The Impact of Population Aging on the Countercyclical Fiscal Stance in Korea, with a Focus on the Automatic Stabilizer

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Contents

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This paper raises questions on the impact of an aging population on the effectiveness of automatic stabilizers (automatic changes in taxes and spending during booms and recessions) in smoothing the business cycle. Population aging will increase the components of tax revenue and spending, which bear weak relationships to the business cycle. That is, the ratios of the consumption tax revenues and the spendings on age-based entitlement programs to total fiscal revenues and spendings, respectively, will grow owing to a declining share of the working-age population. This change could lead to a weakening of countercyclical automatic adjustment of the fiscal balance.

The results, which are mainly derived from the spectral analysis on Korean fiscal and business cycle variables, suggest that the automatic stabilizer has worked in counter-acting output fluctuations in Korea. Also, the cross-country panel analysis of 23 major countries reveals that the level of the elderly dependency ratio (ratio of the number of people aged 65 and above to those aged 15-64), as well as the rising speed of this ratio, reduces the sizes of the automatic stabilizers in the short as well as the long run. This result suggests that population aging is an on-going threat in the Korean economy, where the elderly dependency ratio is rising rapidly. The panel analysis reveals in addition that population aging weakens the function of the automatic stabilizers by suppressing their flexible movements.

This paper suggests that it would be necessary to redesign the tax and spending rules in economies facing rapid population aging so that the effectiveness of their automatic stabilizers in smoothing output fluctuations can be improved.

Keywords: Automatic Stabilizer, Aging Population, Fiscal Policy, Spectral Analysis

JEL Classification: E62, E63, J11

Ⅰ. Introduction

Many previous studies have shown that the role of fiscal policy as a countercyclical tool has been limited compared to that of monetary policy. This is especially true in advanced economies. Blanchard *et al.* (2010) argue that fiscal policy has not been widely used, due to several reasons. These reasons include widespread academic skepticism about the effects of fiscal policy, based on the Ricardian equivalence notion. Ricardian equivalence says that, given the long-term government budget constraint, consumers will undo all stimulative effects of government tax cuts and spending increases by cutting their consumer spending. Expansionary (or contractionary) government policies will thus have no real effects on the economy (Barro, 1980). A more policy-oriented criticism of discretionary fiscal policy is that there are significant lags in its implementation. By the time fiscal policy is proposed by the executive branch (i.e., the President) and passed by the legislative branch (i.e., Congress), two or three years may have passed, at which point the conditions of the economy will have changed. In addition, especially in advanced economies, public debt levels were already high prior to the crisis, leaving little room for further fiscal stimulation given the possibilities of future debt crises.

In contrast, monetary policy was until the recent global financial crisis generally considered successful in stabilizing the output gap. Since the crisis, however, many advanced country central banks have faced difficulties in revitalizing their economies through monetary policy alone. Nominal policy interest rates have been lowered to near zero, but these economies have not revived. One of the policy lessons from the recent global crisis should be that fiscal and monetary policy must be coordinated in order to counteract a recession as deep as that caused by the recent financial crisis. To this end we need to ensure ample fiscal and monetary space in good times, so as to be able to react properly to recessionary shocks when necessary, meaning that in good times nominal interest rates should be raised from their very low levels, and public debt levels should be reduced.

This paper focuses on fiscal policy. As discussed briefly above, some scholars argue that the countercyclical effects of discretionary fiscal policy cannot be so large

given Ricardian equivalence, the usual lags in approval and implementation, and the lack of fiscal space owing to high debt levels. For these reasons, some papers emphasize the role of automatic stabilizers rather than discretionary policy as a countercyclical tool. Taylor (2000) for example argues that the impact of automatic stabilizers is more predictable and works more quickly than discretionary policy:

> *"... it is important to distinguish between discretionary changes in taxes and spending—for example, the legislative and executive actions proposed by Presidents Bush and Clinton in the early 1990s—and changes in taxes and spending due to the automatic stabilizers, like the increase in spending on such programs as unemployment compensation and the decrease in tax revenue as employment and income falls in a recession. The overall size of the actual changes in taxes and spending due to the automatic stabilizers are frequently much larger than even the proposed discretionary changes. Both types of changes in taxes and spending impact aggregate demand, but the automatic ones are more predictable and work more quickly than the discretionary ones."*

Many empirical studies on the U.S. business cycle support this claim (Romer and Romer, 1994; Taylor, 1999). These studies find that monetary policies have had the largest countercyclical effects, followed by automatic stabilizers and then finally discretionary fiscal policies.

A new global development has however called into question the future effectiveness of automatic stabilizers. This development is the rapid aging of populations in advanced countries. Due to this rapid population aging, the future compositions of tax revenues and expenditures will change. A declining share of the working-age population will lower the ratio of income tax to consumption tax revenues. In terms of expenditures, moreover, the trend of increase in the ratio of spending on age-based entitlement programs to total fiscal spending will lead to a more subdued countercyclical automatic adjustment of the fiscal balance. The countercyclical effectiveness of automatic stabilizers depends heavily upon the flexible movements of income tax and unemployment insurance benefits. In other words, as the working age population declines relative to the population as a whole, the countercyclical effects may decline. For example, as consumption taxes

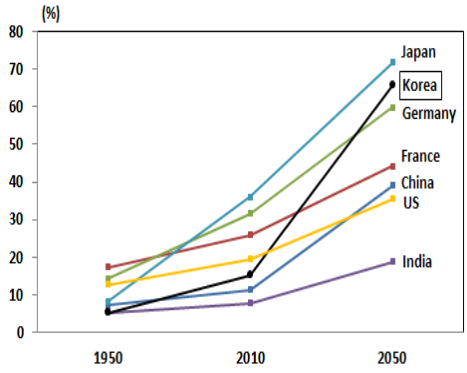
and age-based fiscal spending such as on social security and health care take center stage, the importance of cuts in income taxes and increases in unemployment insurance in stimulating aggregate consumption will decline during a recession.

Population aging is very rapid in Korea, due mainly to its low fertility rate and increasing life span. For example, while baby boomers (born between 1955 and 1963) comprise 19.4% of the working age population in 2013, they will all be 60 and above within 10 years according to the projections of Statistics Korea (2012). The left hand panel of Figure 1 shows that the elderly dependency ratio[1] in Korea is expected to rise more rapidly than those of any other major countries including Japan and Germany. This accelerated population aging is one of the main challenges facing the Korean economy, especially in regard to how it will cause a deterioration of Korea's fiscal balance. In view of such severe population aging[2], this paper attempts to shed light on means of improving the responsiveness and effectiveness of fiscal policy in countering variations in output growth in Korea.

