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The Effect of Population Composition by Age on Government Spending Policy*

Hosin Song† Jisu Hwang‡

Abstract There is a recurrent assertion that the elderly want more public resources to be spent on social protection and health, the young want more on education, and such preferences are reflected in the actual government spending policy. This study aims to empirically confirm whether the assertion is valid in OECD countries. For that goal, we propose an estimation method to exploit the comparison of the actual share of government expenditure and its theoretical share by using aggregate data. The empirical finding is consistent with the recurrent assertion in the sense that the fraction of the young has a significantly negative effect of the spending share of social protection and health but a positive effect on the spending share for education even though we can not find a significant effect of the elderly. In particular, ageing leads to a smaller fraction of the young and a larger fraction of the elderly. Hence, the empirical finding predicts that the ageing trend is likely to bring more public resources to the social protection and health areas, and less public resources to education.

Keywords Ageing, Fiscal Spending Policy, Panel GMM, Population Composition by Age, Spending Share

JEL Classification C54, H30, H50

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†Corresponding author. Associate Professor, Deparment of Economics, Ewha Womans University, E-mail: hsong@ewha.ac.kr

‡Graduate Student, Department of Economics, Cornell University, E-mail: jisu.hw678@gmail.com

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1. INTRODUCTION

In this study, we aim to empirically confirm the recurrent assertion that government spending policy is influenced by the population composition by age, in particular, the preference of the elderly and the young. An ageing society prevails in most democratic countries such as OECD countries. Plümper and Martin (2003) explored the relationship between economic growth and democracy. Razin, Sadka and Swagel (2002, hereafter RSS), Galasso and Profeta (2007) and Disney (2007) are concerned about the public resources allocation in a democracy with a voting system. RSS (2002) used an overlapping generation model to show that an increase in the elderly dependency ratio can lead to lower taxes or less-generous social transfers. Moreover, they found that the elderly dependency ratio is negatively related to labor tax rate and social transfers. Galasso and Profeta (2007), unlike RSS (2002), claimed that the degree of the negative effect of ageing on the welfare state can be different depending on the quality of the social security system. Disney (2007) argued that the results predicted by RSS (2002) do not work in the real world. By using an extended data set, he found that the labor tax rate and social transfers are positively related to the dependency ratio.

Shelton (2007), Sørensen (2013), and Sanz and Velázquez (2007) empirically studied the effect of ageing on public spending. Shelton (2007) took care of omitted variable bias in the determinants of government expenditure. Sørensen (2013) estimated the effect of age-group dummy variables on the public spending preference index of three areas - education, health care, and old-age pensions - by using repeated cross-section survey data for 22 countries.[1] Sanz and Velázquez (2007) estimated the demand function for aggregate government expenditure by functions by using panel data of OECD countries during 1970-1997. They exploited the error correction model to separate the long-run effect from the short-run effect of the elderly share and the young share on the government expenditure share in terms of GDP.[2] They found that the government spending that the elderly prefer has increased in OECD countries data.

It is well known that public pension programs and health-care services are the areas that the elderly prefer, whereas education is the area that the young prefer. For diverse background arguments about public-spending preferences by age groups, see Rhodeback (1993), Mulligan and Sala-i-Martin (1999), Boeri *et al.* (2001), Blekesaune and Quadagno (2003), Busemeyer *et al.* (2009), Goerres and Tepe (2010), Sørensen (2013) and Mello *et al.* (2016). Our study is similar to

[1] Sørensen called them the life-cycle effects.

[2] Specifically, the government expenditure share is the ratio of the government expenditure by function over GDP.

Sanz and Velázquez (2007), and Sørensen (2013) in that they are motivated by a recurrent assertion that the preferences of age groups are closely related to public spending allocation. In addition, our study is also similar to Sanz and Velázquez (2007), in that both use OECD countries' data. However, our approach is quite distinguishable from them. Sørensen (2013) used survey data to measure the strength of public spending preference for each area. The survey data is very likely to be vulnerable to measurement errors. Furthermore, Sørensen (2013) used repeated cross-section data, and thus he could not introduce the fixed effect into the model. Unlike Sørensen (2013), we used country-level aggregate data on spending shares which do not suffer from the measurement error. In addition, we add the fixed effect to the multinomial choice probability model, which avoids the omitted variable bias. Unlike Sanz and Velázquez (2007), we consider the endogeneity problem and propose to use a generalized method of moment estimation.

