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IMF Working Paper

The Impact of Demographics on Productivity and Inflation in Japan

by Yihan Liu and Niklas Westelius

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IMF Working Paper

Asia and Pacific Department

The Impact of Demographics on Productivity and Inflation in Japan

Prepared by Yihan Liu and Niklas Westelius

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Abstract

Is Japan's aging and, more recently, declining population hampering growth and reflation efforts? Exploiting demographic and economic variation in prefectural data between 1990 and 2007, we find that aging of the working age population has had a significant negative impact on total factor productivity. Moreover, prefectures that aged at a faster pace experienced lower overall inflation, while prefectures with higher population growth experienced higher inflation. The results give strong support to the notion that demographic headwinds can have a non-trivial impact on total factor productivity and deflationary pressures.

JEL Classification Numbers: E31, J11, O4

Keywords: Aging, Population Growth, Inflation, and Productivity

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I. Introduction

Japan is at the frontier of the global demographic transition. The working age population has been declining since the early 1990s and total population peaked in 2010 at 127 million. According to UN projections, the overall population is expected to reach 119 million by 2030, the same level as in 1984. Japan is also aging at an unprecedented speed. The old age dependency ratio has more than doubled since 1990 and is expected to exceed 50 percent by 2030. These demographic headwinds have progressively caught the attention of policymakers, particularly in light of Japan's prolonged state of economic stagnation and low inflation.

To some extent, Japan's stagnant growth performance should not be surprising given that a shrinking working age population reduces the availability of labor. Indeed, relative to its G7 peers Japan is outlier both in terms of economic performance and demographics. However, even when measuring economic growth in output per worker, Japan stands out. As shown in Table 1, the slow growth in labor productivity appears to be rooted in depressed total factor productivity (TFP) growth as opposed to capital accumulation.[1] Interestingly, when plotting TFP growth against aging for the G7 countries a strong negative relationship emerges – with Japan at the extreme end – suggesting that demographics could be a contributing factor (see Figure 1).

Table 1. Macroeconomic and Demographic Outcomes for G7 Economies, 1990–2007

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Average
Macroeconomic outcomes								
Annual Inflation	2.3	2.0	2.3	3.9	**0.4**	2.6	3.3	**2.4**
Annual Real GDP Growth	2.6	1.9	1.7	1.5	**1.3**	2.9	3.0	**2.1**
Contributions from								
Labor	0.9	0.4	0.2	0.3	**0.4**	0.3	0.8	**0.5**
Capital stock	1.1	0.8	0.7	0.7	**0.8**	1.0	1.3	**0.9**
Total factor productivity	0.9	0.7	0.8	0.5	**0.2**	1.7	1.0	**0.8**
Output per Worker (i.e., labor productivity)	1.5	1.2	1.4	1.0	**0.8**	2.5	1.8	**1.4**
Contributions from								
Capital/ labor ratio	0.6	0.5	0.6	0.5	**0.6**	0.8	0.8	**0.6**
Total factor productivity	0.9	0.7	0.8	0.5	**0.2**	1.7	1.0	**0.8**
Demographic outcomes								
Aging (change in old age dependency ratio)	2.8	4.1	8.6	8.3	**15.8**	-0.9	-0.4	**5.5**
Annual Population growth	1.1	0.5	0.2	0.3	0.2	0.3	1.11	0.5

Sources: WDI, OECD, World Economic Outlook, and IMF Staff Calculates.

[1] A number of explanations to Japan's slowdown in TFP growth has been put forth in the literature. A common explanation is that the existence of "zombie' firms following the bursting of the asset bubble in the early 1990s prevented more productive firms from entering markets (See Caballero et al, 2008).