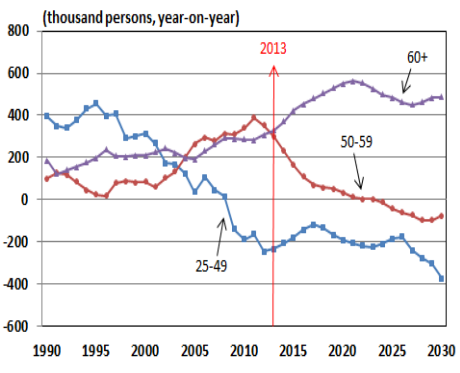
While focusing on Korea, this paper also has more general implications, since

Figure 1: Korean Population Aging Projections

A. Elderly Dependency Ratios



B. Projection: Changes in Population Sizes of Major Age Cohorts



Sources: United Nations and Statistics Korea

1) Elderly dependency ratio = Number of population 65 and above / Number of population between 15 and 64.

2) According to the projection of the OECD, nearly one-third of Koreans will be over 65 and above and half of the labor-force over 50 in 2050.

Korea represents the many economies today that are maintaining relatively prudent current fiscal policies but may face dire situations in the future owing to their aging populations.[3] The main research questions of this paper takes Korea as an example to show how and to what extent population aging affects the working of automatic stabilizers.

This paper will adopt the frequency-domain approach of Cohen and Follett (2000) to examine the properties and effectiveness of the automatic stabilizer in Korea, after extracting the automatic stabilizer from the data on Korean fiscal revenues and spending. In analyzing the effects of demographic changes on the automatic stabilizers, this paper will adopt panel analysis using cross-country data so that it could draw conclusions on how and to what extent population aging would affect the performances of the automatic stabilizers in Korea.

Ⅱ. Literature Review

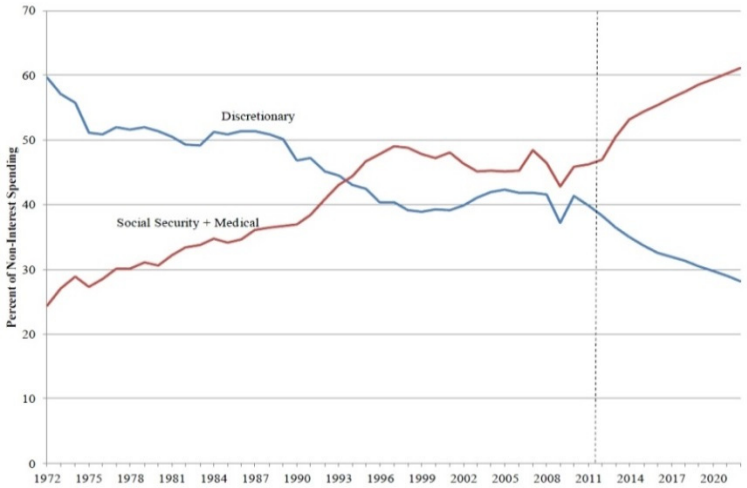
Auerbach (2012) divided federal spending into discretionary and age-based spending, and forecast that the share of the latter will rise sharply due to demographic changes in the near future (see Figure 2). Further, he showed that age-based spending, such as social security and medical spending, bears a weak relationship to the GDP gap in the U.S. It is thus likely that the ability of the government to make policy adjustments to stabilize the business cycle will diminish in an aging society like in the U.S., given the high proportion of age-based fiscal revenues and spending. He also argued that the impact of the growing share of consumption-based taxes relative to income-based taxes in stabilizing GDP is in fact theoretically ambiguous in an aging society, because of two offsetting effects. The first effect is that consumption tax revenues tend to be less responsive to the business cycle than income taxes, as consumers tend to smooth their consumption over the business cycle. However, for a given per unit change in tax revenues, the

3) For the effects of aging on the Korean economy in the long run, see Dekle (2005).

marginal propensity to consume rises as the proportion of the aged increases. This is because, since the aged have shorter lifespans, their marginal propensities to consume are higher. Theory is thus ambiguous as to whether the population aging raises or lowers the effectiveness of automatic stabilizers. To determine the effectiveness of automatic stabilizers, we thus turn in this paper to empirical research.

In the 1990s much attention was paid to the roles of the policies responsible for the stable macroeconomic performance in the U.S. during the 1980s and 1990s, such as monetary and discretionary fiscal policies, and to that of the automatic stabilizers as well. Taylor (2000) argued that the role of automatic stabilizers had been much larger than that of discretionary fiscal policies during the four decades from 1960 to 1999, by comparing the coefficients on the output gap in separate pairwise regressions – of the structural, cyclical and total surpluses on the output gap. Similarly, Romer and Romer (1994) argued that there had been no consistent or strong expansionary discretionary fiscal policies during the eight recessionary periods in the U.S. from 1950 to 1990. They argued that the automatic stabilizers had been more powerful than discretionary policies in stabilizing outputs during these periods. Romer and Romer (1994) concluded that the automatic movements

Figure 2: Share of U.S. Federal Non-Interest Spending



Source: Auerbach (2012)

in budget surpluses during recessions had been large and consistent enough to significantly affect the path of real output following the recessionary troughs.

More specifically, Romer and Romer's dynamic regressions showed that the automatic stabilizers had added an average of 0.6%p to growth in the first year of a recovery, while the effects of discretionary fiscal policies were negligible during that same period. Romer (1999) reached a similar conclusion: adopting the magnitudes of fiscal policy multipliers from a macroeconomic forecasting model, she found that monetary policy contributed 1.5%p to the growth rate of real output in the year following a trough, while discretionary policy contributed 0.5%p. Automatic changes in the budget surplus added 0.85%p, with an average actual growth rate in the year following the trough of 4.6%. Romer (1999) also concluded that one of the distinguishing features of the post-World War II U.S. macroeconomy was the increase in the effectiveness of automatic stabilizers, thanks to the significant rise in income tax revenues and to the emergence of unemployment insurance.[4)]

The methodology of Cohen and Follette (2000) is noteworthy by its use of more sophisticated time series techniques. Their paper adopted frequency-domain analysis including the following variables: labor income taxes, the GDP growth rate, and unemployment insurance spending. They proposed the squared coherence measure, defined as the square of the linear correlation between the two variables at every frequency, as the degree of co-movement of any two variables. Cohen and Follette showed that the squared coherence measures of the relationships between income taxes and the GDP growth rate, as well as between unemployment insurance spending and the unemployment rate, are significant at business-cycle frequencies, thus suggesting the effectiveness of automatic stabilizers. Taken as a whole, therefore, the studies considered conclude that the role of automatic stabilizers had been greater than that of discretionary policies in stabilizing short-run economic fluctuations in the U.S., at the least prior to the 2000s.