To sum up, our approach has some features. First, publicly available aggregate data are used instead of individual level data to take into account the public-resource allocation based on individual utility maximization decision. The use of the aggregate data makes the estimator robust to the measurement error. Second, we assume that the actual share of public spending reflects the theoretical spending share, and thus exploit their difference in the estimation. Based on this approach, we incorporate the fixed effect.

The remainder of this paper is organized as follows. In section 2, our model is presented and the estimation method is proposed. In section 3, estimation results are presented. Section 4 is the concluding remarks, and section 4 is the Appendix.

2. MODEL

Suppose that each individual can vote for one choice out of $J+1$ alternatives or areas. Each individual can rank all alternatives according to the following linear utility as in Berry *et al.* (1995). Specifically, the individual k's utility in country i from choosing the alternative j is

$$U_{k,ij} = x_i'\theta_j + \varepsilon_{k,ij} \tag{1}$$

where x_i is the country i's observed characteristics, and the idiosyncratic error term $\varepsilon_{k,ij}$ is distributed to the type I extreme value distribution. The error $\varepsilon_{k,ij}$ is assumed to be independent across i as well as j, and independent of x_i. If the individual k's decision is $j = j^*$, the indicator variable y_{k,ij^*} can be defined as

$$y_{k,ij^*} = I(U_{k,ij^*} = \max_{j=0,\dots,J} U_{k,ij})$$

where $I(\cdot)$ is the indicator function. Then, the assumption on the error term $\varepsilon_{k,ij}$ leads to the following well-known result: for $j = 0, 1, \dots, J$,

$$\Pr[y_{k,ij} = 1] \equiv p_{ij}(\theta) = \frac{\exp(x_i'\theta_j)}{1 + \sum_{j=1}^{J} \exp(x_i'\theta_j)} \tag{2}$$

which is a function of $\theta = (\theta_1', \theta_2', \dots, \theta_J')'$.[3] In fact, each individual's decision can not be observed, and thus the voting share for alternative j can not be observed either. However, we assume that the actual share of public spending in area j reflects the theoretical voting share in (2) through diverse channels. In principle, the allocation of public resources is decided by the government which is influenced by the congress or the president. Furthermore, the members of the congress or the president are elected by voters, who are made up of different age groups. Thus, the composition of age groups can affect the allocation of government spending through their preferences. The elderly may be more interested in social protection, such as old-age pensions, and health service than the young. Each voter may have different interests depending on his or her economic or socio-demographic conditions as well as age. For example, voters having small children would be more interested in education spending than would be voters having no small children. Then, the fraction of the young may affect the allocation of public resources through voters having small children. The government itself takes care of the allocation of public resources since that is a role delegated by the voters. Therefore, considering that the voters represent the population composition directly or indirectly, it is hard to deny that the population composition by age affects the allocation of public resources. Macroeconomic conditions also may affect the composition of public spending.

We consider the following econometric model to examine how the population composition by age and other macroeconomic factors affect the allocation of government spending. Unlike voting results, the actual share of public spending for area j is observed. Hence, we propose to estimate the area specific parameter θ_j by comparing the actual share and theoretical probability in (2). Suppose we have short unbalanced panel data where each country i has information of T_i periods. We adopt the following Assumption 0, which is maintained throughout

[3]For the identification, we adopt a normalization $\theta_0 = 0$.

the paper.

Assumption 0. *s_{itj} is the actual share of country i's expenditure for the jth alternative or area at period t, and the theoretical share of the expenditure j, p_{itj}, is assumed to have the following functional form*

$$p_{itj}(\theta_0) = \frac{\exp(x_{it}'\theta_{0j})}{1+\sum_{j=2}^{J}\exp(x_{it}'\theta_{0j})} \quad \textit{for } j = 1,\ldots,J,$$
$$p_{it0}(\theta_0) = \frac{1}{1+\sum_{j=2}^{J}\exp(x_{it}'\theta_{0j})} \quad \textit{for } j = 0$$

where $\theta_0 = (\theta_{01}',\ldots,\theta_{0J}')'$ is the true parameter vector, and each θ_{0j} is a K-dimensional vector in a compact set $S \subset \mathbb{R}^K$.

