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Demographic and Social Aspects of an Increasing Elderly Population: Evidence from Panel Data Analysis[1]

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Abstract

This paper investigates determinants of increases in elderly populations by utilizing econometric models such as panel data analysis. All the results support stylized fact in the relationship between elderly populations, fertility, and GDP per capita in the long run. However, bi-directional channels are found to exist regarding changes in elderly populations, signifying that the primary determinants of increases in elderly populations come from demographic aspects rather than social aspects in the short run. Regarding care of the elderly, social aspects therefore appear to be quite vulnerable. It could be asserted that social systems should be carefully developed to suit aging societies.

Keywords*: Panel Data Analysis, Aging Society, Elderly Populations*

1. Introduction

Issues surrounding population aging have received considerable worldwide attention over the past two decades [1]. This is mainly because the ratio of elderly populations in the total population is gradually increasing in most European countries and rising sharply in the rest of the world [1]. This demographic transition can in general be divided into five phases [1, 2]. These are (1) pre-transition, (2) declining mortality, high fertility, accelerating population increases; (3) peak population growth; (4) crude birth rate declining faster than the crude death rate, and slowing population growth, and (5) post-transition [1, 2]. The demographic transition generally reaches its turning point in phase (4) [1]. A decline in fertility rates changes the age structure throughout all age groups by reducing the population in all age groups compared with the population at any higher age in these phases [1]. Declining mortality rates as well as decline in fertility have also been recognized in most developing and less-developed countries [1, 3-5].

Regardless of how demographic transition leads to population aging, in most countries [6], drastic increases in the elderly population tends to be strongly influenced or facilitated by a social aspect such as increased health expenditure or a well-established healthcare system [1]. This aspect is closely related to the national income level [1]. National income should therefore be included as a proxy variable for a social aspect in any analysis of population structure or demographic transition [1].

2. Literature Review

Previous studies in this field have mainly attempted to decompose demographic transition. Stokes and Preston [7] suggested that populations could be analyzed with fixed age-specific rates of fertility, mortality, and migration. They examined population growth

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[1] The paper is an extended version of *Primary Determinants of Increasing in Elderly Populations Implemented by Cross-County Regressions* which was presented at Workshop on Business 2015 Seventh (Paper ID: BUS7001) on August 2015.

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rates above the age of 65 between 2005 and 2010 in a sample of 13 high-income countries, and concluded that the distinction between birth rates and death rates is also useful for clarifying elements of future growth rates above the age of 65.

Angrisani, Palo, Fantaccione, and Palazzo [6] first focused on the relationship between socio-economic development and demographic trends in the population structure and size, and then on the joint effects of declining fertility rates and increasing life expectancies. They analyzed the population forecast of five high-income countries based on their current fertility rates and survival probabilities by utilizing the Leslie model. They found that the population decreases as the value of the Leslie dominant eigenvalue became lower than one.

Menon and Melendes [8] analyzed the trend of population aging in Asia using data from 1950s onward, and suggested structural reforms to manage the sharp increase in the elderly population. They also insisted that more attention be paid to designing policy options to deal with such a trend, as different sub-regions may require different responses.

Chesnais [2] investigated the patterns of demographic transition on the variation in size of all age groups and extended it to decompose the population multiplier by age group, especially for younger and elderly groups.

Hungerford, Rassette, Iams, and Koenig [9] attempted to explain economic trends by identifying changes in income for the elderly, and then analyzing how the trends had affected the demographic changes of the elderly population over the past 25 years.

Thus, previous research has primarily focused on demographic aspects in identifying population structures, and particularly on elderly populations, and has rarely applied quantitative methods of analysis. The present paper therefore analyzes demographic and social aspects simultaneously by formulating econometric models and then performs statistical analysis to enhance understanding of increases in elderly populations.

3. Empirical Results

3.1. Trends of Elderly Populations and Fertility Rates

The trends of elderly populations and fertility rates for 24 countries over 1970-2012 periods are depicted in Figures 1 and 2. These countries are selected on the basis of higher rates of the elderly population and fertility rates. As far as the elderly population is concerned, it begins at Austria (14.1%), Germany (13.2%), Greece (11.1%), Italy (11.1%), Japan (7.1%), and Korea (3.1%), respectively. It ends at 17.9%, 21.1%, 19.9%, 20.7%, 24.1%, and 11.8%, respectively in these periods. These are gradually increasing in most European countries and Japan has reached at the highest ratio in the year 2012. Korea is also one of the countries that experienced a sharply increasing ratio [1].