4) "*The emergence of a significant income tax during and after World War II has made government revenues substantially procyclical; the emergence of unemployment compensation in the 1930s and the evolution of federal and state welfare programs between the 1930s and the 1960s have led government spending to have a noticeable automatically countercyclical component.*" *(Romer 1999, p. 35).*

Table 1: Estimated Sizes of Discretionary Fiscal Policies and Automatic Stabilizers, by Countries

	Korea	US	Canada	UK	Germany	Japan	France	Italy
Discretionary policies[1] (Average during 1984~2005, %)	0.77	0.75	1.01	0.95	0.83	0.86	0.73	1.07
Automatic stabilizers[2] (Average during 1990~2003)	0.21	0.26	0.39	0.65	1.01	0.20	0.40	0.60

Notes: 1) Size of discretionary policy = $\left|\frac{Change\ in\ structural\ surplus}{GDP}\right|$

2) Size of automatic stabilizer = $\left(\frac{Actual\ surplus}{GDP} - \frac{Structural\ surplus}{Potential\ GDP}\right)$ / GDP gap

Source: Park (2013)

In Korea, the role of automatic stabilizers has received much less scrutiny than the roles of monetary or discretionary fiscal policies. There are not many papers that have delved into the effectiveness of automatic stabilizers in securing macroeconomic stabilization in Korea. Park and Park (2002) showed that Korea's income tax elasticity to output growth was significantly higher than the OECD country average. However, the size of its automatic stabilizer was the smallest among the OECD members, as the share of the income tax in total tax revenues was significantly lower. Park (2013) also argued that the size of the automatic stabilizer in Korea was on average half that of other advanced countries (see Table 1), although in contrast computing the volume of discretionary fiscal policies to be as large as those of other advanced countries. He concluded that the role of discretionary fiscal policy has been exaggerated in Korea, because of the small estimated magnitude of the automatic stabilizers.

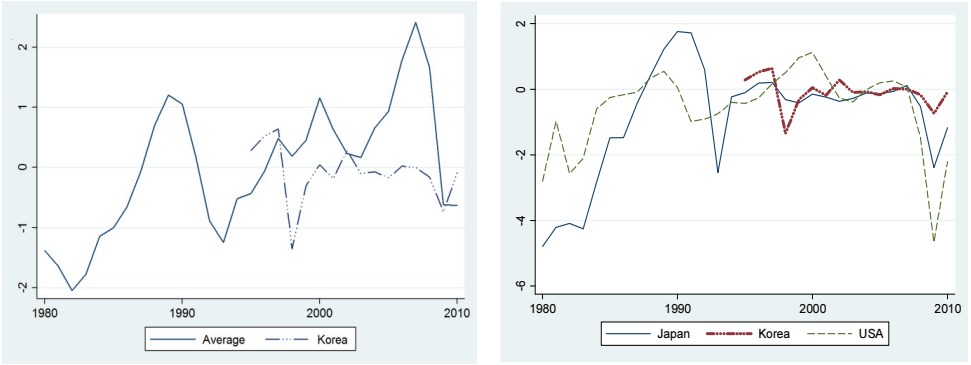
Kim (2012) estimated the responsiveness of discretionary fiscal policies and automatic stabilizer to the output gap in Korea, adopting the regression framework of Romer and Romer (1994). What makes his paper different from previous work is that it divided the structural and cyclical balances into their revenue and spending components. His paper showed that, unlike in other OECD countries, both structural revenues and spending were counter-cyclical, meaning that structural tax revenues tended to work as an amplifier of the business cycle in Korea. He also showed that, while cyclical revenues were mildly pro-cyclical, cyclical spending was not responsive to the Korean business cycle.

Ⅲ. Deriving the Automatic Stabilizer in Korea

This section examines the cyclical properties of the automatic stabilizer on quarterly basis. For this purpose, we estimate quarterly structural and cyclical fiscal balances. With these quarterly estimates, spectral analysis is performed to reveal the cyclical properties of the automatic stabilizers, such as the lengths of the cycles and the co-movements between the cyclical balance and different indicators of the business cycle.

For our analysis, we first collect data for 23 countries[5] to compare the sizes and amplitudes of their automatic stabilizers. Figure 3 shows that, in Korea, the automatic countercyclical functions of the fiscal budget are relatively weak compared to other countries.

Figure 3: Automatic Stabilizers of OECD Countries



Note: Automatic stabilizers measure the difference between the actual budget and structural budget surpluses as a percentage of GDP.
Sources: OECD statistics, IMF WEO database

5) Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and the United States.

1. Decomposing the Quarterly Fiscal Balance: Structural vs. Cyclical Balances

For the empirical analysis, we need to calculate the cyclical components of the budget balance for Korea. Since this is defined as the difference between the actual and the structural fiscal balances, we need to first estimate the structural fiscal balance as follows:

$$B^* = T^* - G^* = \sum T_i^* - \sum G_i^*$$

$$T^* = \sum T_i^* = \sum T_i [\frac{Y}{Y^*}]^{\alpha_i}$$

$$G^* = \sum G_i^* = \sum G_i [\frac{Y}{Y^*}]^{\beta_i}$$

where B^* denotes the structural fiscal balance, T^* structural tax revenues and G^* structural expenditures. Y and Y^* denote output and potential output respectively. Thus we must estimate (i) potential GDP and (ii) the elasticities of fiscal revenues (α_i) and expenditures (β_i) to output gap.

Although there are several ways of estimating potential GDP, subsequent structural balance do not differ much regardless of the methodology used to estimate potential GDP as Kim (2012) shows. We simply use the HP-filter and decompose GDP into its trend and cyclical components, and interpret the former as potential GDP.