Note that the vector of regressors is common instead of being different depending on the area j. Assumption 0 says that the theoretical spending share is determined by observed common factors such as population composition by age, public finance and other macro economic factors. Specifically, we consider 4 areas, i.e., $J = 3$, where $j = 1$ indicates the area of social protection including public pension, $j = 2$ is the area of health, $j = 3$ is the area of education, and $j = 0$ is the area of all but these mentioned three areas.

Now consider the relationship between the theoretical spending share and the actual share. To define the relationship, we address the following assumption.

Assumption 1. *Define the theoretical relative spending share in area j by $p_{itj}^* = p_{itj}(\theta_0)/p_{it0}(\theta_0) = \exp(x_{it}'\theta_{0j})$ where p_{itj} is the theoretical share in area j defined in Assumption 0, $j = 1,\ldots,J$, and $t = 1,\ldots,T_i$. Similarly, define the actual relative spending share of country i's area j at period t by $s_{itj}^* = s_{itj}/s_{it0}$, which is the ratio of the actual share of country i's jth expenditure s_{itj} over the reference share s_{it0}. Assume the relationship between p_{itj}^* and s_{itj}^* is*

$$s_{itj}^* = p_{itj}^* \exp(\eta_i)\exp(\varepsilon_{itj}) \tag{3}$$

where η_i is a country-specific unobservable and ε_{itj} is an idiosyncratic error term.

Equation (3) in Assumption 1 means that the actual relative share is the product of the theoretical relative share, country-specific unobservable, and an error.

Hence, it implies that the discrepancy between the theoretical relative share p^*_{itj} and the actual relative share s^*_{itj} is due to the error ε_{itj} or country-specific unobservable η_i.[4] Assumption 1 leads to the following equation

$$\log s^*_{itj} = x'_{it}\theta_{0j} + \eta_i + \varepsilon_{itj} \tag{4}$$
$$= x'_{it}\theta_{0j} + v_{itj} \tag{5}$$

where $v_{itj} = \eta_i + \varepsilon_{itj}$.

Considering the endogeneity of regressors, we need to put some additional restrictions on regressors and errors, which are addressed in the following assumption.

Assumption 2. *For each $j = 1, \ldots, J$ and $t = 1, \ldots, T_i$, the error term ε_{itj} satisfies the following two conditions: (i) $E[\varepsilon_{itj}x_{it}|\eta_i] \neq 0$ for each t. (ii) $E[\varepsilon_{itj}x_{is}|\eta_i] = 0$ for all $s < t$.*

Part (i) in Assumption 2 says that there are some contemporaneous endogenous regressors in x_{it}. It makes sense to consider that actual spending shares may have simultaneity or reverse causality for the macroeconomic factors. For example, the actual spending share reflecting fiscal policy, may affect the economic activity. Hence, regressors such as GDP can be endogenous. Moreover, the composition of the population such as the fraction of the elderly or the young can be endogenous since it is the result of the optimal choice of giving births under given economic conditions including fiscal spending policy. Part (ii) implies that regressors are predetermined, in that the idiosyncratic error ε_{itj} is uncorrelated with the past regressors x_{is} for all $s < t$. Assumption 2 is much weaker than the strong exogeneity assumption.

Under Assumptions 0, 1, and 2, we propose a GMM model to take into account the endogeneity problem and the fixed effect.[5] For each relative share

[4]The introduction of the country-specific unobservable into the model is one of the main improvements from earlier versions, where p_{itj} and s_{itj} were used for the nonlinear regression model. Moreover, this improved approach is much easier to estimate than is the nonlinear model in earlier versions in terms of computation.

[5]See Hansen (1982), and Arellano and Bond (1991) for GMM.