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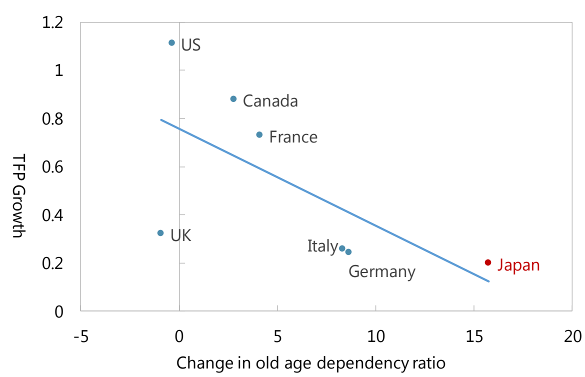
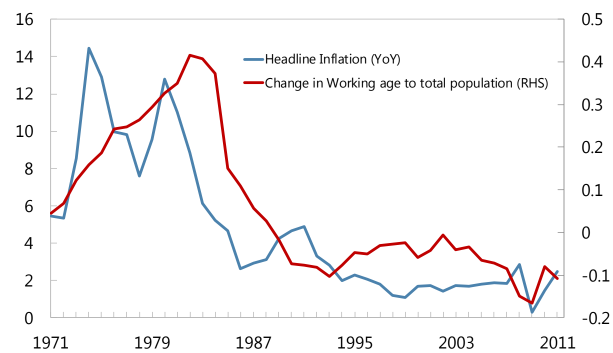
What about demographics and inflation? Figure 2, plots the average annual change in the share of the working age population against the average inflation rate for the G7 countries. Indeed, the decline the share of the working age population appears to coincide with the fall in inflation during the 1980s and the continued low inflation in the 1990s and 2000s.[2] While this transition from high to low and stable inflation is commonly attributed to stronger monetary policy frameworks, recent work argues that structural factors such as demographics may also have played a role.

Figure 1. Aging and TFP growth in G7 Countries, 1990-2007



Sources: WDI, and IMF Staff Calculates.

Figure 2. Aging and Inflation in G7 countries



Source: OECD.
1/ Average in G7 countries, including the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom.

The objective of this paper is to empirically assess the extent to which Japan's aging and now shrinking population have contributed to low TFP growth and inflation. To do so, we exploit inter-regional variation during the period 1990 to 2007 by using prefectural panel data on demographic and economic outcomes. In contrast to cross-country studies, this approach has the advantage that we need not worry about the interaction between national institutional characteristics and demographic trends.

We find that changes in the age distribution of the working age population have significant impact on the level of total factor productivity. Specifically, there is an inverted U-shaped productivity pattern amongst age groups, with those aged 40–49 being the most productive. Moreover, prefectures that are aging at a faster pace tend to have relatively lower overall inflation while those with higher population growth typically have higher relative inflation. Using past and projected national data on demographics, we find that changes in the distribution of the working age population depressed annual total factor productivity growth by approximately 0.7–0.9 percent between 1990 and 2007, primarily reflecting a shrinking share of the 40-year-age group. Deflationary pressures from aging and population growth over the same time period were relatively mild. However, extending the result to 2035 suggests that deflationary pressures from the shrinking population—as opposed to aging—

[2] The share of the working age population was increasing before 1990 but at a declining pace.

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will become more prominent in the future. In sum, our empirical results give strong support to the notion that Japan's demographic headwinds have and will play an important role with respect to total factor productivity and deflationary pressures.

The remainder of the paper is structured as follows. Section II discusses the theoretical and empirical links between demographics and macroeconomic outcomes. Section III and IV describes the empirical methodology and data sources, and section V presents the results. Section VI concludes.

II. Linking Demographics with TFP Growth and Inflation

A. Demographics and Total Factor Productivity

Several potential links between aging and productivity have been highlighted in the literature. First, older workers may enjoy higher productivity due to the accumulation of work experience while younger workers benefit from better health, higher processing speed and ability to adjust to rapid technological changes, and greater entrepreneurship leading to more innovation. These two counterforces may produce an inverted U-shaped pattern between age and productivity.[3] Second, aging is likely to increase the relative demand for services (e.g., health care service), causing a sectorial shift towards the more labor intensive and less productive service sector. Third, the size or density of the population may also impact productivity as it spurs technological change, create positive agglomeration and network effects, and stimulate learning by doing and innovative activity.

Surprisingly, there are relatively few empirical macroeconomic studies attempting to quantify the relationship between demographics and aggregate productivity. A frequent reference is Feyrer (2007) who examines the link between the age distribution of the workforce and productivity using a cross-country panel on OECD and low income countries. Consistent with some microeconomic studies, he finds an inverted U-shaped relationship between the age distribution and total factor productivity, with the age-group 40–49 being the most productive. Aiyar et al (2016) uses a similar methodology but looks at the effect of workforce aging on the *growth rate* of productivity. Using data on European countries, they find that an increase in the share of workers aged 55–64 leads to a significant and permanent increase in TFP growth. Mestas et al (2016) use a panel on U.S. states to estimate the realized impact of the old age dependency ratio on GDP per capita. They find that two-thirds of the impact is due to slower productivity across the entire age distribution and one-third is due to slower labor force growth. Empirical studies on the link between population size/density and productivity stems primarily from growth theory. For instance, trying to estimate agglomeration effects in selected European countries, Ciccone and Hall (1996) and

[3] Looking at Nobel prize winners and great inventors, Jones (2010) not only finds an inverted U shaped relationship between age and innovation, but also that the peak age of innovation has been increasing over time.