Next we need to estimate the elasticities of fiscal revenues (α_i) and expenditures (β_i) to output gap. To this end, we decompose total fiscal revenues into seven categories: personal income taxes, corporate income taxes, social security contributions, indirect taxes (sum of taxes on goods and services, custom duties, and other taxes), and taxes on property, nontax revenues and capital revenues. Fiscal expenditures can meanwhile be divided into non-interest current expenditures, interest payments, capital expenditures and net lending.[6] We estimate the elasticities of personal income taxes, corporate income taxes, social security contributions, indirect taxes and non-interest current expenditures to output gap separately. For example, the

6) Net lending is the difference between lending (to monetary institutions, nonmonetary institutions, nonfinancial public enterprises and etc.) and repayments.

Table 2: Estimated Elasticities

Variable	Coefficient
Personal income tax	1.38
Corporate income tax	1.45
Social security contributions[1)]	0.67
Indirect tax	0.25
Non-interest current expenditure	-0.27

Note: 1) The elasticity of social security contributions is from Kim (2012).

elasticity of personal income taxes is driven by using the elasticity of employment with respect to output gap, the elasticity of personal income tax to the wage bill, and the elasticity of wage bill to the employment gap. We estimate the elasticity of employment with respect to output gap and the elasticity of personal income tax to wage bill, while we assume the elasticity of wage bill to the employment gap as 2.44[7)] which is estimated by Kim (2012). After combining those numbers, we can calculate the elasticity of personal income taxes as 1.38.[8)] Table 2 summarizes the estimated elasticity for each variable. For the rest of the fiscal income and expenditure categories, we assume that the elasticities of these variables are 1 following the OECD (Giorno *et al.*, 1995 and Joumard *et al.*, 2008).

Table 2 shows that the elasticities of the personal income taxes and corporate income taxes exceed unity, meaning that those tax revenues are quite elastic to variations in GDP. In contrast, indirect tax revenue, which comprises mostly consumption tax revenue, is inelastic to GDP fluctuations. This result is quite intuitive, in that consumption tax revenues should be inelastic to economic fluctuations due mainly to agents' willingness to smooth their consumption paths throughout their lives. With these different levels of elasticity, we expect that the changes in the compositions of personal income and indirect tax revenues in total tax revenues will cause a dampening of the automatic stabilization function of the fiscal balances. It should also be noted that the elasticity of fiscal expenditures

7) The elasticity of wage bill to the employment gap can be defined as the weighted averages of the marginal and average tax rates of a representative household. Kim (2012) calculates the average and marginal tax rates by household income decile and family type, using the OECD tax calculator.

8) For more detailed methodology to calculate the other elasticities, please refer to Kim (2012).

excluding interest payments is negative, meaning that movements of fiscal expenditures show a counter-cyclical pattern, although this is not so elastic. From the structural and actual fiscal balances, we can then compute the cyclical fiscal balance as follows:

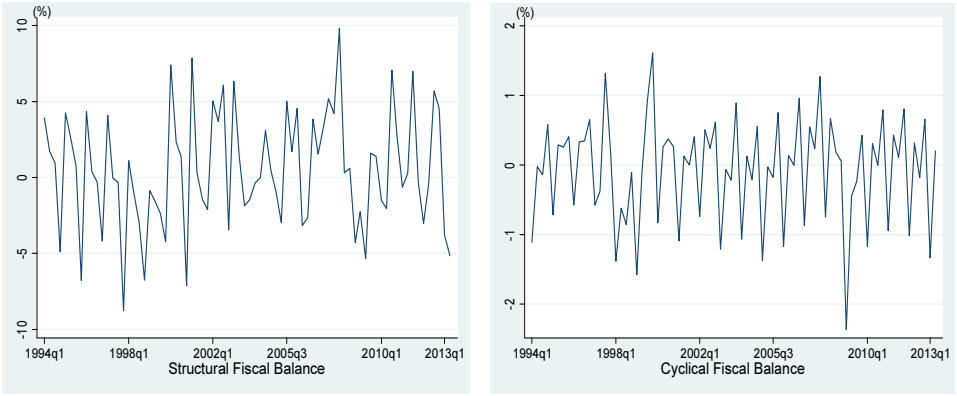
$$\text{Structural Fiscal Balance} = \sum T_i \left[\frac{Y}{Y^*}\right]^{\alpha_i} - \sum G_i \left[\frac{Y}{Y^*}\right]^{\beta_i}$$

Cyclical Fiscal Balance = (Actual Fiscal Balance) - (Structural Fiscal Balance)

where α_i and β_i as the elasticity of tax revenues and expenditures to output gap.

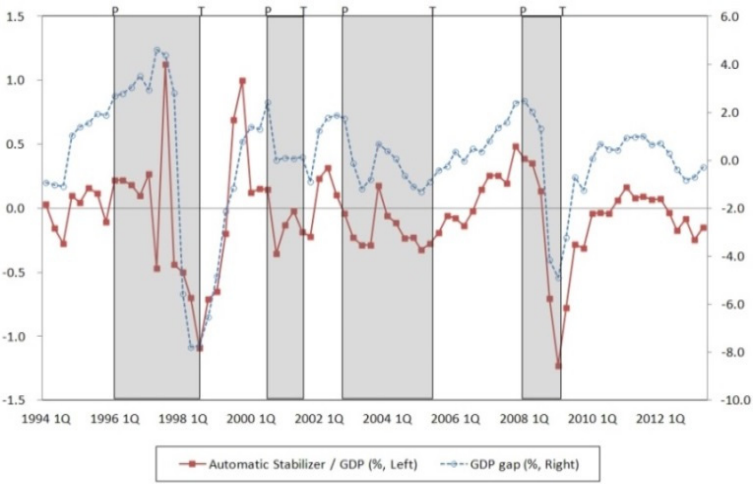
Figure 4 shows the quarterly structural (as ratios to potential GDP) and cyclical fiscal (as ratios to GDP) balances from the 1st quarter of 1994 to the 2nd quarter of 2013, which are drawn on the basis of the method detailed above. In Figure 5 we plot the GDP gap and the cyclical fiscal balance, which are seasonally adjusted. The figure shows that the automatic stabilizers have played a countercyclical role in Korea, except for during some short periods. In the next section we will attempt to determine the properties of the cycles of GDP growth and of the automatic stabilizer, and derive the frequencies at which the automatic stabilizer and the GDP growth rate are highly correlated.

