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Would Population Aging Change the Output Effects of Fiscal Policy?

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Abstract

Would population aging affect the effectiveness of fiscal stimulus? Despite the renewed focus on population aging, there are few empirical studies on the output effects of fiscal policy in aging economies. Our study fills this gap by analyzing this issue in OECD countries. We find that, as population ages, the output effects of fiscal spending shocks are weakened. We also find that, while high-debt countries generally face weaker fiscal multipliers, high-debt aging economies face even weaker multipliers. These results point to important policy implications: population aging would call for a larger fiscal stimulus to support aggregate demand during recession and thus require larger fiscal space to allow a wider swing of the fiscal position without creating concerns for fiscal sustainability. Our analysis also suggests that policy measures to promote labor supply could help increase the output effect of fiscal stimulus in aging economies.

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INTRODUCTION

1.   **Population aging and its impacts are gaining increasing attention.** Due to steady declines in fertility rates and increasing longevity, many countries—particularly advanced economies—are facing rapid aging of their population. In June 2019, G20 leaders pointed out that demographic changes, including population aging, pose challenges and opportunities for all G20 members, and these changes will require policy actions that span the fiscal, monetary, financial, labor market and other structural policies (G20 Osaka Leaders' Declaration). In the meantime, the Framework Working Group on Macroeconomic Implications of Population Aging (2019) highlighted that in light of the expected aging process, G20 policymakers should be forward-looking and proactive in undertaking beneficial reforms.

2.   **The literature identifies significant adverse effects of population aging on the macroeconomy.**[1] Facing such stark demographic changes, an increasing number of studies have examined the macroeconomic implications of population aging. Population aging could reduce potential growth by lowering labor input and productivity (IMF, 2019a; Yoshino and Miyamoto, 2017). Aging would also exert pressure on public finance by lowering fiscal revenues and increasing needs for social expenditures (IMF, 2016a, 2019a; Yashio and Hachisuka, 2014). These findings set the stage for rethinking macroeconomic policy design in aging economies.

3.   **With such changes in policy environments, a critical question for policymakers is how aging modifies the effectiveness of macroeconomic policies.** Recently, a few empirical studies have shed light on this issue. Imam (2013) and Wong (2019), for instance, point out that population aging would reduce the effects of monetary policy on inflation and output. In light of such findings, Imam (2013) concluded that *the relative role of fiscal and macroprudential policy as a means to stabilize the economy may become more important.*"

4.   **The literature, however, provides little empirical evidence as to how population aging affects the effectiveness of fiscal policy.** This paper fills this gap by empirically examining the output effects of fiscal spending shocks using a panel data of OECD countries. We estimate the output effects of government spending shocks by using the local projection method of Jordà (2005) for aging and non-aging economies.[2] We use the old-age dependency ratio to identify the aging state of an economy and identify the government spending shocks as forecast errors of government spending as in Auerbach and Gorodnichenko (2012, 2013).

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[1] IMF (2017, 2019b) examine the implications of demographic changes in major Asian economies and central and eastern European countries.

[2] In this paper, fiscal multipliers and output effects of government spending shocks are used interchangeably. In general, fiscal multipliers are defined as the ratio of a change in output to a discretionary change in government spending. For this purpose, this paper—following the methodologies widely used in the literature—identifies government spending shocks as forecast errors of government spending and estimate their impacts on output. Thus, in an attempt to describe the nuanced nature of this exercise accurately, this paper employs the term "the output effects of government spending shocks."

5.   **To our knowledge, this is the first empirical paper that attempts to assess the impact of population aging on fiscal policy effectiveness using panel data.** While there are a few studies that examine how population aging affects the effectiveness of macroeconomic policies, they focus on monetary policy or are theoretical (see the literature review in Section II). The only exception is Basso and Rachedi (2019). By using the U.S. state-level data, they find that the age structure of the population affects local fiscal multipliers (such that fiscal multipliers are larger in economies with higher shares of young people in the total population). Our study provides empirical evidence that population aging affects fiscal multipliers at the national level in OECD countries.

6.   **We find that the output-boosting effect of fiscal stimulus is weakened as population aging proceeds.** In aging economies, the positive output effects of government spending shocks during recessions are weaker, while during booms, the positive government spending shocks reduce output and the negative effect is long-lasting. Furthermore, even during recessions, the positive output effects of government spending shocks decline with the degree of aging in the economy. For the weaker output effects in aging economies, our analysis suggests a few possible channels, including: (i) Ricardian-type responses; and (ii) lower growth in labor supply.

7.   **These results have important policy implications.** In aging economies, policymakers should account for the weaker demand-supporting effects of fiscal policy. During recessions, a larger fiscal stimulus would thus be called for to support aggregate demand, which would require maintaining a larger fiscal space to allow for wider swings in the fiscal position. Furthermore, given the weak effect of fiscal stimulus to boost output even during recessions, other macroeconomic policies or structural reform measures would have to play a more important role. Our analysis also suggests that policy measures to promote labor supply could help increase the output effect of fiscal stimulus in aging economies.

8.   **The remainder of the paper is organized as follows:** Section II reviews the existing literature. Section III presents the recent developments associated with population aging. Section IV presents the empirical methodology. Section V presents the main findings. Finally, Section VI provides the conclusion and draws policy implications.

I.   Literature Review

9.   **The literature points out the adverse impacts of population aging on demand and potential output.** Specifically, it identifies several channels through which population aging could reduce aggregate potential output. These are, for example: (i) fewer workers; (ii) a higher share of older workers; and (iii) age-specific productivity profiles (Bloom et al. 2010; Maestas et al., 2016; IMF, 2017; Aksoy et al., 2019).[3] Population aging also affects national saving. On one

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[3] In contrast, Prettner (2013) shows that population aging fosters long-run growth in the endogenous growth framework.

hand, population aging may lead to lower aggregate saving as the proportion of dissaving or low-saving elderly rises relative to the proportion of working age people who saves for retirement. On the other hand, it would make people save more by extending their after-retirement life (Heijdra and Ligthart, 2006; Heijdra and Romp 2008)[4].

10.   **Furthermore, many studies find a negative impact of population aging on fiscal balances.** The first of this kind—using an overlapping generations model—was Blanchard (1985), which laid the ground for further theoretical work to analyze the macroeconomic effects of demographic changes. These studies point out that population aging would lead to higher public debt. IMF (2015) highlights the impact of rising spending on age-related programs (pensions and health) on fiscal balances and economic growth, while IMF (2016a) notes that the potential impact on other types of spending (e.g., education) tends to be uncertain.[5] On the revenue side, IMF (2016a) also points out that individual income and consumption spending patterns tend to change over the life cycle.