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Ciccone (2002) find a strong positive relationship between productivity and employment density.

B. Demographics and Inflation

There is little consensus about the link between demographics and inflation. While higher population growth increases demand for goods and services, it also boosts overall supply due to greater availability of labor. Of course, inflationary pressures may arise depending on how fast supply can respond to the increased demand (e.g., land, housing, and natural resources etc).[4] Masaaki Shirakawa, a former governor of the Bank of Japan, suggests that there may also exist an expectations channel. Specifically, he postulates that as agents gradually realize that demographic headwinds will lower future growth, and thus their expected permanent income, they cut back on current consumption and investment which leads to deflationary pressures.[5] Aging in itself may also impact inflation. For instance, Juselius and Takátsin (2015) argue that while aging constrains production through its impact on the availability of labor, dissaving by retirees keeps demand relatively stable, thus leading to excess demand and inflationary pressure. However, Andersson, Botman and Hunt (2014) show – using a theoretical framework – that in the case of Japan this effect is likely to be more than offset by a currency appreciation due to the repatriation of foreign savings by retirees.

An important counter argument to all these channels is that central banks should be able to offset any demographic-induced disturbances to the inflation path. However, there are at least two potential reasons for why this may not hold in the case of Japan. First, with monetary policy in a liquidity trap, it is harder to offset deflationary pressures by stimulating the economy. Second, older age groups—who prefers lower inflation in order to increase the real return on their savings—are likely to gain increased political influence as their population share grows, and thereby indirectly effect monetary policy outcomes (Bullard et al, 2012).

Empirical studies on the link between inflation and demographics are scarce, most likely reflecting the conventional wisdom that inflation is primarily a monetary phenomenon, at least over the long-term. However, in light of persistently low inflation in advanced countries following the global financial crisis, there appears to be a growing interest in exploring the impact of aging and population growth on inflation. The results from this limited empirical literature are mixed. On the one hand, based on a OECD cross-country analysis, Yoon et al (2014) find that a declining and aging population has a significant deflationary impact. In contrast, Juselius and Takats (2015) find based on a panel of 22 advanced countries that a larger share of dependents is associated with higher inflation, while a larger share of working age cohorts is associated with lower inflation. Interestingly, a key driving force behind these

[4] It is also possible that a larger population leads to greater economies of scale and more competition, putting downward pressure on prices.

[5] See opening remarks by Mr. Masaaki Shirakawa at the 2012 BOJ-IMES Conference, hosted by the Institute for Monetary and Economic Studies, at the Bank of Japan, Tokyo, 30 May 2012.

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diverging results seem to be whether an older population is associated with a higher price level or with a higher inflation level.

C. Secular Stagnation Debate

The secular stagnation hypothesis, first put forth by Hansen (1938) and recently revived by Summers (2013), provides another channel through which adverse demographics can lead to *both* low inflation and low growth. The gist of the argument is that structural excess savings due to lack of investment and high saving rates lead to such a low real neutral interest rate that monetary policy can no longer stimulate the economy, causing the economy to operate below potential and thus keeping inflation below the central bank's inflation target. To the extent that demographic factors reduce the propensity to invest and increase the propensity to save, they may play an important role in the secular stagnation theory. For instance, aging combined with stagnant or negative population growth may reduce the willingness of corporates to invest in a shrinking and less productive economy. Moreover, while savings should decrease with age, increased longevity, higher uncertainty with respect to public debt dynamics and future social security payments, and greater bequest incentives due to lack of future opportunities for younger generations may increase savings.[6]

III. Methodology

To assess the impact of aging and population density on total factor productivity we use a similar methodology to Feyrer (2007). Specifically, the following model is considered:

$$log\ TFP_{r,t} = \alpha_1 W20_{r,t} + \alpha_2 W30_{r,t} + \alpha_3 W50_{r,t} + \alpha_4 W60_{r,t} + \beta_1 OADR_{r,t} +$$

$$\beta_2\ log\ DWA_{r,t} + \beta_3\ SER_{r,t} + \delta_r + \theta_t + u_{r,t} \qquad (1)$$