Figure 4: Structural and Cyclical Fiscal Balances



Note: Structural fiscal balance is derived, based on the estimates on elasticity of each tax revenue and expenditure item to output gap. Cyclical fiscal balance is defined as the difference between the actual and structural fiscal balances as a percentage of GDP. Neither of series is seasonally-adjusted.

Figure 5: GDP Gap and Cyclical Fiscal Balance in Korea



Note: The shaded areas are the recession periods (peaks to troughs). All data are seasonally adjusted.

2. Spectral Analysis

Typically, time series analysis is based on finding the properties of the variable in question in the *time* domain. In this section we explore the properties of GDP growth and our calculated automatic stabilizer in the *frequency* domain. This method is commonly called frequency domain or spectral analysis. In the frequency domain analysis, a covariance-stationary process y_t can be expressed as a weighted sum of periodic functions as follows:

$$y_t = \mu + \int_0^{\pi} \{a(\omega)\cos(\omega t)\}d\omega + \int_0^{\pi} \{b(\omega)\sin(\omega t)\}d\omega$$

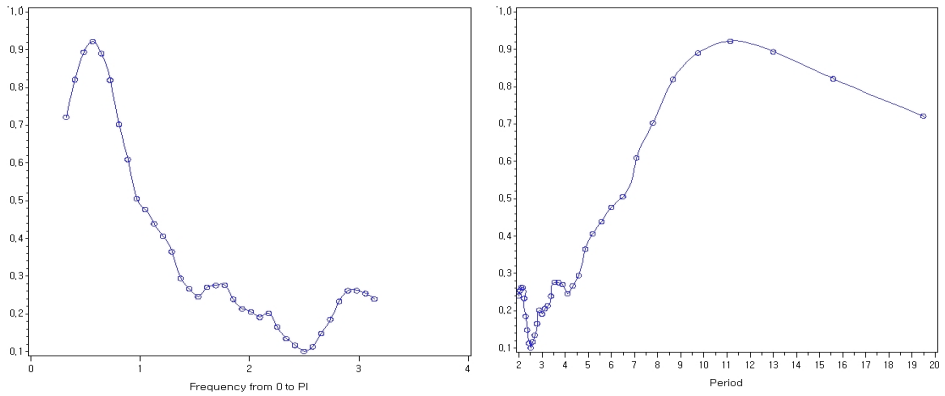
where ω denotes a particular frequency.

Without loss of generality, we can rewrite the above equation in a discrete frequency domain as follows: $y_t = \vartheta + \sum_{k=1}^{M} [a_k \cos(\omega_k t) + b_k \sin(\omega_k t)]$, where M is the number of frequencies, and a_k and b_k are zero-mean random variables which are serially and mutually uncorrelated. a_k and b_k can now be plotted against

frequency k or against wave length to form periodograms. Since the sample periodogram is a volatile and inconsistent estimator of the spectrum, we need to estimate the spectral density by smoothing the sample periodogram through adoption of a weight function.[9] Before looking at the results of analysis, it should be noted that the goal of the spectral analysis is to determine how important cycles of different frequencies are in accounting for the behavior of the target variable (Hamilton 1994).

Figures 6 and 7 are the estimated spectral density functions of GDP growth and of the automatic stabilizer. The GDP growth rate is calculated on a quarter-on-quarter basis, and the automatic stabilizer is computed as the ratio of the cyclical fiscal balance to GDP during the corresponding quarter. Our first finding is that sizable densities are concentrated at between 10 to 13 quarters in the case of GDP growth, while sizable peaks can be found at between 11 to 16 quarters in the case of the automatic stabilizer. This indicates that the components of similar frequency dominate the other frequency components for both the automatic stabilizer and the GDP growth rate.

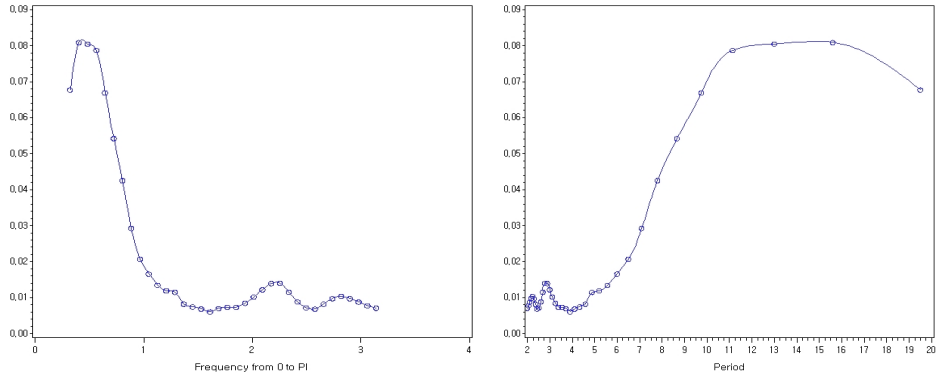
Figure 6: Spectral Density Estimates of GDP Growth



Notes: 1) GDP growth rates are seasonally adjusted on a quarter-on-quarter basis.
2) The density estimates are plotted against frequency (ranging from 0 to π) in the left panel and against period (ranging from 0 to 20 quarters) in the right panel.

9) To draw the spectral density in this paper, we use SAS with a command of "*PROC SPECTRA*." As the weight function, simple triangular weighting is adopted. The command is given in the SAS procedure as follows: "*weights 1 2 3 2 1*".

Figure 7: Spectral Density Estimates of Automatic Stabilizer



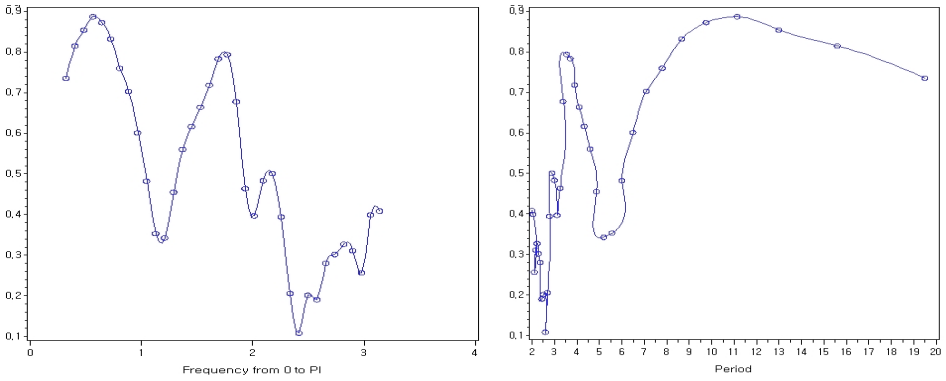
Notes: 1) Automatic stabilizer is expressed as the difference between the actual budget surplus and structural budget surplus in terms of a percentage of GDP. The series is seasonally adjusted using X-12A.
2) The density estimates are plotted against frequency (ranging from 0 to π) in the left panel and against period (ranging from 0 to 20 quarters) in the right panel.

