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Population Ageing and Fiscal Balance in The U.S. States

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Abstract: This study examines the fiscal implications of an increasing old-age population in the U.S. (United States) states. Old-age dependency increases government spending on public welfare health and hospitals. It increases property taxes and charges while it has negative effects on individual and corporate income taxes. A one per cent point increase in old-age dependency decreases the state fiscal balance by $120/person. The increase in old-age dependency has implications for U.S. state governments due to the Balanced Budget Requirements. This study provides stakeholders with estimates of the detailed effects of population ageing on certain categories of public expenditures and revenues.

Keywords: Ageing population, Old-age dependency ratio, Fiscal balance, System-GMM.

JEL codes: J14, H5, H6

1. Introduction

The main research question in this paper is whether population ageing has an impact on certain categories of public expenditures and revenues as well as the overall budget balance in the U.S. It is because demographic changes, especially the ageing population, modify the structure and the size of public expenditures and revenues. As Zokalj (2016) discussed, the obvious changes in public expenditures are age-related expenditures such as pensions, medical care and long-term care. Indirectly, the increase in the elderly population may influence other budgetary categories as well. Public revenue will change, too. The revenues accumulated through the sales tax are affected by changes in aggregate consumer behaviour; the revenues from personal and corporate income taxes are influenced as a result of shifts in the labour market (Zokalj, 2016).

This study has an implication for U.S. state governments because all the U.S. states except Vermont have Balanced Budget Requirements (BBR), which are statutory or constitutional rules that prevent states from spending more than their tax revenues (NCSL, 2010). BBRs obligate states

to balance spending with projected revenues, even though there is flexibility in achieving the requirement. Previous studies such as Alt and Lowry (1994), Bohn and Inman (1996), Campbell and Sances (2013), Crain and Miller (1990), and Poterba (1994) concluded that stricter BBRs result in tighter state fiscal outcomes. Population ageing has a negative impact on fiscal balance with more expenditure and fewer revenues, which makes it difficult for state governments to achieve BBRs. This study provides stakeholders with the estimates of the detailed effects of population ageing on certain categories of public expenditures and revenues as well as the overall budget balance. This study may help policymakers plan strategies to deal with budget deficits created by population ageing in the near future.

The literature associated with ageing populations from a national perspective is large as shown in the literature review section. But, as Newbold (2015) pointed out, ageing is not just a national phenomenon, but from the national level down to the local. The results from the national level may not translate to the regional scale (Kim & Hewings, 2013). Thus, this study aims to investigate the impact of population ageing on public expenditures and revenues using state-level data in the U.S., which is another contribution of the paper. State-level panel data on demographic changes and fiscal balance provide more efficient estimates and greater capacity to capture complex state behaviour (Hsiao, 2005). The results of the study will provide us insights into the impact on fiscal pressure of the population ageing, which might be useful for policy reforms responding to the fast ageing population.

The U.S. population has been ageing due to an increase in life expectancy and the decline of the fertility rate (Mather et al., 2015). In 2005, the share of the elderly (age 65 and above) population was about 12 per cent (He et al., 2005) while this share jumped to 15 per cent in 2016 (Table 1). It is projected to reach 21 per cent in 20 years (Vespa et al., 2018). The year 2030 marks an important demographic turning point, as a significant portion of baby boomers will have entered retirement, leading to an expansion in the size of the elderly population. As shown in Table 1, the 65 years and older population is projected to double from 49 million in 2016 to 95 million in 2060. The share of the elderly population will grow from about 15 per cent to 23 per cent in the same period; the 85 years and older population is expected to triple by 2060 (from 6.4 million to 19 million).