The level of total labor force productivity for prefecture r at time t is denoted as $TFP_{r,t}$. The variables $W20$, $W30$, $W50$, and $W60$ represent the share of 10-year age groups of the working age population—defined as the population between the ages 20 and 69—in prefecture r at time t.[7] The age group $W40$ is the reference age group and therefore excluded from the regression. The coefficients α_i measures the effect on total factor productivity relative to the age group $W40$. The old age dependency ratio, $OADR$, is defined as the population aged 70 or above as a share of the working age population, and DWA measures the density of the working age population (i.e., number of people per unit of area). The model also includes time invariant fixed effects, δ_r, a time trend common to all prefectures, θ_t, and

[6] Gagnon et al (2016) argues that changes in U.S. population growth, family composition, life expectancy, and labor market activity accounted for a 1.25 percentage point decline in the equilibrium real interest rate since 1980 in the U.S.

[7] It is common to specify the working age population as ages 15 to 64. However, as a large share of 15–19 year olds are attending school and men and women tend to exit the labor force at 70 and 67, respectively, we choose to define the working age population as those aged between 20 and 69.

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the size of the service sector in each prefecture, $SER_{r,t}$, expressed as a share of nominal prefectural GDP. The latter is important given that total factor productivity tends to be lower in the service sector than in the manufacturing sector.[8]

There are several potential issues when estimating equation (1). First, as highlighted by Feyrer (2007), it is quite reasonable to assume that the error terms are serially correlated (especially since annual data is used) or that total factor productivity may follow a unit root process. To address this, we estimate equation (1) in first differences as well as by including a lagged dependent variable.[9] Standard errors are made robust to heteroskedasticity and clustered for each prefecture. Second, in contrast to other studies, our specification uses the age distribution of the working age population instead of the workforce. While this prevents us from capturing changes in the age distribution of the workforce due to changes in labor force participation rates, it has the added advantage of ensuring that the estimation is not exposed to the potential endogeneity problem arising from the fact that labor force participation rates for various age cohorts may react differently to productivity shocks.[10]

When investigating the relationship between inflation and demographic trends, we are primarily interested in population growth and the old age dependency ratio. Accordingly, the following model is estimated:

$$\pi_{r,t} = \alpha_1\, \Delta OADR_{r,t} + \alpha\,_2 \Delta logPop_{r,t} + \beta\; OPG_{r,t} + \gamma \pi_{r,t-1} + \delta_r + \theta_t + u_{r,t} \qquad (2)$$

Annual inflation for prefecture r at time t is denoted as $\pi_{r,t}$. As before, $OADR$, is the old age dependency ratio in prefecture r at time t, while Pop is the prefectural population, and OPG, is the prefectural output gap intended to capture regional excess demand dynamics.[11] The

[8] As mentioned earlier, aging may be a driver of this trend. Indeed, regressing the change in the size of the service sector on the change in the old age dependency ratio and population density (with year fixed effects) indicate a significant positive relationship, explaining about 21 percent of the variation across prefectures and 32 percent within prefectures.

[9] Including a lagged dependent variable together with fixed effects makes the standard estimators inconsistent. To address this issue we apply the Arellano-Bond GMM estimator which uses lagged values of predetermined and potentially endogenous variables as instruments.

[10] Our model may still be subject to an endogeneity problem and upward bias of the coefficients if inter-prefectural migration flows are driven by prefectural productivity differentials (e.g., reflected in interregional wage differentials) *and* are large enough to shift the working age population towards younger age groups. However, between 1990 and 2007, net migration as a percent of prefectural population between 1990 to 2007 averaged between 0.1 and 0.4 percent across prefectures. Moreover, only about 18–19 percent of migrants between 1996–2006 said they moved for work related reasons. Also note that the lagged dependent model is estimated using the Arellano-Bond GMM estimator, which uses lagged levels of dependent variables as instruments, potentially mitigating endogeneity problems arising from migration.

[11] The output gap is derived using HP-filtered real prefectural output.

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lagged inflation rate, $\pi_{r,t-1}$, is included to capture the high degree of inflation persistence.[12] As in equation (1), δ_r is the time-invariant fixed effect and, θ_t, represents a common time trend across prefectures.[13] To examine how aging and population growth affects relative prices, equation (2) is also estimated for each of the sub components of the CPI basket.