11.   **A few studies examine the effects of macroeconomic policies in aging economies.** Yoshino and Miyamoto (2017) show that, using a tractable dynamic stochastic general equilibrium (DSGE) model with heterogenous agents, the effectiveness of fiscal and monetary policies is weakened with population aging. They find that less labor supply due to population aging weakens the effectiveness of fiscal policy. Basso and Rachedi (2019) find that local fiscal multipliers depend on the age structure of the population by using the U.S. state-level data (such that fiscal multipliers are larger in economies with higher shares of young people in the total population).[6] They rationalize this finding with a life-cycle open-economy New Keynesian model. Imam (2013) and Wong (2018) empirically examine the impact of the demographic changes on the effectiveness of monetary policies and found that the effectiveness of monetary policies is weakened as society is graying.

II. STYLIZED FACTS

12.   **We look at recent developments associated with population aging, with a focus on its macroeconomic impacts.** As a measure of population aging, we use the old-age dependency ratios, defined as the ratio of people 65 and older to those between 15 and 64 years old.

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[4] While Auerbach et al. (1991) and Auerbach et al. (1989) quantitatively show the negative impact of aging on the saving rate, Lee (2016) notes that the net effect of population aging on saving rates is not clear.

[5] While a smaller fraction of younger age groups could lead to some savings, higher enrollment rates and longer periods spent in education could put upward pressure on total education expenditure. Empirical evidence suggests that the direct budgetary impact of demographic changes on education spending is small (e.g., Grob and Wolter, 2007; McMorrow and Roeger, 1999).

[6] In the baseline regression, Basso and Rachedi (2019) use the ratio of 20–29 year old white males over the total population of white males as the share of young people in total population.

- **The old-age dependency ratios have been rising for several decades and are projected to increase further.** This trend is largely driven by high-income countries. Middle-income countries are projected to follow this trend with a lag of a few decades. As a result, within the next 30 years, more than 20 countries across the world would exceed the old-age dependency ratio of 50 percent (an unprecedented level in global history), with some even reaching 70 percent (Figure 2).

Figure 1. Old-Age Dependency Ratio (Percent)

Figure 2. Projected Demographic Changes (Percent)
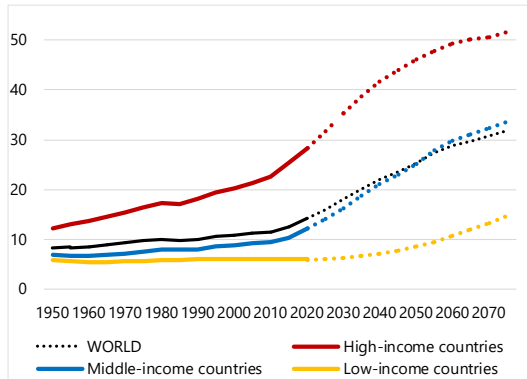
Note: The projections beyond 2020 are based on the medium variant estimates by the United Nations.
Source: United Nations
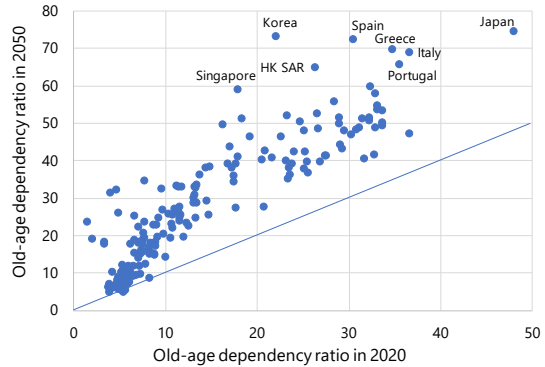
- **Based on the findings in the literature (e.g., IMF, 2019a; Yoshino and Miyamoto, 2017), we highlight the following macroeconomic impacts of population aging:**

  - *Growth:* *Growth performance is relatively low in countries with an aging population (Figure 3).* As the literature identified (IMF 2019a; Yoshino and Miyamoto, 2017), countries with population aging tend to face lower growth, reflecting lower labor input and productivity. Lower potential growth—potentially leading to lower investment returns—could adversely affect the private sector investment.

Figure 3. Growth Performance
(Average annual growth, 2008–2018)
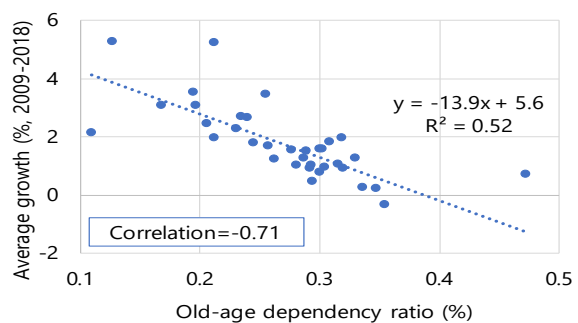
  - *Labor:* *In countries with an aging population, not surprisingly, the working-age population tends to decline (Figure 4), while labor force participation has often risen (Figure 5).* Akitoby, et al. (2019) highlights that, with the increase in female labor force participation, the number of women in total employment has been an increasing trend in G7 countries. While it is not clear if the rising female labor force participation is a response to population aging, an increased labor force participation—with a larger female labor

force, higher retirement age, and/or a larger number of immigrants—may help slow the decline in the labor force brought by aging.