On the other hand, the fertility rate begins in Austria at (2.3%), Germany (2.0%), Greece (2.4%), Italy (2.4%), Japan (2.1%), and Korea (4.5%), respectively. It ends at 1.4%, 1.4% 1.3%, 1.4%, 1.4%, and 1.3%, respectively in these periods. These are gradually decreasing in most European countries; meanwhile Korea and Ireland experienced a drastic decrease in the ratio [1].

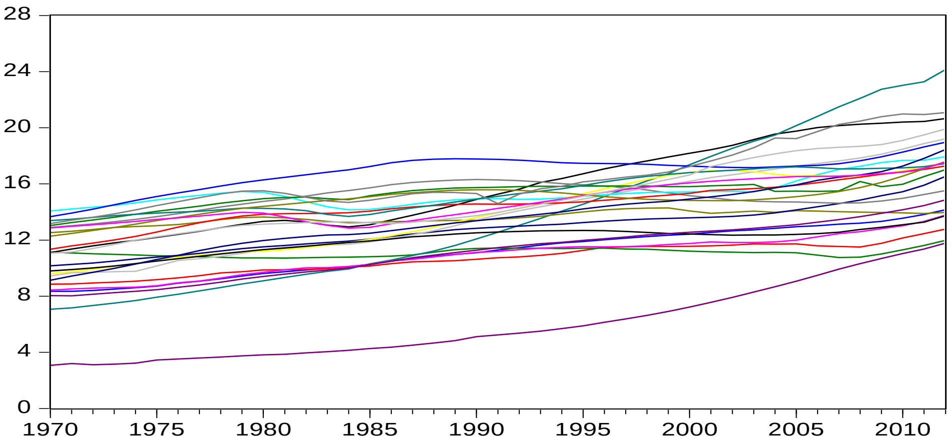

Figure 1. Trend of Elderly Populations: 1970-2012
Source: OECD database [1][9]

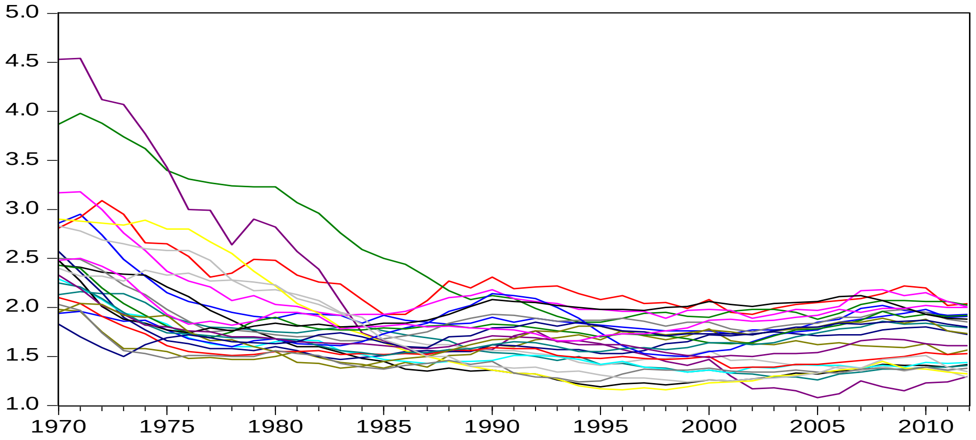

Figure 2. Trend of Fertility Rates: 1970-2012
Source: OECD database [1][9]

3.2. Basic Statistics of Variables

The variables used in the empirical analysis of this paper are as follows. Elderly population (EP) and fertility rates (FR) are a percentage of the total population and of the number of women respectively. GDP per capita (Y) is measured in U.S. dollars. The basic statistics for EP, FR, and Y are shown in Table 1. The standard deviation indicates that the fertility rate is the most stable out of the three variables, and that the elderly population is highly deviated from the mean value. With regards to skewness, fertility rates and GDP per capita are right-skewed because the values of these variables are positive. The fertility rate in particular is heavily right-skewed. The elderly population is identified as left-skewed in the same manner. Since the kurtosis for normal distributions is set at 3, the fertility rate is leptokurtically distributed because it has a kurtosis higher than 3. The elderly population and GDP per capita display a platykurtic distribution because they have kurtosis below 3. Such inferences are confirmed by Jarque-Bera testing because the null hypothesis for all of the cases is rejected by $\chi^2_{(2)}$ =5.99 critical value. These variables therefore fulfill the sufficient and necessary conditions to be considered a normal distribution.