IV. Data

Both models are estimated over the sample period 1990 to 2007 to capture the period between the bursting of the domestic asset price bubble at the end of the 1980s and early 1990s and the Global Financial Crisis in 2008. Yearly data on prefectural real growth, capital stock, and labor input (measured in hours worked) is taken from the Regional-Level Japan Industrial Productivity (R-JIP). The prefectural total factor productivity is derived through simple growth accounting following the same methodology as Kyoji, Tatsuji and Joji (2015). Data on prefectural inflation and its components and annual prefectural age distributions are taken from the Portal Site of Official Statistics of Japan. While the population data is available in 5-year age groups, 10-year age groups are used to more clearly separate age brackets and their potential impact on productivity.

There is significant inter-prefectural variation in terms of demographic. For instance, Akita in northern Japan experienced a drop in the working age population by over 13 percent and an increase in the old age dependency ratio by 20 percentage points between 1990 and 2007. In contrast, the Saitama prefecture saw its working age population rise by 16 percent and the old age dependency ratio only increased by 9 percentage points. The TFP and consumer price trends also vary substantially across prefectures. In Kagoshima, TFP grew by 23 percent between 1990 and 2007 while it contracted by 11 percent in Nara, and Aomori prefecture experienced a rise in the CPI level of 14 percent over the sample period while the Saga prefecture only saw consumer prices rise by 4 percent. Figure 3, shows the data variation across prefectures and over time for TFP growth, inflation, old-age dependency ratio, population growth, and the aging of the working age population. The shaded areas reflect the minimum and maximum values and show significant variation across prefectures over time for all variables. There is no significant skewness in the data with the median and average measures closely following each other. The median prefectural inflation rate shows a general downward trend with temporary episodes of deflation. The spike in inflation in 1997 reflects the consumption tax hike. As is well documented, TFP growth came down significantly in the early 1990s, registering negative growth, but then returned to positive growth in the 2000s. Meanwhile the old age dependency ratio steadily increased across prefectures while population growth slowed. Indeed, a number of prefectures experienced negative population growth for extended periods of time. Finally, the shift in the age distribution is reflected by

[12] Equation (2) can also be interpreted as a regional Phillips curve with purely backward looking inflation expectations and where the intercept is dependent both on national level time fixed effects as well as prefectural demographic variations.

[13] Like the lagged dependent variable specification of eq. (1), eq. (2) is estimated using the Arellano-Bond GMM estimator. The standard errors are made robust to heteroskedasticity and clustered for each prefecture.

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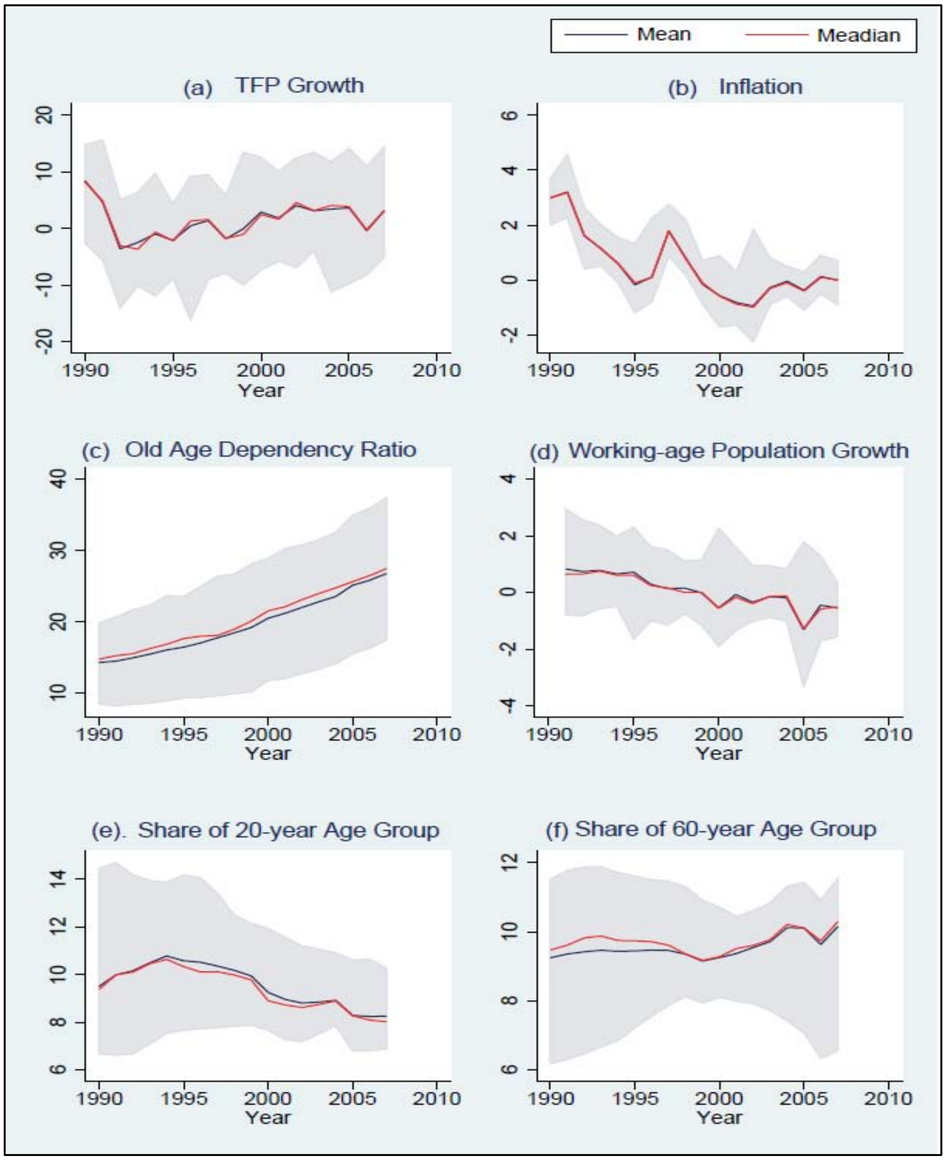
the fall in the 20-year age group starting in 1995 and the rise in the 60-year age group in the 2000s.