$j = 1, \ldots, J$, the GMM estimator $\hat{\theta}_{j,GMM}$ can be defined as follows.

$$\hat{\theta}_{j,GMM} = \arg\min_{\theta_j} \Omega_n(\theta_j), \tag{6}$$

where

$$\Omega_n(\theta_j) = \overline{h}_j'(\theta_j) W_n \overline{h}_j(\theta), \tag{7}$$

$$\overline{h}(\theta_j) = \frac{1}{N} \sum_{i=1}^{N} h_{j,i}(\theta_j), \tag{8}$$

$$h_{j,i}(\theta_j) = \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} h_{j,it}(\theta_j), \tag{9}$$

$$h_{j,it}(\theta_j) = z_{it}(\Delta \log s^*_{it,j} - \Delta x'_{it} \theta_j) \tag{10}$$

where z_{it} is a vector of instruments.[6] Each country i is allowed to have different time periods T_i. $T_i - r$ is the number of actual observations for the estimation since the choice of instruments affects the degree of data availability. For example, $z_{it} = (x'_{it-2}, \ldots, x'_{i1})'$ can be used as instruments for the period $t \geq 3$ in terms of Assumption 2, and thus $r = 2$ in this case. The population moment condition is

$$E[h_{j,i}(\theta_{0j})] = 0.$$

Then, the GMM estimator is

$$\hat{\theta}_{j,GMM} = \left[\left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x'_{it} \right)' W_n \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x'_{it} \right) \right]^{-1} \times \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x'_{it} \right)' W_n \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta \ln(s^*_{it,j}) \right). \tag{11}$$

Using the $R \times R$ identity matrix as a weight matrix, $W_n = I_R$, delivers a first-step GMM estimator $\hat{\theta}_{j,1st}$. Then, the optimal GMM estimator is obtained by using

[6]We denote a vector of instruments by z_{it} as if it were a common vector. However, in principle, it does not have to be a common vector. In general, we may denote it by $z_{j,it}$.

the optimal weight $\widehat{W}_{opt} = \widehat{Q}_j^{-1}(\hat{\theta}_{j,1st})$.[7]

$$\hat{\theta}_{j,opt} = \left[\left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x_{it}' \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x_{it}' \right) \right]^{-1} \times \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta x_{it}' \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \Delta \ln(s_{it,j}^*) \right). \tag{13}$$

Let $z_{it}/(T_i - r) = z_{it}^*$, $\Delta x_{it} = x_{it}^*$ and $y_{j,it} = \Delta \ln(s_{it,j}^*)$. Then,

$$\begin{aligned} \hat{\theta}_{j,opt} &= \left[\left(\frac{1}{N} \sum_{i=1}^{N} \sum_{t=r+1}^{T_i} z_{it}^* x_{it}^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} \sum_{t=r+1}^{T_i} z_{it}^* x_{it}^{*\prime} \right) \right]^{-1} \\ &\quad \times \left(\frac{1}{N} \sum_{i=1}^{N} \sum_{t=r+1}^{T_i} z_{it}^* x_{it}^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} \sum_{t=r+1}^{T_i} z_{it}^* y_{j,it} \right) \\ &= \left[\left(\frac{1}{N} \sum_{i=1}^{N} z_i^* x_i^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} z_i^* x_i^{*\prime} \right) \right]^{-1} \times \left(\frac{1}{N} \sum_{i=1}^{N} z_i^* x_i^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} \sum_{i=1}^{N} z_i^* y_{j,i} \right) \\ &= \left[\left(\frac{1}{N} Z^* X^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} Z^* X^{*\prime} \right) \right]^{-1} \times \left(\frac{1}{N} Z^* X^{*\prime} \right)' \widehat{W}_{opt} \left(\frac{1}{N} Z^* Y_j \right) \end{aligned} \tag{14}$$

where $z_i^* = (z_{ir+1}^*, \ldots, z_{iT_i}^*)'$, $x_i^* = (x_{ir+1}^*, \ldots, x_{iT_i}^*)'$, $y_{j,i} = (y_{j,ir+1}, \ldots, y_{j,iT_i})'$, $X^* = (x_1^{*\prime}, \ldots, x_i^{*\prime})'$, $Z^* = (z_1^{*\prime}, \ldots, z_i^{*\prime})'$ and $Y_j = (y_{j,1}', \ldots, y_{j,N}')'$. Then, it is well known that $\hat{\theta}_{j,opt}$ is consistent and asymptotically normal.

$$\sqrt{N}(\hat{\theta}_{j,opt} - \theta_{0j}) \xrightarrow{d} \mathcal{N}(0, V_{j,opt}) \tag{15}$$