Table 1. Basic Statistics of Variables

	EP (%)	FR (%)	Y (USD)
mean	11.13	1.973	20987.3
maximum	14.16	2.950	43801.6
minimum	8.344	1.730	4653.3
standard deviation	1.719	0.279	12078.0
skewness	-0.128	2.307	0.430
kurtosis	1.764	7.573	1.977
Jarque-Bera	68.54	1814.7	76.82

3.3. Estimating First-differenced Model with the OLS

Prior to applying panel data analysis, we will discuss increasing patterns of the variable by employing the first-differenced model with an individual regression to see a preliminary result. The first-differenced model is superior to the model with level variables not only because it provides statistical implication on marginal changes of the variable, but also stability of the model will be substantially improved in nature. Annual data that is obtained from OECD database [9] between 1970-2012 is used for 24 individual regressions [1].

The first-differenced model would be expressed by the following implemented functional form (Eq. 1), and then it will be estimated by the ordinary least squares (OLS) method (Eq. 2). Here, $\varepsilon_t = \rho\varepsilon_{t-1} + \nu_t$ is also applied as a Cochrane-Orcutt AR (1) transformation to take care of any possible autocorrelation in the error term. And, unlike EP (%) and FR (%) variables, the GDP (USD) per capita is log-transformed to fit in a log-linear form [1].

$$\Delta Y_t = f(\Delta X_{1t}, \Delta X_{2t}, \ldots\ldots, \Delta X_{NT}) \tag{1}$$

$$\Delta EP_t = a + b\Delta FR_t + c\Delta \ln Y_t + \varepsilon_t \tag{2}$$
$$\varepsilon_t = \rho\varepsilon_{t-1} + \nu_t$$

The OLS estimation results of the first-differenced model are described in Table 2. Although the magnitude of estimated coefficients for the changing of fertility rates is not high enough, the sign of estimated coefficients in 15 countries appears as positive and is negative for the other 9 countries. It stands that the increasing rate in elderly populations dominates the increasing rate of fertility rates at the margin, and it directs to an increase in the elderly population in these countries [1].

The sign of estimated coefficients for the GDP per capita, which represents social impact for changing of elderly populations, is negative for 18 countries and is positive for the other 6 countries. It is widely accepted that the sign of estimated coefficients for the GDP per capita should be positive. Also, an inverse sign may be interpreted tentatively as like that the increasing rate of the GDP per capita do not directly affect the changes of elderly populations, instead, these could be connected to indirect channels [1].

The OLS estimation between fertility rates and the GDP per capita is carried out to see if indirect channel exists and the results are reported in Table 3. These Tables show that the sign of estimated coefficients for 13 countries is positive. It means that when the rate of the GDP per capita goes up, it will be followed by an increase in the rate of fertility rates, which will then put pressure on the decreases in elderly populations in these countries. This means that the indirect channel between these variables is properly operated. It indicates that the social aspect seems to be diversified and affects more sophistically on the changes of elderly populations. And, therefore, it could be concluded that the demographic aspect is stably correlated with the changes of elderly populations through direct and indirect channels [1].