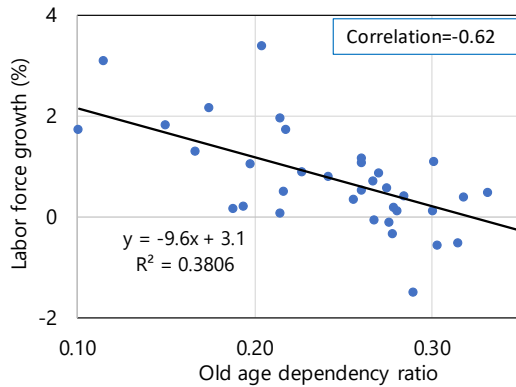**Figure 4. Labor Force Growth and Aging Population (Average, 2009–18)**

Figure 5. Labor Force Participation and Aging Population (2018)
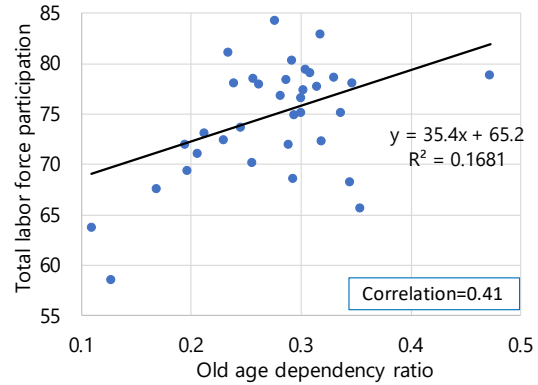
- ***Public debt:*** *The level of public debt tends to be higher with population aging.* Figure 6 shows that population aging is positively associated with high public debt. This may reflect the consequence of increased fiscal spending (e.g., pension and health) for aging population. As highlighted in IMF (2015, 2016a), in many advanced and emerging market economies, aging populations will boost spending on pensions and health care, while projected population dynamics will adversely affect growth and government revenues.

Figure 6. Public Debt and Population Aging (2017)
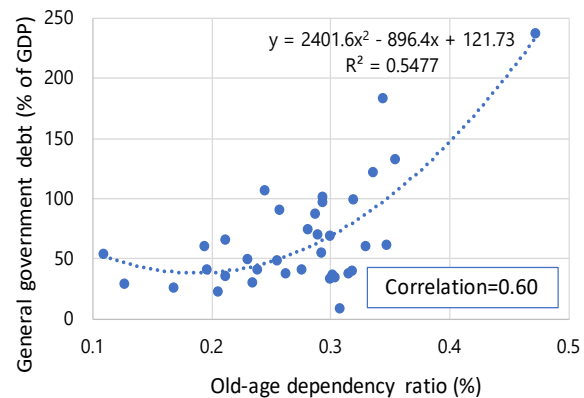
13. **Obviously, these factors (labor supply and public debt) are highly associated with population aging.** As discussed in the literature, and also demonstrated above, population aging would influence the economy through various channels, which include fewer workers and higher public debt. Thus, when we discuss the output impacts of population aging, it would be important to examine through which channel the impacts are emerging. Our empirical analysis will look at the role of each of these factors to examine how they are affecting the effectiveness of fiscal stimulus.

III. DATA AND EMPIRICAL METHODOLOGY

Data

14.   **The data used in the analysis comes from the OECD's Statistics and Projections Database and the World Population Prospects from the United Nations (UN).** The macroeconomic series are taken from the OECD's Economic Outlook. As for the forecast of the government spending, we use the forecasts reported in the fall issue of the OECD's Economics Outlook for the same year to construct government spending shocks. The old-age dependency ratio comes from the UN's World Population Prospects. Our sample covers an unbalanced panel of 17 OECD countries over the period of 1985–2017.[7]

15.   **Our analysis uses the old-age dependency ratio as a measure of the aging state of an economy.** We define an economy to be aging when the old-age dependency ratio is above a certain threshold. For our baseline results, an economy is regarded as aging if its old age dependency ratio exceeds the sample median of 22.7 percent.

Empirical Methodology

16.   **To estimate the output effects of fiscal policy, our benchmark model is based on the local projection method (LPM) proposed by Jordà (2005), using forecast errors to identify fiscal spending shocks**.[8] The benchmark specification is as follows:

$$Y_{i,t+h} - Y_{i,t-1} = \beta_A^h I_{i,t} Shock_{i,t} + \beta_N^h (1 - I_{i,t}) Shock_{i,t} + \theta^h X_{i,t} + \alpha_i^h + \gamma_t^h + \varepsilon_{i,t}^h \qquad (1),$$

where Y is log of real GDP, *Shock* is the government spending shock which is defined below, and I is a dummy variable that indicates the aging state of the economy. It takes the value of 1 for the aging economies and 0 otherwise. X is a vector of control variables, α is the country fixed-effect, γ is the time fixed-effects, and $\varepsilon_{i,t}^h$ represents the stochastic residual. As all coefficients vary with the horizon h, a separate regression is estimated for each horizon. We estimate Equation (1) for each for each h=0,1, ..., 4. As h=0 is the year when the government spending shock takes place, we use the standard medium-term 5-year horizon. Impulse response functions are computed using the estimated standard errors of the coefficients β.

17.   **We use this parsimonious model as our benchmark model.** We then extend it to probe the various channels of aging identified above. Although the LPM has proven to be robust to misspecification and omitted variables, we conduct extensive robustness checks (see Section V below).

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[7] The sample countries are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Japan, Korea, Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States.

[8] The LPM is flexible in estimating state-dependent impulse responses. The LPM does not constrain the shape of the impulse response functions and is therefore less sensitive to misspecification than estimates obtained from VAR models.

18.   **Following Auerbach and Gorodnichenko (2012, 2013), government spending shocks are identified as forecast errors of government spending.** Thus,

$$Shock_{i,t} = G_{i,t} - G_{i,t}^E,$$

where $G_{i,t}$ is the government spending as a share of GDP, and $G_{i,t}^E$ is a prior forecast of government spending. Forecasts are taken from the fall issue of the OECD's *Economic Outlook*. This identification method overcomes two challenges often associated with the estimation of fiscal multipliers, namely the "fiscal foresight" problem (Leeper, Richter, and Walker, 2012; Leeper, Walker, and Yang, 2013) and the potential feedback from the state of the economy to fiscal policy.[9]

IV. EMPIRICAL FINDINGS

A. Basic Results

19.   **The results of the benchmark model find lower output effect of fiscal spending shocks in aging economies.** Figure 7 shows impulse responses obtained from estimation of Equation 1. Here and what follows, horizontal axes measure years after the shock. A positive government spending shock—whose size is 1 percent of GDP— increases output by about 0.1 percent in the first year and 0.5 percent in the fourth year after the shock if the state of population aging is not taken into account (linear model). Population aging, however, alters the output effect of government spending shocks. In non-aging economies, a positive government spending shock is associated with a similar increase in output of about 0.09 percent in the same year and 0.6 percent four years after the shock. In contrast, in aging economies, the output effects are not statistically significant.