[7]Note the following $R \times R$ dimensional matrix $\widehat{Q}_j(\hat{\theta}_j)$ is a consistent estimator of $Q_j = E[h_{j,it}(\theta_{0,j}) h_{j,it}(\theta_{0,j})']$.

$$\begin{aligned} \widehat{Q}_j(\hat{\theta}_{j,1st}) &= \frac{1}{N} \sum_{i=1}^{N} \left(\frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \hat{v}_{j,it} \right) \left(\frac{1}{T_i - r} \sum_{t=r+1}^{T_i} z_{it} \hat{v}_{j,it} \right)' \\ &= \frac{1}{N} \sum_{i=1}^{N} \left(z_i^{*\prime} \hat{v}_{j,i} \right) \left(z_i^{*\prime} \hat{v}_{j,i} \right)' = \frac{1}{N^2} Z^{*\prime} \hat{V}_j \hat{V}_j' Z^* \end{aligned} \tag{12}$$

where $\hat{v}_{j,it} = \Delta \ln(s_{it,j}^*) - \Delta x_{it}' \hat{\theta}_{j,1st}$, $\hat{v}_{j,i} = (\hat{v}_{j,ir+1}, \ldots, \hat{v}_{j,iT_i})'$, and $\hat{V}_j = (\hat{v}_{j,1}', \ldots, \hat{v}_{j,N}')'$ is a $\sum_{i=1}^{N}(T_i - r)$ dimensional column vector .

where $V_{j,opt} = (T_j^{*\prime} Q_j^{-1} T_j^*)^{-1}$, $T_j^* = E\left[\frac{\partial h_{j,i}}{\partial \theta_j'}(\theta_{0j})\right]$, and $h_{j,i}(\theta_j)$ is defined in (9)-(10). The consistent estimator of $V_{j,opt}$ is $\widehat{V}_{j,opt} = (\widehat{T_j^*}' \widehat{Q_j}^{-1} \widehat{T_j^*})^{-1}$ where $\widehat{Q}_j$ is defined in (12) and

$$\widehat{T_j^*} = \frac{1}{N}\sum_{i=1}^{N} \frac{1}{T_i - r} \sum_{t=r+1}^{T_i} (-z_{it}\Delta x_{it}'). \tag{16}$$

If $R > K$, the over-identification restriction (OIR) test can be conducted.

$$T_{OIR,j} = N\Omega_n(\hat{\theta}_{j,opt}) = N\overline{h}(\hat{\theta}_{j,opt})'\hat{Q}^{-1}\overline{h}(\hat{\theta}_{j,opt})$$

asymptotically converges in distribution to $\chi^2(R-K)$ under the null hypothesis $E[h_{j,it}(\theta_{0,j})] = 0$, but it increases to infinity as N increases under the alternative hypothesis $E[h_{j,it}(\theta_j)] \neq 0$ for arbitrary θ_j.

3. ESTIMATION RESULTS

We use unbalanced panel data of 25 OECD countries during 1997-2014 to estimate the effect of population composition by age on the actual government spending among OECD countries.[8] Since the OECD data base does not provide the government spending on specific programs, such as old-age pensions, public health services, and public compulsory education, the information of areas including those specific programs are used. Those are government expenditures by functions. In particular, social protection, health, and education expenditures of the general government are used for the estimation. The expenditure except for those three is the reference expenditure. The definition of social protection, health, and education in OECD data is addressed in the Appendix.[9] We construct the relative actual share of social protection, health, and education to the reference share, and use their natural logarithm as the dependent variable, $\log s_{itj}^*$, $j = 1,2,3$. To consider the effect of the population composition by age on the government spending composition, we use the fraction of the population

[8]The OECD countries data are available at OECD data source: http://data.oecd.org. Specifically, the source includes OECD Employment and Labor Market Statistics, OECD National Accounts Statistics, and Main Economic Indicators. Those 25 countries are Australia, Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Greece, Hungary, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, Norway, Poland, Portugal, Sweden, and USA.