As Sheiner (2018) indicated, the changing demographic profile in the U.S. is of much concern to policymakers as it relates to several essential domains. The fiscal future of the U.S. is under pressure as much of the federal government budget is allocated to programs for the elderly

Table 1: Projected Age Groups and Composition of the Population from 2020 to 2060

	Population (millions)						*Changes from 2016*	
	2016	*2020*	*2030*	*2040*	*2050*	*2060*	*Number*	*Per cent*
Total population	323.1	332.6	355.1	373.5	388.9	404.5	81.4	25.2
Under 18 years	73.6	74.0	75.5	77.1	78.2	80.1	6.2	8.4
18 to 64 years	200.2	202.6	206.3	215.6	225.0	227.8	29.4	14.7
65 years and above	49.2	56.1	73.1	80.8	85.7	94.7	45.5	92.3
Share of 65+	15.2%	16.9%	20.6%	21.6%	22.0%	23.4%		

Source: Vespa et al. (2018)

population such as social security (pension), transfer systems, and the health (medicare) and well-being of the ageing population. Because the ageing population is a progressive phenomenon, the federal government cannot simply borrow to adjust its spending on the elderly. Slowing growth of GDP due to the ageing population (less working-age population in the economy) may cause working-age people to pay more to support the elderly and, thus, create pressure on the public budget. This study provides policymakers and stakeholders with the impacts of population ageing across each category of public expenditure and government revenue.

2. Literature Review

The relationship between demographic changes, especially the ageing population, and public finances has been the subject of extensive research. Auerbach et al. (1989) investigated the implication of demographic transition (ageing) in the U.S., Japan, Germany, and Sweden using an overlap generation model which was developed by Auerbach and Kotlikoff (1987). They concluded that the ageing population has many economic effects that impinge on a country's fiscal viability. Yashiro (1997) examined the fiscal implications of Japan's ageing population and also concluded that the growth of the elderly population increases the fiscal burden in the country as the ageing population shrinks the workforce which leads to lower savings. Díaz-Giménez and Díaz-Saavedra (2009) and Kurdna et al. (2015) arrived at similar conclusions for Spain and Australia respectively; the public pension system is not sustainable with population ageing. Chun (2006) used a life-cycle model and showed that rapid population ageing and long-term budgetary imbalance substantially lower the national savings rate in Korea.

Lee and Edwards (2002) pointed out that population ageing in the U.S. would have a negative impact on fiscal balance since expenditures on Social Security, Medicare, and Medicaid make up more than a third of the Federal budget. Population ageing would eventually increase the cost

of Federal programs under government program structures. In the case of Germany, Seitz and Kempkes (2007) examined the effects of demographic change on federal, state, and local government expenditures. Empirical results suggested that demographic changes would result in significant expenditure imbalances between the federal and the sub-national governments as well as within the sub-national government sectors. They also showed that the structure of expenditures had to be adjusted considerably to avoid deficits since demographic changes increased public expenditures such as pensions. Zokalj (2016) also found that there existed a significant and positive impact of the elderly's share on expenditure for social welfare and protection using panel data on 25 EU countries during the period from 1995 to 2014.

The ageing population also has a negative relationship with savings and international capital flows (Higgins, 1997). Among others, Kim and Lee (2007) analysed the empirical relationships among demographic changes, savings, and current account balances in East Asia using the panel Vector Autoregression model. They found that an increase in the dependency ratios, especially the old-age dependency ratio, significantly lowered the saving rates and subsequently worsened the current account balances. Their empirical results implied that the future ageing of the population in East Asia would have a significant impact on global capital flows and current account imbalances due to lower saving rates.

The other vein of empirical studies regarding ageing populations investigated specific categories of public expenditure, for example, increase in health expenditure (Chawla et al., 1998; Di Matteo & Di Matteo, 1998; Di Matteo, 2005), (modest) decline in asset prices (Poterba, 2004), leading to negative impacts on real GDP and private consumption (Castro et al., 2017), increase in public debt (Kamiguchi & Tamai, 2019), and lowering of economic growth (in the U.S.) (Maestas et al., 2016).

3. Data

For this study, 50 U.S. states were sampled (Washington DC excluded). The sample period covered a 16-year period from 2004 to 2019. The final data set had 800 observations (50 states × 16 years).

3.1. Expenditure and Revenue

Public expenditure and revenue data were compiled from the Tax Policy Center, the Urban Institute, and the Brookings Institution (https://www.taxpolicycenter.org). Tax Policy Center provided tax information compiled from a variety of sources including the Internal Revenue Service (IRS), the Congressional Budget Office, the Department of the Treasury,

the Federation of Tax Administrators, the Urban Institute, Brookings Institution, the Joint Committee on Taxation, and the Organization for Economic Cooperation and Development. Using the state and local general revenue and expenditure data tables, we constructed

- Fiscal balance in billions of dollars: the difference between total revenue and total expenditure in the corresponding fiscal year,
- Fiscal balance per capita in dollars: the difference between total revenue per capita and total expenditure per capita, and
- Fiscal balance in per cent of state personal income: per cent of fiscal balance in billions of dollars of state personal income.