In checking the properties of co-movements of the GDP growth rate and the automatic stabilizer, we use the squared coherence measure, which captures the square of the linear correlation between the variables at each frequency. It should be noted that the squared coherence measure should have values between 0 and 1 by construction. In Figure 8, the magnitude of the squared coherence between the GDP growth rate and the automatic stabilizer is highest (≈ 0.9) at 10 to 13 quarters. This means that the GDP growth rate and the automatic stabilizer are highly correlated at a frequency of about three years (12 quarters). This finding indicates again that the automatic stabilizer and the Korean business cycle (for GDP) swing at similar frequencies. It should also be noted that the other peak of the squared coherence, occurring at around four quarters (one year), may be a reflection of the seasonality properties of both GDP growth and the automatic stabilizer.[10)]

The preceding analysis showed that the automatic stabilizer swings at a frequency similar to that of GDP growth. Separate from these findings, the correlation was calculated between the automatic stabilizer and GDP growth as

10) Despite the seasonal adjustment applied to those target variables by using an econometric tool, it is our conjecture that the seasonality properties have not been entirely removed; hence, the coherence measure peaks around 4 quarters.

Figure 8: Coherence Measure of GDP growth and Automatic Stabilizer



Note: The coherence measures are plotted against frequency (ranging from 0 to in the left panel and against period (ranging from 0 to 20 quarters).

another robust check on the co-movements. The correlation between the two variables was -0.06 from 1994Q1-1997Q4 and 0.32 from 1998Q1-2013Q2, meaning that the movement of the automatic stabilizer has become more correlated with GDP growth since the Asian crisis. This implies that the mechanism of automatic fiscal counter-cyclical adjustment has improved since the late 1990s.

Ⅳ. Impact of Population Aging on the Automatic Stabilizer

As noted in the Introduction, a rising share of the elderly relative to the working age population will change the composition of tax revenues. That is, indirect tax revenues will increase, while direct tax revenues will decrease owing to the declining proportion of the working age population. Age-based spending for example on health care and pensions will also rise. Given that these types of age-based spending are inflexible over the business cycle, as a country's population ages the magnitudes of the automatic stabilizers can be expected to decline.

Considering these possibilities, we project now how the changes caused by population aging will impact the automatic stabilizers in terms of their magnitude, amplitude and correlation with the business cycle. We will conduct our analysis by regressing

the magnitudes of the automatic stabilizers on various explanatory variables over time and across countries; specifically, we will conduct a panel data analysis, with our measure of the automatic stabilizers for each country as the dependent variable.[11]

1. Short-run Effects

We collect macroeconomic and demographic data from the IMF (WEO database) and the OECD (fiscal database). The 23 OECD member countries are included in the sample[12], with yearly data from 1990 to 2010 used in the analysis. We estimate the fixed effects by adopting the following specifications:

$$auto_{it} = \alpha + \beta_1 ln(Y/Y^*)_{it} + \beta_2 dep_{it} + \beta_3 \Delta dep_{it} + \beta_4 ln\, y_{it} + \mu_i + \epsilon_{it} \quad (1)$$

$$auto_{it} = \alpha + \gamma_0 auto_{i\,t-1} + \gamma_1 ln(Y/Y^*)_{it} + \gamma_2 dep_{it} + \gamma_3 \Delta dep_{it} + \gamma_4 ln\, y_{it} + \varepsilon_i + u_{it} \quad (2)$$

Note that specification (1) is for the fixed effect estimator, and (2) for the dynamic panel analysis. The estimation under the dynamic panel specification will be performed by the system GMM method.

Table 3: Panel Analysis Variables[1)]

Variable	Notation	Source	Note
Automatic stabilizers / GDP (%)	$auto$	IMF *WEO*	–
GDP gap (%)	$ln(Y/Y^*)$	GDP data from IMF *WEO*	Y^* is a trend component of real GDP by HP filtering; Y is real GDP
Elderly dependency ratio (%)	dep	OECD	Number of people aged 65 and above to number of people aged between 15 and 64
Per-capita GDP	$ln\, y$	OECD	Log of per-capita GDP (US$, PPP, constant prices)

Note: 1) The 23 OECD member countries are included in the sample, with yearly data from 1990 to 2010 used in the analysis.

11) In related earlier work, Chen (2004) studied whether changes in the age structure affect the budget deficit sizes of governments due to increasing social security benefits to the elderly and decreasing economic tax bases. Using country and time-fixed effects panel regression from 1975 to 1992 for 55 developed and developing countries, he found evidence indicating that increases in the shares of the elderly and youth populations tend to widen budget deficits in developing countries.

12) Eleven OECD member countries are excluded from the sample – Chile, the Czech Republic, Estonia, Hungary, Israel, Luxembourg, Mexico, Poland, the Slovak Republic, Slovenia and Turkey.

Our results are summarized in Table 4. First, the results show a positive correlation between the magnitude of the automatic stabilizer ratio (relative to GDP) and the GDP gap. The relationship is significant at 1% level and robust regardless of the various model specifications. This result verifies the existence of built-in fiscal stabilizer. Second, the coefficient on the elderly dependency ratio is negative and significant at 1% or 5% level regardless of the specification. According to the estimates, the automatic stabilizer ratio (relative to GDP) will decrease by 0.1~0.3%p when the elderly dependency ratio increases by 1%p. Third, importantly, our results show that the speed of population aging, which is captured by the first difference of the elderly dependency ratio in our analysis, tends to depress the magnitude of the automatic stabilizers further. The results of columns (3)-(5) and (8)-(10) in Table 4 show the magnitudes of the automatic stabilizers declining as population aging accelerates. Including the level of the elderly dependency ratio does not change the result, showing that this relationship is robust and statistically significant. And given that its population aging is expected to accelerate significantly in the near future, the results indicate that Korean government may not be able to rely on automatic stabilizers to smooth output fluctuations as much as in the past.