[9]See 5.2 for the definitions. For more details, see the classification of the functions of government at the website "https://www.imf.org/external/pubs/ft/gfs/manual/pdf/ch6ann.pdf".

over 65 and the fraction of the population under 15.[10] Similarly, the fraction of the population under 15 is used to reflect the preference of the young. Both regressors are closely associated with the population ageing trend, in that ageing leads to a higher fraction of the elderly and a lower fraction of the young. Per-capita GDP, debt-GDP ratio, and interest rate are selected to control the state of the economy. As addressed below Assumption 2, in particular, per-capita GDP, debt-GDP ratio, and interest rate are highly likely to have endogeneity because of the reverse causality. Similarly, even the fraction of the elderly and the young can be endogenous.[11] To consider the endogeneity of regressors, we propose to use lagged regressors as instruments. To test the exogeneity of instruments, the over-identification restriction tests are conducted. In addition, to test the validity of instruments, we test the null hypotheses that all parameters except for a constant are zero in each equation.[12] Summary statistics of variables are presented in Table 3 in the Appendix.

We consider the case of $J = 3$, where the first area is the social protection, the second area is health, and the third area is education. The zero area is all except for these three. Considering the simultaneity of the regressors and actual spending share, the presence of the endogeneity problem is natural. Therefore, we propose to use the GMM estimation as addressed in Section 2. Table 1 presents the GMM estimation results under Assumptions 0,1 and 2. The fraction of the young has a significantly positive effect on education, but it has a significantly negative effect on social protection and health. The increase in the fraction of the young leads to an increase of the share of government spending for education, which is the area the young prefer. However, the increase in the fraction of the young leads to a decrease in the share of government spending for social protection and health, which are less preferred areas for the young. The effect of the fraction of the elderly is shown to be insignificant for all areas. These findings at least weakly confirm the recurrent assertion that actual public spending reflects the interest of age groups. In particular, ageing leads to a smaller fraction of the young and a larger fraction of the elderly. Thus, the estimation results imply that

[10]Strictly speaking, the population over 65 indicates people of age 65 and more. For convenience, we use the terminology population over 65 even though it is not correct.

[11]The fraction of the elderly and the young can be influenced by the government fiscal policy including spending policy. For example, childbirth promotion policy, maternity protection policy policy, and health care policy affect the decision of giving births, which may change the fraction of the young and the elderly.

[12]The rejection of the null hypotheses implies that instruments are not weak. In practice, the common instruments are used for the estimation. Therefore, the same F-test statistic is obtained in each equation of area j. If different instruments are used to estimate each area j, three F-test statistics would be obtained.

the ageing is likely to bring more public resources to the social protection and health areas, and less public resources to the education area.

It is found that a 1% increase of per-capita GDP is associated with a 0.74% decrease in the relative share of the social protection area and 0.96% decrease in the relative share of the health area. However, a 1% increase of per capita GDP is associated with a 0.24% increase in the relative share of the education area. Debt-GDP ratio has a significantly negative effect on the relative share of the health and education areas. It is also noticeable that the interest rate has a significantly negative effect on the relative shares of all three areas. For the estimation, we use the common instrument $z_{it} = (1, x'_{i,t-1}, x'_{i,t-2}, x'_{i,t-3})'$. Over-identification restriction tests from the estimation results for all $j = 1,2,3$ indicate that the instrument vector satisfies the moment condition. Moreover, F-test results from the regression of Δx_{it} on z_{it} indicates that the instruments are not weak, in the sense that the null hypotheses that all parameters except for a constant are zero, are rejected at the 5% significance level. See Table 2.

Table 1: Estimation Results

	social protection	health	education
fraction of under 15	-0.080**	-0.353***	0.055***
(s.e.)	(0.037)	(0.030)	(0.012)
fraction of over 65	0.074	0.006	0.015
(s.e.)	(0.057)	(0.027)	(0.011)
log of per capita GDP	-0.739***	-0.959***	0.236***
(s.e.)	(0.234)	(0.114)	(0.051)
debt/GDP	-0.002	-0.003***	-0.001***
(s.e.)	(0.002)	(0.001)	(0.001)
interest rate	-0.047***	-0.031***	-0.027***
(s.e.)	(0.003)	(0.003)	(0.001)
OIR test stat.	0.026	0.005	0.044

† *, **and *** indicate that the null hypothesis that the parameter is zero is rejected at the 10%, 5% and 1% significance level respectively.
†† The number in ( ) indicates the standard error of the estimated parameter.
††† The number of observations is 369. The critical value at the 5% significance level is 19.675 since $\Pr[\chi^2_{11} < 19.675] = 0.95$ with $R = 16$ and $K = 5$.
†††† Instruments for GMM estimation are $z_{it} = (1, x'_{i,t-1}, x'_{i,t-2}, x'_{i,t-3})'$. F-test results from the regression of Δx_{it} on instruments z_{it} shows that instruments are not weak.