These three variables serve as the primary and dependent variables. Table 2 presents the basic statistics of the variables used, including general revenue and expenditure. We anticipate heterogeneity in the data due to differences in size, population, and tax systems among U.S. states.

To illustrate the dynamic nature and heterogeneity of fiscal balances, Figure 1 was generated. The solid lines in Panel A and B in Figure 1 represent the average fiscal balance across states in billions of dollars and dollars per person, respectively. Points above zero indicate a fiscal surplus, whereas points below zero indicate a fiscal deficit.

California's fiscal deficit over the sample period was substantial, exceeding 20 billion dollars during the 2008-2009 financial crisis. New York had a fiscal surplus during the sample period, and in recent years,

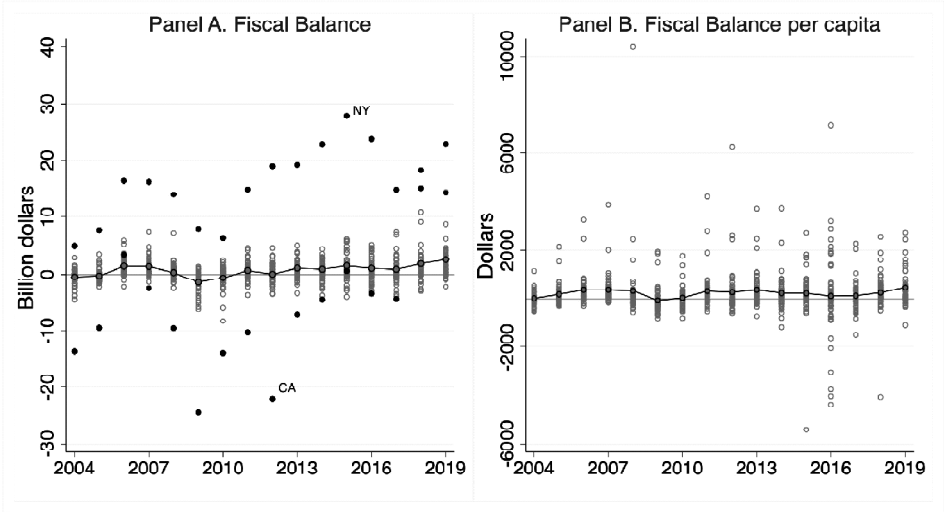

Figure 1: Fiscal Balance across the U.S. States

Authors' calculation using public revenue and expenditure data from Tax Policy Center

the surplus has reached close to 30 billion dollars. Note that, for example, per capita state revenue in New York in 2015 was $14,499, and per capita public expenditure was $13,033, resulting in a per capita fiscal balance of $1,466/person.

Considering New York's population was about 20 million in 2015, a fiscal surplus of 30 billion dollars was not unreasonable; however, it might have been an outlier. Additionally, Wyoming and North Dakota had substantially higher per-person fiscal surpluses well above $2000, probably due to the shale gas boom in the early 2010s.

Table 2: Public Expenditure, Revenue and Fiscal Balance in the U.S. States

Variable	*Mean*	*St. Dev.*	*Min*	*Max*
Revenue (billion dollars)	52.55	66.32	4.35	533.19
Expenditure (billion dollars)	52.03	65.80	4.16	518.87
Revenue per capita (dollars)	8,588	2,443	5,294	27,144
Expenditure per capita (dollars)	8,361	2,147	5,120	20,072
Fiscal balance (billion dollars)	0.691	3.520	-24.605	20.834
Fiscal balance per capita (dollars)	226	889	-5,415	10,381

Source: Revenue and expenditure data are compiled from Tax Policy Center; Fiscal balance is the authors' calculation

3.2. Dependency Ratios

The old-age dependency, or elderly dependency ratio, measures an ageing population. It is derived by dividing the population aged 65 and above by the population aged 18 to 64 and multiplying by 100 (Vespa et al., 2018). This ratio indicates the potential burden of the dependent population on the working-age population. Young age dependency, or youth dependency ratio, is defined as the number of children under 18 for every 100 adults aged between 18 and 64. It is introduced to control for any impact on fiscal balance in the U.S. states.

