% change	1.12	0.04	0.21	Poland	% Change	3.11	0.02	0.16
France	2004	157.36	80.40	15.40	Portugal	2004	13.31	78.40	13.40
France	2020	650.78	82.30	17.30	Portugal	2020	44.55	81.10	16.10
France	% change	3.14	0.02	0.12	Portugal	% Change	2.35	0.03	0.20
Germany	2004	300.23	79.30	14.30	Slovenia	2004	110.27	77.20	12.20
Germany	2020	649.81	81.10	16.10	Slovenia	2020	221.40	80.60	15.60
Germany	% change	1.16	0.02	0.13	Slovenia	% Change	1.01	0.04	0.28
Greece	2004	1.37	79.40	14.40	Spain	2004	95.16	80.40	15.40
Greece	2020	28.55	81.40	16.40	Spain	2020	195.55	82.40	17.40
Greece	% change	19.81	0.03	0.14	Spain	% Change	1.05	0.02	0.13
Hungary	2004	38.17	73.00	8.00	Switzerland	2004	690.25	81.30	16.30
Hungary	2020	70.83	75.70	10.70	Switzerland	2020	1212.59	83.10	18.10
Hungary	% change	0.86	0.04	0.34	Switzerland	% Change	0.76	0.02	0.11
Iceland	2004	467.46	81.10	16.10	United States	2004	358.85	77.60	12.60
Iceland	2020	723.85	83.10	18.10	United States	2020	593.93	77.00	12.00
Iceland	% change	0.55	0.02	0.12	United States	% Change	0.66	−0.01	−0.05
Japan	2004	68.35	82.10	17.10					
Japan	2020	416.00	84.60	19.60					
Japan	% change	5.09	0.03	0.15					

*Per capita, current prices, current PPPs, long-term care (health), and residential long-term care facilities.
Abbreviations: LTCFE: Expenditures on long-term care facilities; LEAB: Life expectancy at birth; LEO65: Life expectancy at 65 years and over.

= 0.9613). According to these results, the econometric model was analyzed under the RE model, revealing that the independent variables had a good explanatory power on the dependent variable; however, multicollinearity, cross-sectional dependence, and autocorrelation problems persisted in the model. Therefore, the new model was re-estimated under the AR(1) model, and no multicollinearity, cross-sectional dependence, or autocorrelation problem (at a 1% significance level) were found. According to the least squares results in Table 2, a 1% increase in the LEAB increased LTCFE by 2.1%, while a 1% increase in the LEO65 decreased LTCFE by 0.54%. Furthermore, diagnostic tests showing the validity of least squares analyses confirm the suitability of the econometric model established in the research.

At this stage, the augmented Dickey-Fuller Fisher Chi-square test, which is a unit root test, was done to determine whether the variables were stationary (Levin *et al.*, 2002). In these tests, the null hypothesis indicates the presence of a unit root, and the alternative hypotheses indicate the absence of a unit root. Table 3 shows that all variables were stationary at the 1% significance level.

Causality analysis is a technique used to explain the causal relationship between two variables. It evaluates whether the lagged values of the other variable (for example, the X_t variable) in a relationship contribute to explaining the current value of one of the variables (for example, the Y_t variable) (Granger, 1969). This study used the DH causality method to determine the causal relationship between the variables. Panel causality analyses developed by Dumitrescu and Hurlin (2012) do not require testing the cointegration relationship between variables; they provide more effective and consistent results in cases of horizontal cross-section dependence and take heterogeneity and short time dimension into account (Tang *et al.*, 2009). The results obtained in the analysis revealed unidirectional causality relationships of LEAB and LEO65 with LTCFE. According to this result, changes in LEAB and LEO65 unilaterally affected LTCFE. Table 4 presents the results.

Table 2. Least squares test results

Dependent variable	Independent variable	Coefficient	Significance
LTCFE	LEAB	2.168702	0.0000
	LEO65	−0.543117	0.0338*
	AR (1)	0.978071	0.0000

Diagnostic test results: Breusch–Pagan LM=0.0265*; Pesaran scaled LM=0.0447*; Durbin Watson=1.926913; Skewness Value=0.508116; Kurtosis Value=5.658287; R^2=0.99; Adjusted R^2=0.99. * denotes a 5% significance level; variables are used in logarithmic form in the analysis.
Abbreviations: LTCFE: Expenditures on long-term care facilities; LEAB: Life expectancy at birth; LEO65: Life expectancy at 65 years and over.

Table 3. Unit root test results

Variables	Augmented Dickey-Fuller Fisher Chi-square test	Level
LTCFE	0.0000*	I (0)
LEAB	0.0002*	I (0)
LEO65	0.0000*	I (0)

*1% significance level.
Abbreviations: LTCFE: Expenditures on long-term care facilities; LEAB: Life expectancy at birth; LEO65: Life expectancy at 65 years and over.