Table 2. The OLS Estimations by the First-differenced Model: △ EP vs △ FR and △ Ln Y

no	countries	constant	△ FR	△ Ln Y	$\bar{R}^2$	F	DW	AR(1)
1	Australia	0.17 (4.39) *	-0.11 (-1.04)	-0.09 (-0.38)	0.46	12.5	1.71	0.79 (5.76) *
2	Austria	0.14 (1.37)	0.21 (0.54)	-0.65 (-0.93)	0.64	25.1	0.95	0.82 (8.49) *
3	Belgium	0.13 (2.06) *	0.23 (0.67)	-0.39 (-0.86)	0.62	22.4	1.12	0.81 (7.98) *
4	Canada	0.26 (2.21) *	-0.13 (-0.65)	-0.04 (-0.16)	0.64	24.4	1.17	0.89 (8.64) *
5	Denmark	-0.02 (-0.17)	0.06 (0.78)	0.01 (0.03)	0.95	250.7	0.58	1.06 (27.6) *
6	Finland	0.09 (0.56)	-0.01 (-0.07)	0.23 (1.00)	0.75	40.1	1.31	1.08 (11.0)
7	France	0.19 (1.48)	0.12 (0.53)	-0.48 (-0.81)	0.72	34.6	0.77	0.89 (9.77) *
8	Germany	0.30 (2.88) *	1.48 (1.98) *	-1.68 (-1.10)	0.15	3.43	2.10	0.38 (2.50) *
9	Greece	0.25 (3.74) *	0.01 (0.01)	-0.15 (-0.44)	0.56	18.0	1.79	0.78 (7.24) *
10	Iceland	0.14 (2.74) *	0.03 (0.24)	-0.44 (-1.20)	0.45	11.8	1.79	0.73 (5.66) *
11	Ireland	0.26 (0.38)	-0.22 (-1.54)	-0.21 (-0.84)	0.72	35.2	1.15	0.96 (9.69) *
12	Italy	0.24 (3.16) *	0.16 (0.41)	-0.31 (-0.61)	0.62	22.9	1.34	0.80 (8.10) *
13	Japan	0.51 (6.82)	0.21 (0.41)	-0.86 (-1.13)	0.52	15.4	1.61	0.68 (4.61) *
14	Korea	0.27 (2.52) *	0.10 (1.81)	-0.01 (-0.01)	0.77	44.6	2.17	0.89 (10.7) *
15	Luxembourg	0.04 (1.06)	0.01 (0.03)	-0.11 (-0.39)	0.32	7.25	1.78	0.61 (4.56) *
16	Netherlands	0.08 (2.95) *	-0.11 (-1.04)	0.13 (0.72)	0.89	105.6	1.29	1.28 (18.0) *
17	New Zealand	0.23 (0.83)	0.19 (1.54)	0.63 (2.09)	0.53	15.1	1.60	-0.92 (7.02) *
18	Norway	0.26 (0.39)	-0.09 (-0.64)	-0.01 (-0.12)	0.91	139.9	1.20	0.98 (20.3) *
19	Portugal	0.29 (7.36) *	0.39 (1.74)	-0.63 (-1.47)	0.41	10.2	1.54	0.57 (4.08)
20	Spain	0.20 (1.84)	-0.04 (-0.20)	0.27 (0.53)	0.78	47.8	1.35	0.90 (12.0) *
21	Sweden	0.21 (0.68)	-0.04 (-0.34)	-0.17 (-0.87)	0.91	137.4	0.81	0.97 (20.6) *
22	Switzerland	0.14 (2.51) *	-0.39 (-2.21) *	-0.01 (-0.05)	0.74	39.3	1.27	0.87 (9.94) *
23	United Kingdom	0.07 (1.03)	0.32 (0.54)	0.49 (0.46)	-0.05	0.34	1.96	0.19 (1.08)
24	United States	-0.04 (-0.15)	0.12 (0.73)	-0.14 (-0.42)	0.72	36.0	1.22	1.06 (10.6) *

Remark: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Table 3. The OLS Estimations by the First-differenced Model: Δ FR vs Δ ln Y