The dependency ratios were compiled from the U.S. Census Bureau (available at http://www.usa.gov/federal-agencies/u-s-census-bureau). Table 3 presents the basic statistics of the dependent ratios. Like fiscal balances, there exists heterogeneity across states (Figure 2). As shown in Figure 2, the old-dependency ratio keeps increasing monotonically during the sample period (solid line in Panel A in Figure 2). Florida has the highest old-age dependency ratio while Utah has the lowest old-age dependency ratio. In the case of the youth dependency ratio, we observe a negative trend in the sample period, which reflects the recent lower fertility rate. Utah has a substantially high youth dependency ratio, over 50% during the sample period. Vermont has the lowest youth dependency ratio at around 30%.

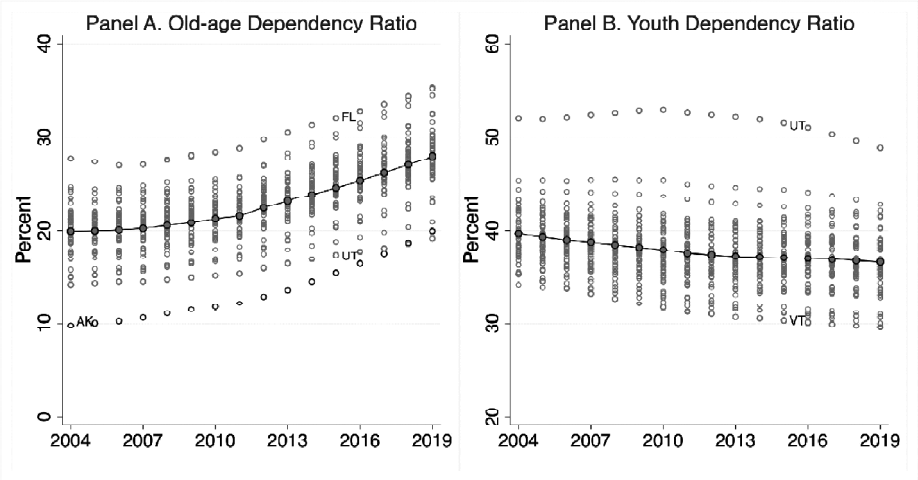

Figure 2: Dependent Ratios across the U.S. States

Source: http://www.usa.gov/federal-agencies/u-s-census-bureau

3.3. Additional Explanatory Variables

Other than dependency ratios, data on the unemployment rate, population density, 2008-2009 financial crisis dummy, and trend variables were collected. It is believed that unemployment may impact fiscal balance due to spending on safety-net programs such as unemployment insurance.

In addition, the unemployment rate controls the economic cycle effects on government finances. The unemployment rate was compiled from the Bureau of Labor Statistics (available at https://www.bls.gov/). Financial crises dummy controlled any abnormal activities during 2008 and 2009 when the U.S. economy experienced a great recession. During this time, the unemployment rate increased to 10% and GDP decreased substantially by roughly 5% (U.S. Department of Treasury, 2012). Table 3 presents a summary of the additional explanatory variables included in the analysis.

4. Dynamic Panel Model

It is justifiable to assume that the fiscal balance is persistent; it means that current revenue and expenditure are somewhat dependent on previous periods. It is hard to believe that public revenue and expenditure will experience abrupt changes in a short period of time. This assumption makes the dynamic panel model preferred over the static model as discussed in Zokalj (2016). The inclusion of a lagged dependent variable, the previous year's fiscal balance, may provide an adequate characterisation of the dynamic adjustment process. Bond (2002) pointed out that allowing for dynamics in the underlying process may be crucial to obtaining consistent

estimates of other parameters even though the lagged dependent variable is not of direct interest. The general linear dynamic model takes the form of:

$$y_{i,t} = \mu + \gamma y_{i,t-1} + \boldsymbol{\beta X}_{i,t} + \alpha_i + \epsilon_{i,t} \quad (1)$$

where i denotes the state ($i = 1, \cdots, 50$) and t denotes time periods ($t = 2004, \cdots, 2019$). The variable $y_{i,t}$ represents the dependent variables, for example, fiscal balance in state i in the year t; $X_{i,t}$ represents the vector of the vector of explanatory variables including the elderly and youth dependency ratios; $\boldsymbol{\beta}$ is the vector of parameters of interest. The error term $\epsilon_{i,t}$ is assumed to be identical and independently distributed over time with zero mean and constant variance. The parameter α_i represents the unobserved individual-specific time-invariant effect which allows for heterogeneity across states.

Table 3: Dependent Ratios and Additional Explanatory Variables

Variable	*Mean*	*St. Dev.*	*Min*	*Max*
Old-age dependency ratio (%)	22.80	3.94	9.78	35.27
Youth dependency ratio (%)	37.81	3.58	29.62	52.97
Unemployment rate (%)	5.65	2.11	2.10	13.70
Financial crisis (dummy = 1 for 2008-2009)	0.125	0.331	0	1

Source: http://www.usa.gov/federal-agencies/u-s-census-bureau Unemployment rate (https://www.bls.gov/)

Estimating equation (1) faces the endogenous issue because of the presence of the lag-dependent variable $y_{i,t-1}$, on the right-hand side which is correlated with the error term. In this case, the standard panel data estimator is not consistent even if the $\epsilon_{i,t}$ is not serially correlated (Baltagi, 2005) i.e., order 1 should be rejected. The issue with the correlation could be resolved by taking first difference which tends to eliminate the individual-specific effect parameter. The first difference dynamic model looks like this:

$$\Delta y_{i,t} = \gamma \Delta y_{i,t-1} + \boldsymbol{\beta} \Delta X_{i,t} + \Delta \epsilon_{i,t} \quad (2)$$

And use $\Delta y_{i,t-2}$ or $y_{i,t-2}$ as an instrument for $\Delta y_{i,t-1}$. The instrument will not be correlated with $\Delta \epsilon_{i,t}$ as long as $\epsilon_{i,t}$ are not serially correlated (Anderson & Hsiao, 1981; Baltagi, 2005). This instrument variable estimation leads to consistency but is not efficient because it does not use all the available moment conditions (Ahn & Schmidt, 1995).

Arellano and Bond (1991) proposed a generalised method of moments (GMM) procedure, which was extended in Arellano and Bover (1995), to estimate equation (2) with all the lag variables, $\Delta y_{i,t-2-j}$ for $j \geq 0$. It is more efficient than the estimator in Anderson and Hsiao (1981) by using additional instruments and all the available moment conditions. Blundell and Bond (1998) exploited the initial condition in generating an efficient estimator of the model and suggested a system GMM estimator. The system GMM estimator is shown to have substantial efficiency gains over the first-difference GMM. The system GMM is used to estimate equation (2) in this study.

5. Results and Discussion

To examine the impact of the old-age dependency ratio on fiscal variables, we estimated equation (2) using the data discussed in the Data section with the system GMM. Table 4 reports the estimation results with two models depending on the dependent variables. Model 1 estimates the impact of the old-age dependency ratio on the fiscal balance in billions of dollars, and Model 2 uses fiscal balance per capita in dollars as the dependent variable.

Note that, as shown in Table 4, the Arellano-Bond test (Arellano & Bond, 1991) was tested for zero autocorrelation in first-differenced errors. By construction, the first-differenced errors are first-order serially correlated, i.e., order 1 should be rejected. Arellano-Bond test fails to reject the serial correlation with order 2 and it indicates that the moment conditions used in estimation are valid. Sargan test (Sargan, 1958; Hansen, 1982) fails to reject the null hypothesis that the model and over-identified conditions are correct (the instruments used in the analysis are valid). All the parameters in Table 4 are statistically significant and have expected signs. The estimates for the lag dependent variables are significant at 1% with values between 0.372 and 0.374. The parameter estimates for the old-age dependency ratio are negative in both models. In Model 1, it is estimated to be -0.31, meaning that a one percentage point rise in the old-age dependency would result in a $0.31 billion decrease in fiscal balance, moving toward a fiscal deficit. This is equivalent to about $68/person (coefficient of the old-age dependency ratio in Model 2 in Table 4).