Figure 3. Prefectural Variation and Trends in Demographic and Economic Variables



V. Results

Table 2 displays the estimated coefficients from the total factor productivity regressions. Overall, the results show that the age distribution of the working age population did have a significant impact on total factor productivity. The first difference model suggests a clear inverted U-shaped productivity pattern amongst age groups, with the excluded age group 40–49 being the most productive. The point estimates indicate that a one percentage point shift from the 30-year age group to the 40-year age group *increases* the level of total factor productivity by close to 4.4 percent, while a similar shift from the 40 to the 50-year age

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group *decreases* productivity by 1.3 percent. The lagged dependent variable model does not give as strong results, but still shows a negative statistical significance for the 20-year and 60-year groups relative to the 40-year age group. As Table 2 shows, some of the estimates are roughly similar to what Feyrer (2007) obtained in his cross-country study of 87 OECD and low income countries, particularly with respect to the 60-year age group. The estimated economic impact from the old age dependency ratio is negative and relatively large but statistically insignificant. There is no evidence that population density matters for TFP. Finally, in line with our prior, a consistent result across specifications is that prefectures with a larger service sector have on average lower overall total factor productivity.

Table 2. Impact of Aging and Population Density on Total Factor Productivity

Independent variabbles	First difference	Lagged dependent variable[1]	Feyrer (2008)
Age group			
20-29	-1.174***	-2.225***	-3.169**
	(0.320)	(0.544)	(1.297)
30-39	-4.382***	-1.039	-3.828***
	(0.988)	(0.833)	(1.206)
50-59	-1.256	-0.475	-2.120**
	(0.884)	(0.563)	(1.051)
60-69	-2.221**	-1.593*	-2.066*
	(0.989)	(0.885)	(1.211)
Old-age dep. ratio	-0.788	-0.220	0.478
	(0.600)	(0.675)	(1.001)
Pop. density	-0.0554	0.141	...
	(0.331)	(0.263)	
Size of service sector	-2.245***	-1.595***	...
	(0.239)	(0.249)	
Lagged TFP	...	0.758***	...
		(0.0336)	
Time fixed effects	Yes	Yes	Yes
No. observation	799	799	499
No. prefectures	47	47	87

[1] The Arellano-Bond estimator is used using one lag of dependent variables as covariates.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 displays the results from the inflation regressions. In general, aging and population growth appear to have a significant impact on overall inflation. A one percent increase in the old age dependency ratio reduces the inflation rate by 0.1 percentage points, while a one percent increase in population growth increases inflation by 0.3 percentage points. As the

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time fixed effects will eliminate any trends in national inflation, any uniform impact of BoJ's monetary policy on prefectures is taken into account. Looking at the subcomponents of the CPI basket, one would expect that prefectures that are aging faster would be associated with higher inflation of services. However, our results do not seem to provide consistent evidence in this regard. For instance, while an increase in the old age dependency ratio is negatively related to the cost of food and beverages, it is also negatively related to the cost of medical care.[14] Similar ambiguity appears to be true for population growth. For example, as expected, population growth is positively related to the cost of housing and food and beverages, but population growth is also negatively related to energy costs, clothes and footwear, and transportation and communication.