20.   **The results highlight the importance of heterogeneity by aging.** The results above suggest the need to consider the degree of population aging in estimating the size of the output effects, in addition to various other factors.[10] We find that while the output effects of fiscal policy shocks are statistically different from zero over the whole 5-year horizon in non-aging economies, those are not statically significant in aging economies. We also find that the differences of estimated output effects between aging and non-aging economies are statistically significant at the 5 percent level from t=1 and at 10 percent at t=0.[11] Furthermore, size of the output response to fiscal policy shocks in aging economies is much smaller than that in non-aging economies. Clearly, these differences are economically important and policy relevant.

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[9] Economic agents receive signals about future changes in fiscal spending policy before they actually take place, which may affect their decision behavior. This is known as the fiscal foresight problem. Also, fiscal policy is likely to be a response to the current state of the economy even if the policy is unanticipated. Using the forecast error approach would reduce the probability that the fiscal policy shock contains information about the current business cycle since most of the information of the business cycle in year t would be contained in the forecast (published in October), not in the forecast errors.

[10] The recent literature finds that the size of fiscal multipliers is influenced by various factors. IMF (2014) provides a comprehensive survey.

[11] We follow the method in Boeckx et al. (2019).

Figure 7. Output Effects of the Government Spending Shock
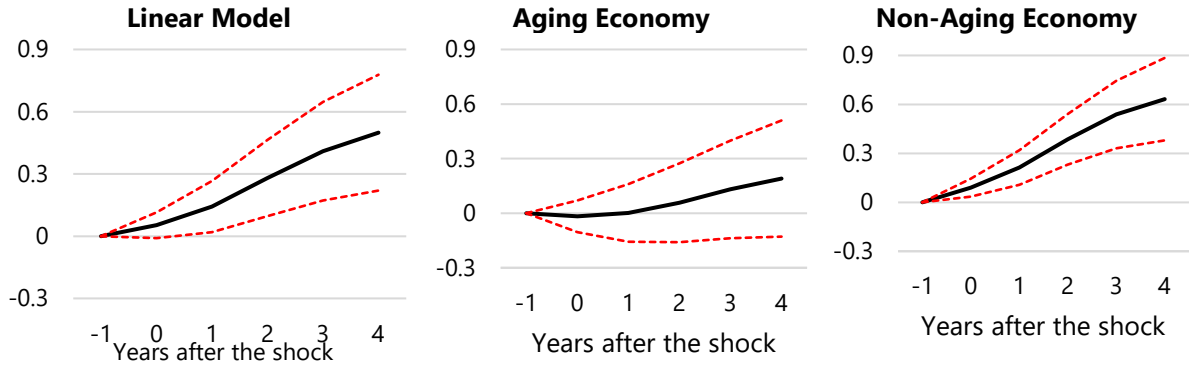
Note: t=0 is the year of the shock. Solid lines present the responses (in percent) to an unanticipated shock to government spending of 1 percentage point of GDP. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the median of 22.7 percent.

B. Recessions vs. Booms

21.   **We extend our analysis to examine how population aging affects output effects of fiscal policy over the business cycle.** Recent studies on the fiscal multiplier find that the state of the business cycle affects the size of the fiscal multiplier (Auerbach and Gorodnichenko, 2012 and 2013; Ramey and Zubairy, 2018). Thus, it is important to examine whether population aging would affect the state-dependent output effect of the government spending shock. For this purpose, we allow the response of output to vary with the state of the economy:

$$Y_{i,t+h} - Y_{i,t-1} = I_{i,t}[\beta_{R,A}^h G(z_{i,t})Shock_{i,t} + \beta_{B,A}^h \left(1 - G(z_{i,t})\right)Shock_{i,t}] + (1 -$$
$$I_{i,t})[\beta_{R,N}^h G(z_{i,t})Shock_{i,t} + \beta_{B,N}^h \left(1 - G(z_{i,t})\right)Shock_{i,t}] + \theta^h X_{i,t} + \alpha_i^h + \gamma_t^h + \varepsilon_{i,t}^h \qquad (2),$$

with

$$G(z_{i,t}) = \frac{\exp(-\delta z_{it})}{1 + \exp(-\delta z_{it})}, \ \delta > 0$$

where *z* is an indicator of the business cycle normalized to have zero mean and unit variance, and *G*(·) is the corresponding smooth transition function. The transition function can be interpreted as the probability of the economy being in recession. *G*=1 corresponds to a situation in which the economy is in a deep recession, while *G*=0 corresponds to the economy being in a strong expansion. Following Auerbach and Gorodnichenko (2013) and IMF (2014a), we use real GDP growth as a measure of the business cycle and set the parameter *δ*=1.5.[12, 13]

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[12] Auerbach and Gorodnichenko (2013) set δ=1.5 so that a typical economy spends about 20 percent of the time in a recession regime, which is consistent with the fraction of recessionary periods in the U.S. Auerbach and Gorodnichenko (2014) estimate government purchase multipliers for Japan by setting δ=1.5.

[13] Instead of using the output gap, we identify the state of the economy using GDP growth as the output gap is unobservable and subject to substantial and frequent revisions, and thus estimates of output gaps are typically surrounded by great uncertainty. However, as noted below, similar results are obtained when we use the output gap as the business cycle indicator.

22.   **Population aging also affects the state-dependent fiscal multipliers.** Figure 8 presents state-dependent impulse responses of output to an unanticipated increase in government spending by 1 percent of GDP. For both aging and non-aging economies, we show impulse responses in an expansionary regime (boom) and a recessionary regime (recession). As in previous studies in the literature (Barro and Redlick, 2011; Auerbach and Gorodnichenko, 2012 and 2013; Dell'Erba et al. 2014), the output responses are significantly different by the state of an economy. Figure 8 shows that population aging weakens the positive output effects of government spending shocks under recessions. We find that the differences of the estimated output effects under recessions are statistically significant between aging and non-aging economies in the medium term (from t=2).[14] In contrast, the difference in output responses under booms are not statistically significant between aging and non-aging economies, although the negative output impact of the government spending shock is long-lasting in aging economies.[15]