The youth dependency ratio also has a negative impact on fiscal balance as a higher youth population would worsen fiscal balance. As shown in Table 4, it is estimated to be about $1.01 billion (Model 1) or $105/person (Model 2).

It is natural to ask how dependency ratios affect state government revenue and expenditure. As Zokalj (2016) and Sheiner (2018) explained,

Table 4: Fiscal Balance Estimation Results using System GMM

Variables	*Model 1* *Fiscal balance in billion $*	*Model 2* *Fiscal balance per capita in $*
$\Delta y_{i,t-1}$	0.3743***	0.3724***
	(0.0069)	(0.0023)
Old-age dependency ratio	–0.3116***	–68.47***
	(0.0274)	(2.9695)
Youth dependency ratio	–1.0122***	–104.81***
	(0.0560)	(8.1358)
Unemployment rate	–06001***	–76.84***
	(0.0293)	(3.6793)
Financial crisis dummy	–1.7525***	–113.28***
	(0.0322)	(5.6652)
Constant	49.43***	6125.59***
	(2.8062)	(329.49)
Number of obs.	750	
Number of groups	50	
Arellno-Bond test[1]		
Order 1	–2.196 [0.030]	–2.754 [0.006]
Order 2	–1.116 [0.257]	0.500 [0.617]
Sargan's J test[2]	47.33 [1.000]	47.47 [1.000]

Robust standard errors reported in parentheses; *, **, *** indicate the significance at 10%, 5% and 1%, respectively.

[1] Arellano and Bond test statistics (Arellano & Bond, 1991) with a p-value in the bracket, which is testing for zero autocorrelation in first-differenced errors.

[2] Sargan's J test statistics (Sargan, 1958; Hansen, 1982) with a p-value in the bracket, which is testing over identifying restrictions, are valid.

the obvious change in public expenditures is age-related expenditures such as pensions, medical care and long-term care. Indirectly, the increase in the elderly population may influence other budgetary categories as well as expenditure on education. It is expected that the increase in the elderly cohort, by decreasing the pupil-to-teacher ratio, will bring into consideration the efficiency of allocating the current level of expenditures for education. Public revenue will change as well. The revenues accumulated through the sales tax are affected by changes in aggregate consumer behaviour and the revenues from personal and corporate income taxes are influenced as a result of shifts in the labour market (Zokalj, 2016; Sheiner, 2018). To answer these questions we ran regressions of each government revenue category such as property tax revenue, sales tax revenue, and income revenue on demographic variables. In a similar fashion, equations for public expenditure categories are estimated, for example, education, public welfare expenditure, and health and hospitals. Figure 3 presents the estimation results graphically. Note that all the

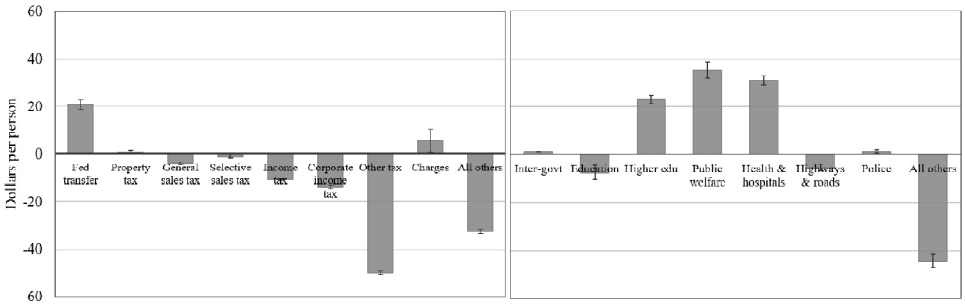

Figure 3: Marginal Impact of Old-age Dependency on Government Revenue and Public Expenditure

Note: Unit is dollars per person; Error bars indicate 95% confidence intervals

revenue and expenditure categories are dollars per person and estimated individually using the dynamic panel in Equation 1 (estimation results are not reported here to save space and will be made available upon request).