Table 2: F-test Results: $\Delta x_{it,k} = z_{it}'\pi_k + \varepsilon_{it}$

	Null hypo.	F-test stat.
fraction of under 15	$H_0 : \overline{R}\pi_2 = 0$	1101.6^{***}
fraction of over 65	$H_0 : \overline{R}\pi_3 = 0$	466.0^{***}
log of per capita GDP	$H_0 : \overline{R}\pi_4 = 0$	125.1^{***}
debt/GDP	$H_0 : \overline{R}\pi_5 = 0$	89.7^{***}
interest rate	$H_0 : \overline{R}\pi_6 = 0$	142.7^{***}

† The table shows F-test statistics from the regression of $\Delta x_{it,k}$ on z_{it} where $\Delta x_{it,k}$ the k-th regressor in Δx_{it} and the instrument vector is $z_{it} = (1, x_{i,t-1}', x_{i,t-2}', x_{i,t-3}')'$. *, **and *** indicate that the null hypothesis is rejected at the 10%, 5% and 1% significance level respectively. The critical values of χ^2_{R-1} at the 10%, 5% and 1% significance level are 22.31, 25.00, and 30.58 respectively.
†† $\overline{R} = (r_2, r_3, \cdots, r_{16})'$ where r_j' is a 16-dimensional row vector whose j-th element is one and the other elements are zero.
††† The number of observations is 369.

If we combine social protection and health into one area and consider three areas with $J = 2$, where $j = 1$ is social protection and health, $j = 2$ is education, and $j = 0$ is the reference area, then similar estimation results are obtained. See Table 4 in the Appendix.

4. CONCLUDING REMARKS

This study aims to empirically confirm the recurrent assertion that government spending policy is influenced by the population composition by age, in particular, the preference of the elderly and the young. For that goal, we propose a GMM estimation method to examine the effect of the population composition by age on government spending policy in OECD countries by comparing the actual spending share and the theoretical spending share based on the multinomial choice probability. Estimation results using unbalanced panel data of OECD countries imply that it is hard to deny the assertion, in the sense that the fraction of the young has a significantly negative effect on the spending share for social protection and health, but a positive effect on the spending share for education. That finding is consistent with the recurrent assertion, even though we can not find a significant effect of the elderly. In particular, ageing leads to a smaller fraction of the young and a larger fraction of the elderly. Hence, the empirical finding implies that the ageing trend is likely to bring more public resources to the social protection and health areas, and less public resources to the education area.

Besides the empirical finding, this study has some contributions. First, it tackles the endogeneity problem of regressors, which has not been taken care of by RSS (2002). Second, we propose to exploit the difference between the actual spending share and the theoretical spending share by constructing a model where their difference comes from the country-specific unobservable and idiosyncratic error. Moreover, the proposed method can be implemented by using aggregate data even though the theoretical spending share is based on individual utility maximization. However, there are some limitations of the study. First of all, the estimation results can be sensitive to the choice of the set of instruments even though it can be one of usual problems when choosing instruments.[13] We have no choice but to use the data on government expenditure by function which the OECD currently provides. If more specific information such as old-age pension instead of social protection expenditure can be available, more relevant research can be conducted.

[13]We tried other instruments such as $z_{it} = (1, x'_{i,t-1}, x'_{i,t-2})'$ and $z_{it} = (1, x'_{i,t-1}, x'_{i,t-2}, x'_{i,t-3}, x'_{i,t-4})'$. Admittedly, we found that estimation results are sensitive to the choice of instruments.