Figure 8. State-Dependent Fiscal Multipliers in Both Aging and Non-Aging Economies
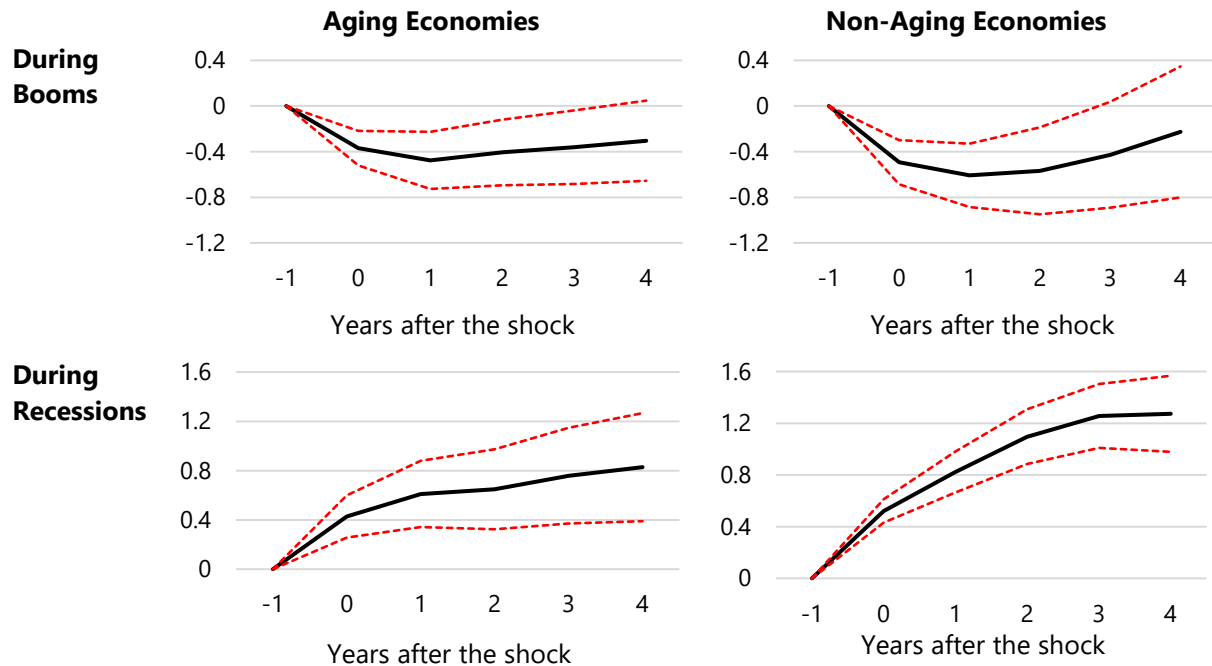
Note: t=0 is the year of the shock. Solid lines present the responses (in percent) to an unanticipated shock to government spending of 1 percentage point of GDP. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the median of 22.7 percent.

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[14] It is important to note that an overlap of the confidence intervals by itself does not imply that the differences are statistically insignificant. For example, Boeckx et al. (2019) show that the difference between the impulse responses are statistically significant though the confidence intervals overlap.

[15] Auerbach and Gorodnichenko (2012) also found negative fiscal multipliers during booms in the U.S.

Box 1. Would Fiscal Stimulus be Effective During Recessions in Highly Aging Economies?

We confirm that in aging economies (with old-age dependency ratio above 22.7 percent), the output effects of fiscal spending shocks are state-dependent. The analysis above (Figure 8) suggests "lower but still positive" impacts of fiscal spending shocks in aging economies during recessions. This finding raises further the question, "does the effectiveness of a *fiscal stimulus during a recession depend on the degree of aging?*"

To answer this question, we now examine how the output effects of government spending shocks would change by varying the threshold for aging population. Using the same model specification as above, the output effects are now estimated by setting a threshold for the old-age dependency ratio at 22 percent, 24 percent, and 26 percent.

The figure below shows that the output effect of fiscal stimulus during recessions are significantly weakened with higher population aging. For economies with the old-age dependency ratio below 22 percent or 24 percent, the estimated effects stay almost the same as under the benchmark. Once the threshold is increased to 26 percent, however, the output effects would become statistically insignificant a year after the spending shock.[1] It appears that the demand-supporting effects of a fiscal stimulus in a recession do decline as aging progresses.

Output Effects During Recession by Different Threshold for Old-Age Dependency Ratio (Threshold Analysis)

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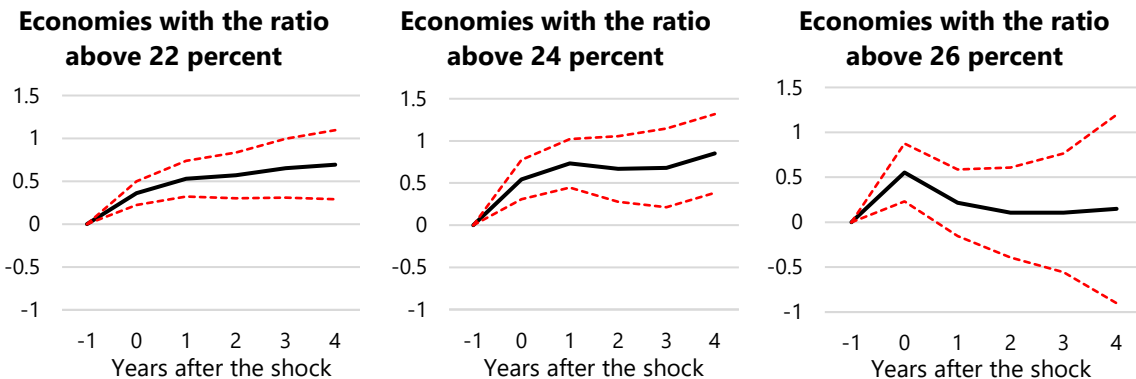
[1]Raising the threshold for old-dependency ratio reduces the sample size accordingly. To secure sufficient sample size, we are unable to raise the threshold beyond 26 percent.

C. Possible Channels of Transmission

23. **This section explores possible channels through which population aging affects the output effects of fiscal spending shocks, focusing on: (i) macroeconomic interlinkages with population aging; and (ii) private consumption and investment.** In order to examine whether some macroeconomic variables modify the output effects of fiscal policy shocks, we extend equation (1) as follows:

$$Y_{i,t+h} - Y_{i,t-1} = I_{i,t}[\beta^h_{R,A}D_{i,t}Shock_{i,t} + \beta^h_{B,A}(1 - D_{i,t})Shock_{i,t}]$$
$$+ (1 - I_{i,t})[\beta^h_{R,N}D_{i,t}Shock_{i,t} + \beta^h_{B,N}(1 - D_{i,t})Shock_{i,t}] + \theta^h X_{i,t} + \alpha^h_i + \gamma^h_t + \varepsilon^h_{i,t} \quad (3)$$

where *D* is a dummy variable that takes value 1 if the variable of interest is above the median value in the sample, and 0 otherwise.