2. Long-run Effects

To capture more of the long-run effects of population aging on the automatic stabilizers, we construct a 3-year non-overlapping panel dataset by averaging the data for three years during 1990-2010 for the same countries considered above. The results (Table 5) confirm the outcomes described above, and suggest that economies with smaller per-capita GDPs or higher elderly dependency ratios will have smaller automatic stabilizers. In addition, the speed of rise in the share of the elderly among population will depress the sizes of the automatic stabilizers.[13)]

13) The dynamic panel regression was not adopted in checking the long-run relationship, since the Arellano-Bond test statistics (H_0: no autocorrelation in first difference errors) were less than the 10% critical value in the dynamic specifications with the same explanatory variables as in Table 5. Nevertheless, if we adopt the dynamic panel specifications the negative coefficients of the demographic variables are mostly significant at 5% level.

Table 4: Impacts of Population Aging on Automatic Stabilizers

Dependent variable: ratio of automatic stabilizers to GDP (%)	Fixed Effects					Dynamic Panel				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lag of automatic stabilizers (%)						0.65*** (0.037)	0.55*** (0.035)	0.58*** (0.035)	0.65*** (0.038)	0.56*** (0.035)
GDP gap (%)		0.42*** (0.042)	0.42*** (0.042)		0.40*** (0.04)		0.28*** (0.030)	0.27*** (0.030)		0.27*** (0.030)
Elderly dependency ratio (%)	−0.29*** (0.054)	−0.23*** (0.049)		−0.26*** (0.054)	−0.21*** (0.049)	−0.13*** (0.042)	−0.11*** (0.038)		−0.11** (0.042)	−0.09** (0.038)
Δ in elderly dependency ratio (% p)			−2.07*** (0.563)	−1.96*** (0.615)	−1.69*** (0.560)			−2.24*** (0.401)	−2.40*** (0.444)	−2.18*** (0.398)
Per-capita GDP (log)	7.38*** (0.768)	6.68*** (0.701)	5.45*** (0.646)	7.35*** (0.760)	6.66*** (0.695)	2.41*** (0.650)	2.54*** (0.576)	1.82*** (0.497)	2.37*** (0.646)	2.48*** (0.574)
Constant	−68.8*** (7.467)	−62.8*** (6.812)	−54.9*** (6.617)	−68.7*** (7.392)	−62.8*** (6.751)	−21.6*** (6.200)	−23.4*** (5.501)	−18.0*** (5.085)	−21.3*** (6.173)	−22.9*** (5.490)
Obs.	472	472	472	472	472	466	466	466	466	466
R-sq.[3]	0.18	0.32	0.31	0.19	0.33					
Arellano-Bond test[4] p-value (order 1) (order 2)						0.013 0.936	0.035 0.818	0.031 0.855	0.013 0.932	0.033 0.849

Notes: 1) The sample includes all OECD member countries with the exceptions of Chile, the Czech Republic, Estonia, Hungary, Israel, Luxembourg, Mexico, Poland, the Slovak Republic, Slovenia and Turkey. The dependent variable is the ratio of automatic stabilizers to GDP. Sample period is from 1990 to 2010.

2) The figures inside parentheses indicate standard errors.

3) Within R^2

4) The Arellano-Bond test statistics are computed, given estimates of robust standard errors.

5) The superscripts *, ** and *** denote that the corresponding coefficients are significant at 10%, 5%, and 1% levels respectively.

Table 5: Long-Run Impacts of Population Aging on Automatic Stabilizers

Dependent variable: ratio of automatic stabilizers to GDP (%)	(1)	(2)	(3)	(4)
GDP gap (%)			0.45*** (0.130)	0.42** (0.161)
Elderly dependency ratio (%)	−0.27*** (0.076)	−0.14 (0.096)	−0.23*** (0.074)	−0.14 (0.093)
Δ in elderly dependency ratio (% p)		−0.90** (0.364)		−0.84** (0.356)
Per−capita GDP (log)	6.11*** (1.047)	6.70*** (1.322)	6.03*** (1.007)	5.97*** (1.321)
Constant	−56.3*** (10.08)	−64.6*** (12.78)	−56.3*** (9.693)	−57.0*** (12.81)
Obs.	161	138	161	138
R−sq.[3)]	0.20	0.22	0.27	0.26

Notes: 1) Results based on the 3-year non-overlapping averages during 1990-2010 for OECD member countries excluding Chile, the Czech Republic, Estonia, Hungary, Israel, Luxembourg, Mexico, Poland, the Slovak Republic, Slovenia and Turkey.
2) The figures inside parentheses indicate standard errors.
3) Within R^2.
4) The superscripts *, ** and *** denote that the corresponding coefficients are significant at 10%, 5%, and 1% levels respectively.

We also try to find a relationship between population aging and the volatility of the automatic stabilizers. To measure the volatility of automatic stabilizers, the standard deviations of the automatic stabilizers (as a ratio to GDP) in the year *t* are computed during an 11-year window centered on the year *t*. For the panel analysis, the standard deviations of output gap ratios with the same length of rolling window as well as per-capita GDP are included in the right hand side as control variables. The sample period is 1985 to 2005; but the difference of data availability across the countries makes the panel unbalanced. The estimation results in the second and third columns in Table 6 show that the fixed effect coefficients of the elderly dependency ratio are negative with statistical significance. Its coefficient in the fourth column in the table is also negative but shows weak statistical significance. The coefficient under the dynamic panel specification also reveals the negative relationship between the volatility of automatic stabilizers and elderly dependency ratios although the dynamic panel specification (fifth column in the table) is not desirable for the analysis according to the Arellano-Bond test statistics.