Panel A in Figure 3 presents the impact of the old-age dependency ratio on government revenue. It is positive and statistically significant on federal transfers (+$21/person) and charges (tolls on highways, tuition paid to state universities, etc.) ($6/person). On the other hand, the old-age dependency ratio has negative effects on individual income tax (-$11/person), corporate income tax (-$14/person), other taxes (taxes on motor vehicle licenses, etc.) (-$50/person), and all other revenue (miscellaneous general revenue, including lottery revenues) (-$32/person). From the graph, a one percentage point increase in the old-age dependency ratio would decrease state revenue by $85/person (the sum of all the estimates in Panel A in Figure 3).

Panel B in Figure 3 illustrates the impact of the old-age dependency ratio on public expenditure. An ageing population increases public welfare (spending on Medicaid, temporary assistance for needy families, supplemental security income) (+$35/person) and health and hospitals expenditure (spending on community and public health programs, government-owned hospitals, and payments to private hospitals) (+$31/person). Interestingly, the old-age dependency ratio increases state spending on higher education (+$23/person). The old-age dependency ratio decreases spending on highways and roads (spending on the operation, maintenance, and construction of highways, streets, roads, sidewalks, bridges, and related structures) (-$5/person), spending on primary education, and all others (corrections, housing & community development, courts), which are hard to explain. All said, a one percentage point rise in

the old-age dependency ratio makes the state spend $35/person more (the sum of all the estimates in Panel B in Figure 3). Combining changes in government revenue, a one percentage point increase in the old-age dependency ratio would result in a $120/person change in the state's fiscal balance, which is larger than the $68/person reported in Model 2 in Table 4.

6. Concluding Remarks

In conclusion, demographic changes occur with an ageing population. The ageing population leads to an increase in the share of the elderly population due to longevity accompanied by a decline in the fertility rate. According to the 2017 US population projection, if the current trend persists, the demographic profile will change dramatically by the middle of the century. The U.S. population will rise to 404 million by 2060, and 23% of the population will be 65 years and older. The old-age dependency ratio will be 41%, substantially higher than the 2015 average ratio of 25% across the U.S. states (Vespa et al., 2018). We expect that government budgetary projections will increase over the years due to the rapid increase in the elderly population. Since there are no unanimous criteria for economists and policymakers to determine how exactly an ageing population affects state budgets, we examined the relationship between the ageing population and fiscal balances across the U.S. states

The dataset for the study spans over a period from 2004 to 2019 (16 years) including observations for 50 states in the U.S. The dependent variables are 1) fiscal balance in billions of dollars and 2) fiscal balance per capita. The explanatory variables are in three categories: demographic changes represented by the old-age dependency ratio and youth dependency ratio, other control variables represented by the unemployment rate, and the dummy for the Great Recession in 2008 and 2009. As reported in Table 4 with the system-GMM method, the old-age dependency ratio has negative impacts on all fiscal balances; a one percentage point increase in the old-age dependency would result in a $0.31 billion decrease in fiscal balance (moving towards a fiscal deficit) (Model 1) and about $68/person (Model 2). With regard to other control variables, the youth dependency ratio, unemployment rate, and financial crisis dummy are all significant and have expected signs.

Old-age dependency increases government spending on higher education, public welfare (Medicaid), and health and hospitals. Old-age dependency increases property taxes and charges while it has negative effects on individual and corporate income taxes, other taxes, and all other revenue. All said, a one percentage point increase in old-age dependency

would decrease the state's fiscal balance by $120/person. This study has implications for U.S. state governments because all U.S. states except Vermont have Balanced Budget Requirements. This study provides stakeholders with estimates of the detailed effects of population ageing on certain categories of public expenditures and revenues as well as the overall budget balance. This study may help policymakers plan strategies to deal with budget deficits created by population ageing.

It is imperative for state and federal governments to pay more attention to demographic changes and make budgetary projections for the near future. The empirical findings in this study have provided evidence to support policies with Balanced Budget Requirements to mitigate fiscal deficits in an ageing population. Suggesting tax reform or relevant policies to mitigate the impact of an ageing population may be beyond the scope of this study. However, we strongly recommend policymakers develop policy measures aimed at reducing the government deficit.

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