(i) Interlinkages with the Macroeconomic Impact of Population Aging

24. **As identified in the literature (and discussed earlier in this paper), aging population is associated with changes in labor supply and public debt, through which the output effects of fiscal policy may be affected.** Below we analyze these channels in detail.
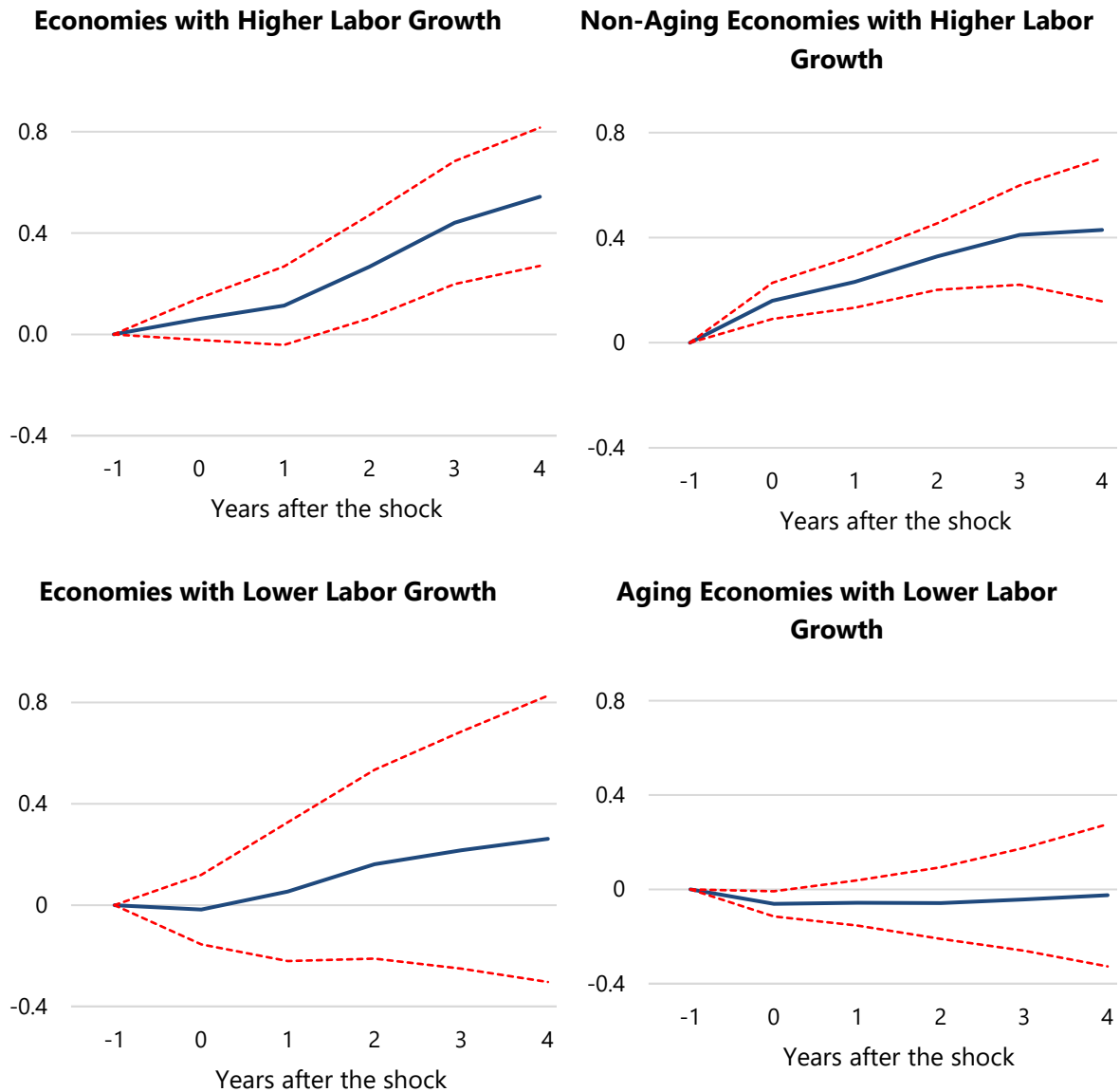
Labor Supply

25. **W we first examine how the changes in labor supply would affect the size of the output effects of fiscal spending shocks.** We first start with the analysis using the estimation equation (1), by splitting the sample by the level of labor force growth (below or above the median growth of 0.8 percent). Then, to distinguish the impacts by changes in labor supply from those by population aging, we use dummy variables based on the annual growth in labor force (which take value 1 if the growth in labor force is above the average value in the sample, and 0 otherwise) with the estimating equation (3).

26. **The results point that the growth of labor force matters for the output effects, possibly contributing to the weaker fiscal multipliers in aging economies (Figure 9).** While fiscal spending shocks have a positive impact on output with higher labor force growth, it does not have any statistically significant impact on output with lower growth of labor force. These results are consistent with the literature. Given that population aging is associated with low growth of labor force (Figure 4), the low output effects with lower growth of labor force may have contributed to the weaker output effects in aging economies. Indeed, 61 percent of observations in aging economies are associated with below-median labor force growth, while 61 percent of observations in non-aging economies come with above-median labor force growth. Focusing on these associations, we find that in non-aging economies with higher labor force growth, the output effects of fiscal policy shocks are positive and statistically significant, while the output effects are generally insignificant in aging economies with lower labor force growth. The differences of estimated output effects between these two economies are

statistically significant at the 1 percent level. The results also suggest that increasing labor supply could mitigate the adverse impact of population aging on the output effects of fiscal policy.

Figure 9. Labor Supply and Population Aging

Economies with Higher Labor Growth

Non-Aging Economies with Higher Labor Growth

Economies with Lower Labor Growth

Aging Economies with Lower Labor Growth

Note: *t*=0 is the year of the shock. Solid lines present the responses to an unanticipated shock to government spending of 1 percentage point of GDP. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the median of 22.7 percent.