Table 6: Impacts of Population Aging on Volatility of Automatic Stabilizers

Dependent variable: standard deviation of ratio of automatic stabilizers to GDP[2)]	Fixed Effect (1)	Fixed Effect (2)	Fixed Effect (3)	Dynamic Panel
Lag of standard deviation of ratio of automatic stabilizers to GDP	–	–	0.863*** (0.033)	0.880*** (0.029)
Elderly dependency ratio (%)	−0.146*** (0.021)	−0.098*** (0.022)	−0.020 (0.014)	−0.016 (0.014)
Standard deviation of GDP gap[2)]	0.366*** (0.066)	0.529*** (0.071)	0.145*** (0.045)	0.229*** (0.038)
Per-capita GDP (log)	–	−1.557*** (0.297)	0.330* (0.195)	–
Constant	4.136*** (0.468)	18.69*** (2.816)	−2.957 (1.916)	0.150 (0.320)
Obs.	404	404	381	358
R-sq.[4)]	0.17	0.23	0.74	
Arellano-Bond test p-value				
(order 1)				0.187
(order 2)				0.076

Notes: 1) The sample includes all OECD member countries except for Chile, the Czech Republic, Estonia, Hungary, Israel, Luxembourg, Mexico, Poland, the Slovak Republic, Slovenia and Turkey. Due to the data unavailability, the analysis is based on the unbalanced panel data.
2) The standard deviations of the automatic stabilizers and output gaps in the year *t* are computed during an 11-year window centered on the year *t*.
3) The figures inside parentheses indicate standard errors. The Arellano-Bond test statistics are computed, given estimates of robust standard errors in case of dynamic panel estimation.
4) Within R^2.
5) The superscripts *, ** and *** denote that the corresponding coefficients are significant at 10%, 5%, and 1% levels respectively.

These estimation results imply that aging populations will tend to see reduced amplitudes or volatilities of the cycles of their automatic stabilizers in the long run. These outcomes are matched with our conjecture: as the ratio of elderly people rises, the composition of tax revenue and expenditure, which are inelastic to the business cycle, would increase thereby making the automatic stabilizer inflexible to the business cycle. It should be also noticed that the coefficients of the standard deviation of GDP gap are positive and robust, regardless of the model specifications. This result confirms that the volatility of automatic stabilizers are strongly correlated with the fluctuations of GDP gaps.

Taking the estimations of the short- and long-run results described above into consideration, population aging will weaken the automatic counter-cyclical adjustment of the fiscal balance by suppressing the size and flexible movements or volatilities of the automatic stabilizers.

Ⅴ. Conclusion

It is widely accepted that population aging will be a significant challenge to the Korean economy in the long run, and there are two prevailing concerns regarding its impacts. One is the shrinkage of the labor supply, which means that there will be no further demographic dividend in the Korean economy in the future. The other concern is the fiscal pressures due to the rise of age-related spending. The literature tends to focus on long-term effects of population aging in terms of growth and fiscal sustainability (Dekle 2005, IMF 2012 and S&P 2013). For example, the IMF's 2012 Article IV consultation report expected that fiscal pressures stemming from an increase in age-related spending will emerge in the medium term in Korea, but not in the short run.[14)]

This paper shows, however, that even in the short run there may be negative effects of population aging, such as the weakening of the automatic stabilizer function of the fiscal balance. That is, the negatively significant coefficients of the first difference of the elderly dependency ratio and the size of the dependency ratio (Table 4) imply that it may be not only the level of population aging but also its speed that makes the automatic stabilizers weaken in counteracting business cycle fluctuations. These results thus suggest that population aging can be a challenge even in the short run. This paper also reveals that there exists another

14) *"While currently one of the youngest countries in the Organization for Economic Co-operation and Development (OECD), Korea is projected to shift rapidly to the second oldest by mid-century, given its low fertility rate and gains in longevity. According to the OECD, the working age population is projected to peak in 2016 and then decline by a quarter by 2050. Although pressures will not show in the near term, age-related spending will begin to appear in the medium term and accelerate from 2020 with the rapid aging of the population."* (IMF 2012)

channel in which population aging may weaken the automatic stabilizers: the population aging can reduce the flexibility of the automatic stabilizer (Table 6).

As mentioned in Section II, Auerbach (2012) could not draw firm conclusions from the theory with regard to the effects of aging population (more precisely in terms of the rise in the proportion of consumption tax revenues stemming from population aging) on the automatic stabilizers. This is because population aging can theoretically have both positive and negative effects on the relationship between the automatic stabilizers and output growth. This paper has found empirically that the negative effects of population aging may exceed its positive effects on the countercyclical automatic stabilizers in both the long and the short run. This paper implies that fast-aging economies including Korea should redesign the tax and spending rules to make the automatic stabilizers more effective.

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<Abstract in Korean>

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인구고령화로 생산가능인구의 비중이 하락하면서 정부의 조세수입과 지출 중 경기움직임에 대한 민감도가 높지 않은 항목의 비중이 상승할 것으로 예상된다. 즉, 세수(稅收) 면에서는 근로소득세의 비중이 감소하고 소비세의 비중이 상승할 것으로 예상되며, 지출 면에서는 연금 및 보건의료 관련 지출이 늘어날 것으로 보인다. 이는 재정수지에 내재된(built-in) 경기안정화 기능, 즉 재정의 자동안정화 기능을 약화시킬 가능성이 있다.

이에 본고에서는 우리나라 재정 데이터를 이용하여 경기변동에 따른 재정수지의 자동적인 변동을 나타내는 경기적 재정수지(cyclical fiscal balance)를 도출하고 우리나라의 경기순환과 재정의 자동안정화 장치 간 공행성에 관한 분석을 실시하였다. 아울러, OECD 주요 가입국을 대상으로 한 국가패널 분석을 통해 인구고령화와 재정의 자동안정화 기능 간 관계를 분석하였다.

우리나라의 경우 재정의 자동안정화 장치 비율(경기적 재정수지의 GDP 대비 비율)은 경기와 뚜렷한 공행성이 있는 것으로 나타나 재정의 자동안정화 기능이 경기의 진폭을 줄이는 데 일정부분 역할을 한 것으로 분석되었다. 아울러 국가패널을 통한 분석 결과에서는 고령화 정도를 나타내는 고령자 부양비율(elderly dependency ratio)이 높을수록 재정의 자동안정화 장치 비율이 하락하고, 표준편차로 측정된 유연성이 낮아지는 것으로 나타났다. 특히, 고령자 부양비율의 1차 차분으로 측정한 고령화 속도도 재정의 자동안정화 장치 비율을 하락시키는 요인인 것으로 분석되었다. 이는 인구고령화 수준뿐만 아니라 고령화 속도도 재정의 자동안정화 기능에 부정적 영향을 미치는 것을 시사하는 것으로서, 인구고령화 속도가 점차 빨라지고 있는 우리나라의 경우 이에 대한 대응방안 마련이 필요한 것으로 판단된다.

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