Table 4. Dumitrescu Hurlin panel causality test results

Null hypothesis	W-Stat.	ZbarStat	Prob.	Decision
LEO65 ≠|> LTCFE	4.08902	2.45029	0.0143*	LEO65→LTCFE LEAB→LTCFE
LTCFE ≠|> LEO65	2.98160	0.73955	0.4596	
LEAB ≠|> LTCFE	4.02408	2.34998	0.0188*	
LTCFE ≠|> LEAB	2.94350	0.68071	0.4961	
LEAB ≠|> LEO65	2.14428	0.55108	0.5816	
LEO65 ≠|> LEAB	2.27707	0.34536	0.7298	

*5% significance level.
Abbreviations: LTCFE: Expenditures on long-term care facilities; LEAB: Life expectancy at birth; LEO65: Life expectancy at 65 years and over.

4. Discussion

Elderly populations in OECD countries are increasing because of high life expectancy and declining fertility rates. While the share of the population aged 65 years and over in these countries averaged <9% in 1960, it increased to 17% in 2015 and is expected to reach 28% by 2050 (OECD, 2017).

The aging of the population brings a significant increase in the number of individuals with diseases requiring long-term care, such as chronic and mental disorders. The demand for long-term care is considered age-related and mostly demanded by individuals aged 65 years and over (Colombo *et al.*, 2011). In addition, the global long-term care industry was projected to reach a market value of $1.6 trillion, with an annual growth rate of 8.5% between 2021 and 2027 (Ugalmugle & Swain 2021). The need for long-term care also means increased health expenditures. A study examining the expenditures per patient during the 60 months before death calculated total long-term care expenditure as USD48, 319, of which USD27, 217 belonged to institutional care services and USD21, 102 to home care services (Teraoka *et al.*, 2021). French *et al.* (2017) determined that health expenditure per capita in the past 12 months of life was USD80,000 in the United

States, USD60,000 in Denmark and the Netherlands, and USD50,000 in Germany. Brent (2022) reported that the value of years of life lost per person in nursing home adults was USD1.7 million that corresponding to in 2016 approximately 10% of national income as USD 18.7 trillion for the USA.

This study aimed to determine the economic evaluation of the relationship between long-term care expenditures and LEAB and those over 65 years of age in the silver economy, where long-term care investments are essential. The causality results revealed unidirectional relationships of LEAB and LEO65 to LTCFE. According to this result, changes in LEAB and LEO65 unilaterally affect LTCFE. Analyses using the econometric model revealed that a 1% increase in the LEAB increased LTCFE by 2.1%, while a 1% increase in the LEO65 decreased LTCFE by 0.54%. While this effect increased LTCFE because of extended life expectation at birth, LEO65 decreased LTCFE. Considering the increasing effect of LTCFE in LEAB and the extension of life expenses, it is necessary to build infrastructure and investments for LTCFE and increase these investments. In contrast, the increase of LEO65 decreased LTCFE because it can be interpreted that there is inherently a limit to the life expectancy of those aged 65 years and over. Therefore, this study's results confirmed the hypothesis that LEAB, LEO65, and LTCFE are related and were evaluated in line with the literature (Jaba *et al.*, 2014; Sey & Aydın, 2019; Şener & Yiğit, 2017; Şahbudak & Şahin, 2015).

5. Conclusion

When the needs that develop because of aging are considered from socioeconomic and health perspectives, increases in the incidence of chronic diseases (such as heart diseases, diabetes, hypertension, and cancer) that develop with old age, deterioration in joints and muscles, development of movement restrictions due to osteoporosis, mental health problems (such as dementia, Alzheimer's disease, and depression), and decreases in vision and hearing abilities require health services. Decreased income during retirement and decreased participation in social activities due to physical limitations or health problems may increase the feeling of social isolation in elderly individuals. For these reasons, the ability to perform daily living decreases with old age, which may increase the need for daily care. Furthermore, elderly individuals may have problems accessing health services because of mobility and economic factors. All these reasons can negatively affect the quality of life of elderly individuals. With the projected increase in the need for long-term care due to longer life expectancy, governments must design innovative health and social policies to implement services such as employment, health, infrastructure, and social protection in care services. In this context, we recommend the following:

- Design sports activity centers and culture-art centers specifically for the elderly
- Establish support teams to support daily activities in long-term care
- Define standards for long-term care processes
- Develop home healthcare services (home environment, palliative care, or integration into primary care services)
- Support/develop long-term care centers
- Design and support products suitable for the needs of elderly individuals[1]
- Increase public support to prevent economic inadequacy
- Expand/strengthen long-term care and support insurance.

This study provides policymakers with macroeconomic evidence to advance and regulate the future of long-term care needs in healthcare. Furthermore, this study's results provide evidence for resource allocation decisions in determining public expenditure policies.

The limitations of this study, considering the variables subject to the research, were the year range of these variables (between 2004 and 2020), and the countries included in the research. Moreover, the methods and variables used within the scope of the research were also considered research limitations.

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Conflict of interest

The author declares that she has no competing interests.

Author contributions

This is a single-authored article.

Ethics approval and consent to participate

Not applicable.

[1] I have worked in the field of nursing before. According to an incident I experienced in this field; "A 94-year-old patient of mine, who has a habit of regularly reading books using the bedside light before going to sleep, one day took the book printed on glossy paper in my hand and examined it, and told me that while reading these books at night, it tired her eyes because they reflected the light back. Because in their time, books were printed on straw paper."

Consent for publication

Not applicable.

Availability of data

OECD. Stat.report.

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