Public Debt

27.   **Next, we examine if the level of debt would affect the size of the output effects.** As indicated in Figure 6, population aging is positively associated with high public debt. In our sample, 54 percent of observations in aging economies are associated with above-median public debt ratios, while 53 percent of observations in non-aging economies—with below-median debt (the sample median is 57.2 percent of GDP). This may imply that the results (the weaker output effects of fiscal spending shocks) could be driven by high debt. If the impact of debt on the output effects is so confirmed, it would be then important to analyze whether the results are really driven by high public debt or other factors. First, we analyze the estimation equation (1), by splitting the sample by the level of public debt (below or above the sample median of 57.2 percent of GDP). Then, to distinguish the impacts by changes in public debt from those by population aging, we use dummy variables based on the ratio of public debt to GDP (which take value 1 if the debt is above the average value in the sample, and 0 otherwise) with the estimating equation (3).
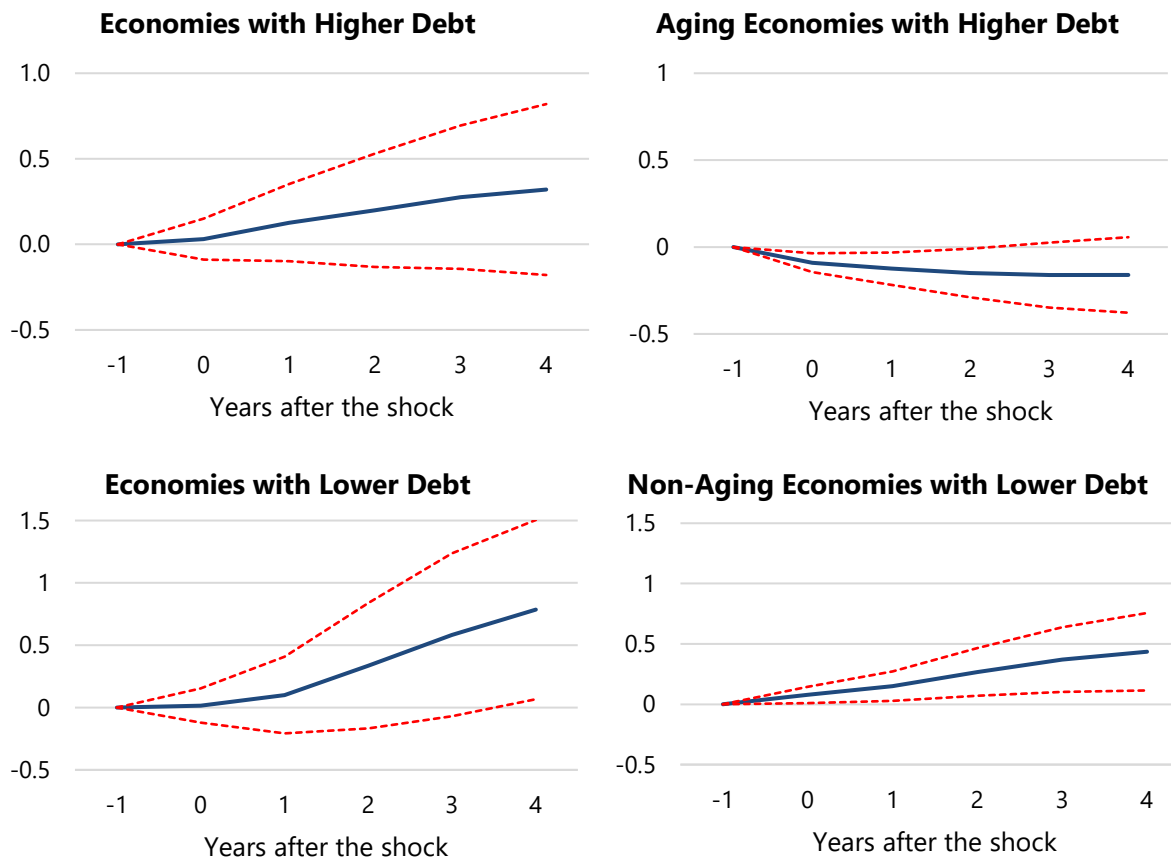
28.   **Our results highlight the impact of the level of debt on the size of the output effects (Figure 10).** In lower-debt countries, the shocks have robust impacts on output (positive and statistically significant). In contrast, in higher-debt countries, the effects are not statistically significant. Such adverse impacts of high debt on fiscal stimulus are consistent with the literature (Ilzetzki et al., 2013; Kirchner et al., 2010).[16] Taking into account the tendency of higher level of debt with population aging, the weaker effects with higher debt may have contributed to the weaker output effects in aging economies. In order to make this distinction more clear, we estimate output effects of government spending shocks in aging economies with higher debt and non-aging economies with lower debt. The results show that while in non-aging economies with lower debt, the output responses are statistically significant, while they are not in aging economies with higher debt.[17] This analysis reveals that, compared with the output effects in aging economies (Figure 10), while high-debt countries generally face weaker fiscal multipliers, high-debt aging economies face even weaker multipliers. [18]

29.   **The results may imply that population aging would amplify the Ricardian effects.** The weakest effects in high-debt aging economies may be affected through the amplification of the Ricardian effects and/or other factors. This suggests that it is important to take into account the role of population aging when analyzing the relationship between public debt and growth.

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[16] The debt level could affect the size of fiscal multipliers. As fiscal stimulus tends to have negative credibility and confidence effects on private demand and the interest rate risk premium, economies with high debt are more likely to have lower fiscal multipliers.

[17] The differences of estimated output effects between these two economies are statistically significant at the 5 percent level at *t=0* and 1 percent level from *t=1*.

[18] The differences of estimated output effects between aging economies and high-debt aging economies are statistically significant at the 5 percent level at *t=0* and 1 percent level from *t=1*.

Figure 10. The Role of Public Debt Level

Economies with Higher Debt

Aging Economies with Higher Debt

Economies with Lower Debt

Non-Aging Economies with Lower Debt

Note: *t*=0 is the year of the shock. Solid lines present the responses to an unanticipated shock to government spending of 1 percentage point of GDP. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the median of 22.7 percent.

(ii) Impact on Private Consumption and Investment

30.   **To better understand the transmission of fiscal stimulus in aging economies, it is important to examine the impact of fiscal spending shocks on private consumption and investment.** Population aging may lower the effect of fiscal stimulus on private consumption, with the prospect for future tax burden and consumers' concerns about future uncertainty. This could be more pronounced for high-debt economies. Population aging may also lower the effect of fiscal stimulus on private investment, with lower prospective investment returns and expectations for a higher future tax burden. We estimate the effects of fiscal spending shocks on private consumption and investment in aging and non-aging economies, based on the empirical model (1).