APPENDIX

A. SUMMARY STATISTICS OF VARIABLES

Table 3: Summary Statistics

	mean	median	standard deviation	min	max
social protection share	16.2	16.7	4.3	6.5	25.4
health share	6.3	6.5	1.4	1.7	8.9
education share	5.4	5.4	0.9	3.4	7.5
fraction of under 15	17.2	17.1	2.4	12.9	28.4
fraction of over 65	16.0	15.9	2.5	9.9	25.1
log of per capita real gdp	10.4	10.4	0.4	9.0	11.5
debt/GDP	70.0	62.1	37.9	6.7	232.9
interest rate	3.4	3.1	3.2	0.0	23.1

† Social protection, health and education are their shares in the total government spending.
†† The unit is the percentage except for log of per-capita real GDP. This interest rate is short-term nominal interest rate whose standardized names are money market rate and treasury bill rate.
††† The period of the unbalanced panel data is 1997-2014, and the number of observations is 394. 25 countries are included.

B. DEFINITION OF SOCIAL PROTECTION, HEALTH AND EDUCATION IN OECD DATA

The category of social protection is defined as government outlays on social protection including expenditures on services and transfers provided to individual persons and households and expenditures on services provided on a collective basis. Expenditures on individual services and transfers are allocated to groups (7101) through (7107); expenditures on collective services are assigned to groups (7108) and (7109). (7101) is SICKNESS AND DISABILITY, (7102) is OLD AGE, (7103) is SURVIVORS, (7104) is FAMILY AND CHILDREN, (7105) is UNEMPLOYMENT, (7106) is HOUSING, (7107) is SOCIAL EXCLUSION N.E.C., (7108) is R&D SOCIAL PROTECTION, and (7109) is SOCIAL PROTECTION N.E.C..[14]

The category of health is defined as government outlays on health including expenditures on services provided to individual persons and services provided on a collective basis. Expenditures on individual services are allocated to groups (7071) through (7074); expenditures on collective services are assigned to groups (7075) and (7076). (7071) is MEDICAL PRODUCTS, APPLIANCES, AND EQUIPMENT, (7072) is OUTPATIENT SERVICES, (7073) is HOSPITAL SERVICES, (7074) is PUBLIC HEALTH SERVICES, (7075) is R&D HEALTH, and (7076) HEALTH N.E.C.

The category of education is defined as government outlays on education including expenditures on services provided to individual pupils and students and expenditures on services provided on a collective basis. Expenditures on individual services are allocated to groups (7091) through (7096); expenditures on collective services are assigned to groups (7097) and (7098). (7091) is PRE-PRIMARY AND PRIMARY EDUCATION, (7092) is SECONDARY EDUCATION, (7093) is POST-SECONDARY NON-TERTIARY EDUCATION, (7094) is TERTIARY EDUCATION, (7095) is EDUCATION NOT DEFINABLE BY LEVEL, (7096) is SUBSIDIARY SERVICES TO EDUCATION, (7097) is R&D EDUCATION, and (7098) is EDUCATION N.E.C..

[14]N.E.C. stands for “Not Elsewhere Classified”.

Table 4: Estimation Results when $J = 2$

	social protection and health	education
fraction of under 15	-0.166 ***	0.055***
(s.e.)	(0.041)	(0.018)
fraction of over 65	0.042	0.015
(s.e.)	(0.054)	(0.016)
log of per capita GDP	-0.634***	0.236***
(s.e.)	(0.210)	(0.076)
debt/GDP	-0.003	-0.001*
(s.e.)	(0.002)	(0.001)
interest rate	-0.043***	-0.027***
(s.e.)	(0.003)	(0.002)
OIR test stat.	0.010	0.044

† *, **and *** indicate that the null hypothesis that the parameter is zero is rejected at the 10%, 5% and 1% significance level respectively.

†† The number in ( ) indicates the standard error of the estimated parameter.

††† The number of observations is 369. The critical value at the 5% significance level is 19.675 since $\Pr[\chi^2_{11} < 19.675] = 0.95$ with $R = 16$ and $K = 5$.

†††† Instruments for GMM estimation are $z_{it} = (1, x'_{i,t-1}, x'_{i,t-2}, x'_{i,t-3})'$. F-test results from the regression of Δx_{it} on instruments z_{it} are the same as the case $J = 3$ since the same regressors and instruments are used. Hence, instruments are not weak.

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