no	countries	constant	Δ Ln Y	$\bar{R}^2$	F	DW	AR(1)
1	Australia	0.01 (0.07)	-0.53 (-1.25)	0.22	6.51	1.57	0.38 (2.40) *
2	Austria	-0.03 (-1.50)	0.31 (1.04)	0.16	4.92	2.40	0.55 (3.80) *
3	Belgium	-0.02 (-0.96)	0.28 (1.28)	0.46	18.2	1.84	0.75 (6.89) *
4	Canada	0.01 (0.03)	-0.17 (-0.84)	0.51	22.1	2.27	0.63 (5.49) *
5	Denmark	0.01 (0.60)	-0.36 (-1.17)	0.02	1.31	2.01	0.09 (0.57)
6	Finland	0.01 (0.03)	0.05 (0.24)	0.06	2.17	2.13	0.30 (2.04) *
7	France	-0.01 (-0.43)	-0.03 (-0.07)	0.25	7.79	1.87	0.53 (3.85) *
8	Germany	0.01 (0.05)	-0.26 (-0.08)	0.15	4.51	1.79	0.39 (2.59) *
9	Greece	-0.03 (-2.00) *	0.14 (0.65)	0.01	1.21	2.19	0.20 (1.31)
10	Iceland	0.02 (0.75)	-0.84 (-2.05)	0.07	2.42	1.99	0.22 (1.43)
11	Ireland	-0.05 (-1.71)	-0.03 (-0.09)	0.31	9.81	1.50	0.55 (4.30) *
12	Italy	-0.02 (-1.17)	0.03 (0.15)	0.35	11.8	2.39	0.64 (4.63) *
13	Japan	-0.01 (-0.69)	-0.17 (-0.93)	0.04	1.94	2.08	0.21 (1.32)
14	Korea	0.01 (0.27)	-1.00 (-1.96) *	0.05	2.06	1.76	-0.02 (-0.11)
15	Luxembourg	-0.02 (-0.79)	0.11 (0.40)	-0.05	0.09	1.78	0.04 (0.23)
16	Netherlands	-0.02 (-0.85)	0.42 (1.72)	0.63	35.2	2.41	0.75 (8.89) *
17	New Zealand	-0.01 (-0.23)	-0.48 (-1.17)	0.21	6.21	1.94	0.39 (2.52) *
18	Norway	-0.03 (-1.12)	0.15 (1.06)	0.40	14.2	1.88	0.68 (5.68) *
19	Portugal	-0.04 (-1.76)	-0.02 (-0.08)	0.02	1.51	2.02	0.27 (1.62)
20	Spain	-0.06 (-1.86)	0.39 (1.06)	0.42	15.2	2.80	0.70 (5.85) *
21	Sweden	-0.01 (-0.40)	0.18 (0.71)	0.39	13.8	2.07	0.65 (5.31) *
22	Switzerland	-0.03 (-1.58)	0.33 (1.44)	0.21	6.17	2.30	0.51 (3.73) *
23	United Kingdom	-0.03 (-0.98)	0.33 (0.96)	0.30	9.75	1.72	0.62 (4.63) *
24	United States	-0.01 (-0.08)	0.01 (0.04)	0.48	19.3	2.24	0.63 (6.06) *

Remark: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

3.4. Panel Data Analysis

3.4.1. The Model: As has been acknowledged, panel data are composed of a set of data with simultaneous cross-sectional and time-series samples. A panel data set is useful because it enables researchers to identify a statistical influence between dependent and independent variables in analytical econometric models. Such variables cannot be easily analyzed by using either cross-sectional or time-series data alone. In addition to this, panel data analysis generally increases the stability of estimated coefficients within a structural model, as it would include numerous observations on each variable in the sample. Accordingly, the degree of freedom can highly be increased.

The first step of analyzing panel data is to pool all the cross-sectional and time-series data, and then estimate the underlying structural model by employing OLS. The second step is to deal with any statistical disturbances in the cross-sectional and time-series intercepts. Models with fixed effects do so by adding dummy variables in structural models; random effects models deal with these issues by taking into account a variation of generalized least squares estimates. In these procedures, any possible correlations in error terms caused by cross-sectional and time-series data would be minimized in general [10].