31.   **The results show that the weaker effects of the government spending shock on private consumption and investment in aging economies (Figure 11)**. There is a sharp contrast between aging and non-aging economies. The effect on private consumption is not statistically significant in aging economies while it is positive and statistically significant in non-

aging economies. A similar trend is observed for private investment (with statistically significant effect in non-aging economies). Such a contrast is apparently a reflection of the impacts, including through: (i) Ricardian-type responses and (ii) lower growth in labor supply, as discussed above.

Figure 11. Government Spending Shocks on Private Consumption and Investment

Note: t=0 is the year of the shock. Solid lines present the responses to an unanticipated shock to government spending of 1 percentage point of GDP. Dashed lines denote 90 percent confidence bands. An economy is regarded as aging if its old age dependency ratio exceeds the median of 23 percent.

D. Robustness Checks

32. **The results are robust in several directions.[19]**

• *Indicator of population aging*: We check whether our results are sensitive to the chosen measure of population aging. Instead of using the old-age dependency ratio, we use: (i) the share of youth aged 20–29 in total population; and (ii) the share of working-age population in total population as measures of population aging. We find that the main results remain broadly unchanged. We also confirm that our main results do not change if the smooth transition function, instead of the dummy variable, is used to distinguish aging economies and non-aging economies

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[19] The results of robustness checks are available upon request.

- *Government spending shocks*: We also check whether our results hold for alternative measures of government spending shocks. Instead of using the forecasts made in October of the same year, we use the forecasts from October of the previous year and April of the same year to compute the forecast errors of government spending. Our results remain broadly unchanged with the alternative shock series. We also add current and lagged output growth innovations as control to address endogeneity concerns and confirm that our main results are robust to this specification change.[20] Furthermore, we examine whether the sign of government spending shock matter. By introducing a dummy variable that takes value one for positive shocks and zero otherwise, we find that there is no statistically significant difference between positive and negative shocks.

- *Different spending shocks*: We further examine different type of government spending shocks by decomposing them into fiscal consumption and investment shocks. The analysis confirms that the results remain broadly consistent with the analysis based on overall spending shocks. It shows that (i) both consumption and investment shocks have positive output effects in both aging and non-aging economies; and (ii) the output effects of consumption shocks are larger in non-aging economies.[21]

- *Business cycle measures*: We used the growth rate and the unemployment rate as the business cycle indicator. Our results remain unchanged with the regressions using the output gap as a business cycle indicator.

- *Control variables*: Although the local projection method is robust to misspecification (Jordà, 2005), we consider different combinations of control variables (lag of growth rate, lag of shocks, the level of public debt, interest rates, and revenue shocks). Our main results remain broadly unchanged with the regression using these control variables.

V. CONCLUSION AND POLICY IMPLICATIONS

33.   **This paper finds that the effect of fiscal stimulus on output is weakened as population aging proceeds.** In economies with a lower share of aged population, a positive government spending shock increases output. In contrast, in economies with a higher share of aged population, a government spending shock does not have a statistically significant impact on output. Moreover, we also find that, during recession, the positive output effects in aging economies are weaker than those in non-aging economics, while during booms, the negative output effect is long-lasting with population aging. We also find that the output effects are particularly weak in highly aging economies and in high-debt aging economies.

34.   **Our analysis also suggests a few possible channels through which population aging weakens the output effects of fiscal policy.** Specifically, those include: (i) Ricardian-type

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[20] Output growth innovations are defined as the difference between actual GDP growth and its forecast. We obtain the forecast from WEO in October of the same year.

[21] It should be noted that, in both economies, investment shocks have larger output effects than consumption shocks. Population aging changes the composition of government spending towards government consumption and transfer, leading to lower fiscal multipliers.

responses and (ii) lower growth in labor supply (likely leading to lower growth prospects). Population aging—through these channels—reduces the impacts of fiscal stimulus on private consumption and investment, resulting in the lower output effects of fiscal spending shocks. We, however, acknowledge that fuller analyses on the channels, possibly based on a model-based analysis, would be warranted to fully identify the channels in a comprehensive manner, which we defer to future studies.

35.   **Important policy implications for aging economies can be drawn from our findings:**

- **During recessions, a larger fiscal stimulus would be required to support aggregate demand.** Given the weaker power of fiscal spending, a larger fiscal stimulus would be required to achieve a given level of demand-supporting effect. The stimulus packages should be designed to allow discretionary and temporary spending increases in areas with larger multipliers (e.g., capital spending).

- **A larger fiscal space may be required to allow wider swings of the fiscal position.** To prepare for a larger fiscal stimulus during recessions, sufficiently large fiscal space should be secured during booms. Given larger needs for social expenditures in aging economies (IMF, 2016a, 2019a; Yashio and Hachisuka, 2014), from a longer-term perspective, countries should prepare for building significant fiscal space before aging progresses too far.

- **Policy measures to promote labor supply could help increase the output effect of fiscal stimulus in aging economies.** Increased labor supply would help bolster the output effects of fiscal stimulus. To ensure demand-supporting effects of fiscal policy, policy measures to enhance labor supply (e.g., through stronger female labor force participation or labor-market-need-based immigration) would help.

- **Other macroeconomic policies and structural reforms need to play a more important role in supporting domestic demand.** Articulating a set of effective policies in aging economies would go well beyond the scope of this paper. It is, however, important to acknowledge that the output effects of both monetary policy (Imam, 2013) and fiscal policy would likely be weakened in aging economies. Thus, to support aggregate demand, other macroeconomic and structural policies may need to play a more important role.[22]

36.   **The results of this paper also have important implications for analyzing the relationship between public debt and growth.** We find that, while higher-debt countries generally face weaker fiscal multipliers, high-debt aging economies face even weaker fiscal multipliers. Fiscal stimulus in these countries—even rightly undertaken during recession—may have a limited impact on output. This also demonstrates the importance of taking into account the role of population aging when analyzing the relationship between public debt and growth.

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[22] For the details of structural reforms, see IMF (2016b). It argues that faster progress on structural reforms would support growth in the near term and bolster potential growth in the medium term. How best to prioritize amongst structural reforms, however, depends critically on each country's macroeconomic conditions.

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