To provide a more dynamic depiction of the impact of demographics on TFP growth and inflation we use UN data on realized and forecasted 5-year changes in the distribution of the working populations from 1990 to 2035, and apply the estimated coefficients from our first difference (FD) and lagged dependent variable (LDV) models to calculate the corresponding impact on annual TFP growth and inflation. The results are depicted in Figures 4 and 5, respectively. The projected impact on productivity and inflation beyond 2005 is subject to the usual caveat that our coefficients may be specific to our sample period.

Figure 4 shows that shifts in the age distribution contributed negatively to TFP growth in the 1990s and 2000s, potentially explaining part of the low TFP growth observed in Japan during this time period. In fact, back-of-the-envelope-calculations suggest that the shift in the age distribution reduced Japan's annual TFP growth by around 0.7–0.9 percent between 1990 and 2005. Interestingly, the magnitude is similar to the productivity gap between Japan and U.S in Table 1. As shown in Figure 4, the large negative impact was mainly due to the decline in the 40-year age group—the most productive—between 1990 and 2005. The subsequent increase in the 40-year age group after 2010, however, should have a positive but declining effect on TFP growth. After 2025, shifts in the age distribution will again have a negative impact on TFP growth.

The demographic impact on inflation dynamics is more straightforward. As Figure 5 shows, deflationary pressure from aging was more than offset by population growth in the first half of the 1990s. However, the combination of slowing population growth and the increased speed of aging eventually started to exert overall deflationary pressure in the 2000s. Going forward, based on UN projections, the shrinking of the population will overtake aging as the most prominent deflationary demographic source.

[14] One possible reason for this puzzling result is that medical care prices in Japan are largely regulated by the government.

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Table 3. Effect of Aging and Population Growth on Inflation

Dependent variable	Overall inflation	Food and beverages	Housing	Fuel, light and water charges	Furniture and household utensils	Clothes and footwear	Medical care	Transportation and communication	Education	Reading and recreation
Δ Old-age dep. ratio	-0.110***	-0.385***	0.0179	-0.144	0.306*	0.0229	-0.192**	0.0829*	0.105	0.255***
	(0.0401)	(0.0845)	(0.114)	(0.139)	(0.165)	(0.168)	(0.0902)	(0.0455)	(0.0853)	(0.0786)
Pop. Growth	0.304**	0.517**	0.897***	-1.693**	-0.0214	-0.892*	0.685**	-0.367*	0.192	-0.0773
	(0.143)	(0.216)	(0.275)	(0.685)	(0.534)	(0.469)	(0.309)	(0.199)	(0.387)	(0.379)
Regional output gap	0.0506***	0.0652***	-0.0189	0.168***	0.116***	0.181***	-0.0525***	0.0489***	-0.00533	0.0272**
	(0.00793)	(0.0160)	(0.0224)	(0.0277)	(0.0299)	(0.0368)	(0.0120)	(0.00771)	(0.0165)	(0.0119)
Lagged inflation rate	0.233***	-0.000274	0.343***	0.0941***	0.141***	0.229***	-0.271***	0.149***	0.325***	0.163***
	(0.0353)	(0.0419)	(0.0379)	(0.0283)	(0.0502)	(0.0403)	(0.0265)	(0.0363)	(0.0341)	(0.0263)
Observations	752	752	752	752	752	752	752	752	752	752
No. prefectures	47	47	47	47	47	47	47	47	47	47