Estimating models with panel data are given by the following, and single large pooled regression is performed with N x T observations, where N is the number of cross-sectional samples and T the number of time-series samples [10]. The implicit functional form of the panel equation is given by Eq. (3); the structural equation for empirical analysis is given by Eq. (4) [10].

$$Y_{it} = \alpha + \beta X_{1t} + \gamma X_{2t} \ldots\ldots + \delta X_{NT} + \varepsilon_{it} \tag{3}$$

for i = 1, 2, ….., N and t = 1, 2, ….., T

$$EP_{it} = \alpha + \beta FR_{it} + \gamma \ln Y_{it} + \varepsilon_{it} \tag{4}$$

3.4.2. Estimating with Panel Data Analysis: We have discussed in Rhee [1] whether demographic or social aspects affect increases in elderly populations using a first-differenced model with cross-country regressions. In this section, we conduct panel data analysis to capture economic influences at an aggregate level. We obtained the annual cross-sectional and time-series data to perform the panel data analysis from the OECD database [11] for the 1970–2012 period for 24 countries; there are therefore 1,032 observations. Countries with a higher elderly population ratio were chosen for analysis. Random-effects model in which error terms are allowed and may be correlated between time-series and cross-sectional parts is applied for this case.

The results estimated using panel data analysis are shown in the following Tables. Tables 4-6 present level variables that capture the long-term trend. Table 4 shows that if the fertility rate increases by 1%, the elderly population decreases by 0.170% at the level. It implies that increasing fertility dominates an increase in the elderly population in the long run. Increases in fertility therefore strongly dominate the elderly population, and in this case, led to a decrease in elderly populations. The estimated coefficient for GDP per capita is 2.116; increases in the elderly population are highly affected by changes in GDP per capita in the long run. Therefore, elderly populations not only increase as a result of fertility rates but also GDP per capita in the long run.

On the other hand, the relationship between the fertility and GDP per capita is estimated by -0.429 in Table 5. It signifies that when GDP per capita increases, the fertility will go down. Table 6 shows that the estimated coefficient for elderly population and GDP per capita is 2.049. It implies that as GDP per capita increases, the elderly population will go up by the same manner. All the results support stylized fact in the relationship between elderly populations, fertility, and GDP per capita.

The forecasting error of the panel data analysis is also evaluated. The root mean square error (RMSE), mean absolute percent error (MAPE), and Theil inequality coefficient (IC) evaluate how the forecasted variable tracks the actual data in a different way. As long as the index values decrease, the higher predictive powers are verified. On the other hand, Theil IC falls between 1 to 0, and its predictive power increases when it approaches zero. The predictive power of the structural model for panel data analysis is satisfactory in estimating stable coefficients and disturbances in Tables 4-6.

Table 4. Estimated Results by Panel Data Analysis: EP vs FR and Ln Y

	coefficient	standard deviation	rho	foresting error		
				RMSE	MAPE	Theil IC
constant	-6.681 (-6.59)*	-	-	1.32	7.44	0.05
FR	-0.170 (-1.12)	-	-			
Ln Y	2.116 (28.6)*	-	-			
cross-section random	-	1.88	0.72			
period random	-	0.01	0.01			
idiosyncratic random	-	1.18	0.28			
$\bar{R}^2$				0.59		
F-statistic				742.8		
DW				0.02		

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Table 5. Estimated Results by Panel Data Analysis: FR vs Ln Y

	coefficient	standard deviation	rho	foresting error		
				RMSE	MAPE	Theil IC
constant	5.952 (23.7)*	-	-	0.24	9.65	0.06
Ln Y	-0.429 (-17.0)*	-	-			
cross-section random	-	0.24	0.45			
period random	-	0.12	0.11			
idiosyncratic random	-	0.23	0.43			
$\bar{R}^2$				0.22		
F-statistic				288.0		
DW				0.06		

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Table 6. Estimated Results by Panel Data Analysis: EP vs Ln Y

	coefficient	standard deviation	rho	foresting error		
				RMSE	MAPE	Theil IC
constant	-6.345 (-6.88)*	-	-	1.27	7.03	0.05
Ln Y	2.049 (25.3)*	-	-			
cross-section random	-	2.24	0.76			
period random	-	0.29	0.01			
idiosyncratic random	-	1.24	0.23			
$\bar{R}^2$				0.38		
F-statistic				638.9		
DW				0.02		

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Tables 7-9 show the first-differenced variables that represent the short-term trend. a fixed-effects model that allows dummy variables to take care of varying intercept over time-series and cross-sectional parts is utilized for this case. Like the structural model with level variable, the predictive power of the structural model is also satisfactory in estimating stable coefficients and disturbances in Tables 7-9.