The Arellano-Bond estimator is used using one lag of dependent variables as covariates.
Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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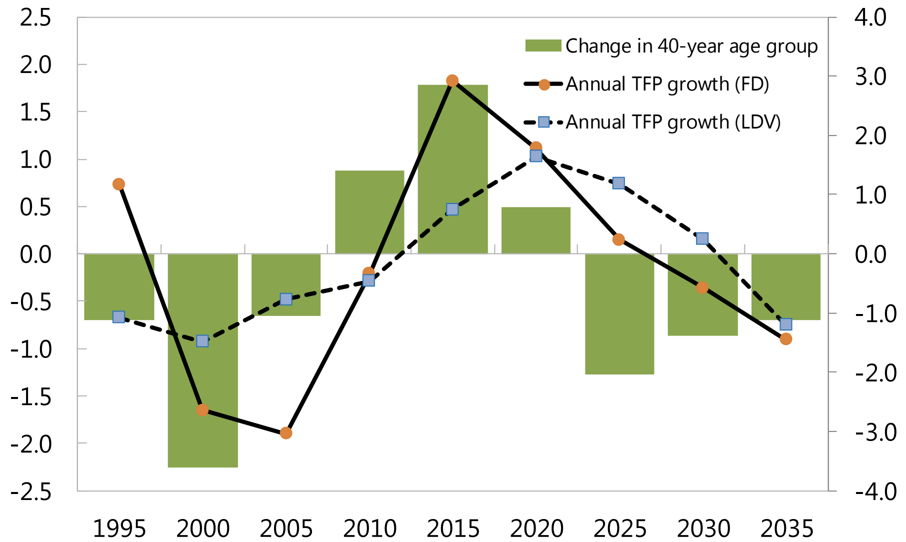
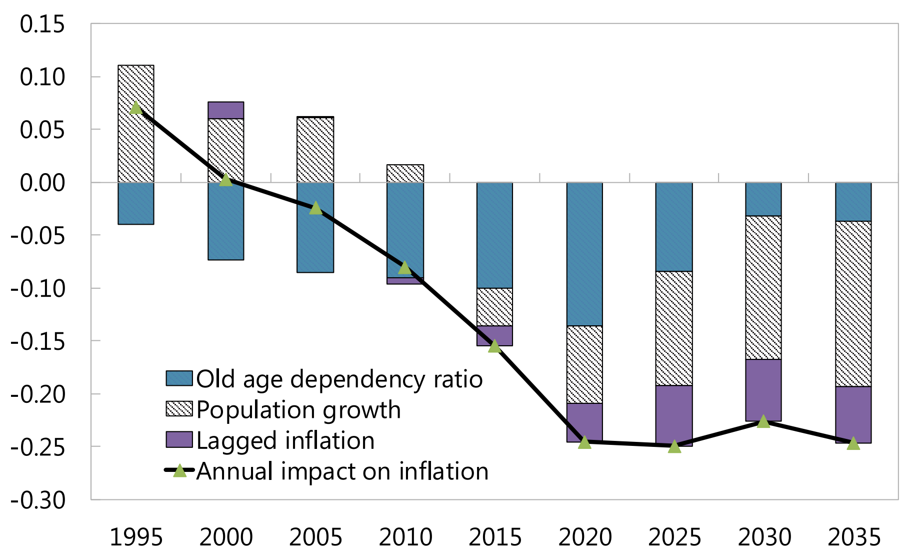
Figure 4. Contributions from Changes in Age Distribution of Working Age Population to TFP Growth, 1995-2035



Sources: UN population statistics and authors' calculations

Figure 5. Deflationary Pressures from Aging and Population Growth, 1995-2035.



Sources: UN population statitistics and authors' calculations

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VI. CONCLUSION

A number of advanced countries are or will be facing declining and aging populations. These trends present a potentially daunting economic challenge in terms of their impact on growth, resource scarcity, and fiscal stability. However, empirical research trying to estimate realized macroeconomic effects from demographic changes has been relatively scarce. Japan constitutes in many ways the perfect candidate for such empirical analysis because of its prolonged experience with demographic and economic headwinds.

To this end, this paper sheds some light on whether the age composition of Japan's working age population can help explain the low TFP growth between 1990 and 2007 and whether the sharp increase in the speed of aging and slow population growth have contributed to deflationary pressures. In both cases, our empirical results give an affirmative answer. While it is true that monetary policy should in principle be able to offset such effects on national inflation, the fact that short-term nominal interest rates were close to or at their lower effective bound during this period severely constrained the Bank of Japan's ability to stimulate the economy. Moreover, to the extent aging and a slower population growth lowered the real neutral interest rate, these demographic forces have further hampered the ability of monetary policy to reflate the economy.

The results suggest that policies designed to push the Japanese economy out of its the current muddle-through status quo must address underlying demographic headwinds. Hence, it is reassuring that the structural reform agenda under Prime Minister Abe's administration gives demographics a high priority. To enhance these efforts further, more research is needed to identify and better understand the mechanism through which demographic factors affect productivity and inflation.

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