Table 7 shows the estimated coefficients for elderly populations associated with fertility rates and GDP per capita at 0.092 and -0.464 respectively. This result indicates that the elderly population would increase when fertility rates increase, or GDP per capita decreases in the short run. Even though this result turns out inversely comparing with the expectation, the fertility rate scenario is explainable by an offsetting mechanism. That is, increases in elderly populations dominate the fertility rates strongly, and in this case, led to an increase in elderly populations. However, the GDP per capita result is complicated as a positive estimated coefficient was expected. The negative sign strongly suggests that an indirect channel is involved. That is, when GDP per capita increases boosts fertility rates, which in turn causes elderly populations to decrease in the short run. Such linkage was shown in Table 8. However, Table 9 shows that the relationship between the elderly population and GDP per capita, which captures a direct effect, is ambiguous because the estimated coefficient indicates that when GDP per capita increases, elderly populations will go down. Also, it can be said that bi-directional channels exist in the changes of elderly populations in the short run, and thus social aspects seem to be connected to changes in elderly populations in the short run, but in a complicated fashion. In summary, it could be concluded that demographic aspects are more stable and significant than social aspects in terms of their influence on the changes of elderly populations in the short run.

Table 7. Estimated Results by Panel Data Analysis: △ EP vs △ FR and △ Ln Y

	coefficient	foresting error		
		RMSE	MAPE	Theil IC
constant	0.177 (16.1)*	0.12	153.3	0.31
△ FR	0.092 (1.30)			
△ Ln Y	-0.464 (-2.67)*			
$\bar{R}^2$	0.36			
F-statistic	9.76			
log likelihood	692.2			
DW	0.68			

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Table 8. Estimated Results by Panel Data Analysis: △ FR vs △ ln Y

	coefficient	foresting error		
		RMSE	MAPE	Theil IC
constant	-0.022 (-4.39)*	0.06	102.3	0.46
△ Ln Y	0.022 (0.27)			
$\bar{R}^2$	0.32			
F-statistic	8.33			
log likelihood	1477.5			
DW	1.43			

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

Table 9. Estimated Results by Panel Data Analysis: △ EP vs △ ln Y

	coefficient	foresting error		
		RMSE	MAPE	Theil IC
constant	0.175 (16.0)*	0.12	152.0	0.31
△ Ln Y	-0.462 (-2.66)			
$\bar{R}^2$	0.36			
F-statistic	9.88			
log likelihood	691.3			
DW	0.69			

Remarks: 1) $t_{(41)}$ =1.96 at 5% significance level and (*) indicates H_0 is rejected.

4. Summary and Conclusion

Elderly populations have been gradually increasing in most European countries and have risen sharply across the rest of the world over the past two decades [1]. Issues regarding aging societies have therefore received much attention worldwide [1]. This paper investigates the primary determinants for an increase in elderly populations by utilizing econometric models such as panel data analysis [1]. The structural models consider demographic and social aspects simultaneously [1].

All the results support stylized fact in the relationship between elderly populations, fertility, and GDP per capita in the long run. However, the result indicates that the elderly population would increase when fertility rates increase, or GDP per capita decreases in the short run. This result turns out inversely comparing with the expectation, and the fertility rate scenario is explainable by an offsetting mechanism. That is, increases in elderly populations dominate the fertility rates strongly, and in this case, led to an increase in elderly populations. However, the GDP per capita result is complicated as a positive estimated coefficient was expected. The negative sign strongly suggests that an indirect channel is involved. When GDP per capita increases boosts fertility rates, which in turn causes elderly populations to decrease in the short run. The relationship between the elderly population and GDP per capita, which captures a direct effect, is ambiguous because the estimated coefficient indicates that when GDP per capita increases, elderly populations will go down. Also, it can be said that bi-directional channels exist in the changes of elderly populations in the short run, and thus social aspects seem to be connected to changes in elderly populations in the short run, but in a complicated fashion. In summary, it could be concluded that demographic aspects are more stable and significant than social aspects in terms of their influence on the changes of elderly populations in the short run. The results show that the primary determinants of increases in elderly populations arise from demographic rather than social aspects in the short run. Regarding care of the elderly, social aspects appear to be quite vulnerable. Finally, it could be asserted that social systems should be carefully designed to suit aging societies.

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