THE EFFECT OF DEMOGRAPHIC CHANGE ON PRODUCTIVITY, WAGES AND INFLATION

Research analysing the impact of demographic change on the macro economy focuses predominantly on real variables. There are considerably fewer papers discussing the impact on productivity and nominal variables. While most papers conclude that aging lowers productivity growth, the findings on the impact on nominal variables are contradictory. I provide a summary of the literature and highlight the key assumptions from which papers derive opposing results. These include the response of consumption and savings over the life-cycle, the response of aggregate supply, the adequacy of the social safety net and any changes in life expectancy or retirement ages resulting from expected demographic change. To make a better assessment of the likely effect on the Australian economy, I propose a number of avenues for future work.

Motivation

Structural change is one of EA's analytical priorities. One element of structural change that is occurring globally is changing demographics, specifically an aging population and a rise in the dependency ratio. The influences of demographic change are multi-fold, both on a micro and macro level. On a micro level, aging influences individuals' behaviour, such as labour supply, consumption and investment decisions, which tend to vary over the life cycle. On a macro level, changing demographic trends can directly affect aggregate macroeconomic variables by changing the structure of the economy.

This note reviews the literature that discusses the effects of demographic change on productivity, wages growth and inflation. While some papers extend their analysis to the role of monetary policy in responding to the impact of demographic change, a summary of these findings is outside the scope of this note. I conclude with a number of suggestions for future work by Economic Group to explore the effect of demographic change on the Australian economy.

Productivity

Characteristics of workers

One way to analyse the impact from demographic change and its implication for labour productivity is to examine the characteristics of workers by age cohort. The literature finds that there are mixed forces at play. Younger workers' productivity benefits from generally better health, and a higher ability to adapt to innovations and technological change. In addition, younger workers also tend to be more risk-taking and entrepreneurial given they have more time to recover any lost income from an unsuccessful project. Conversely, older workers have more experience which increases their productivity relatively to that of younger workers.

Empirical studies appear to confirm these mixed effects. Using panel regressions for 87 countries, Feyrer (2007) finds that productivity, measured by output per capita, increases with age and peaks for workers aged 40-49, before declining at older age cohorts. He finds that a 5 per cent increase in the size of 40-49 age cohort raises the level of aggregate productivity by 1 to 2 per cent each year over the next decade. The paper also suggests that this result is independent from any response in participation or hours worked due to changes in productivity.

Liu and Westelius (2016) apply Feyrer's approach to Japanese data, using a panel of Japanese prefectures, to allow for variations in regional demographic characteristics. Their results are consistent with Feyrer's findings; productivity increases with age up to cohort 40-49, before declining. The magnitude of the results are also similar to those in Feyrer's paper.

Compositional and indirect effects

Another strand of the literature combines the characteristics of age cohorts with population projections. From this, the effects of demographic change on economy aggregates are estimated.

A paper by Maestas, Mullen and Powell (2016) looks at the effects of aging on GDP growth per capita, labour force participation and labour productivity growth across the 50 US states. Using an empirical production function approach, the paper finds that a 10 per cent increase in the share of the population older than 60 reduces real GDP growth per capita by 5.5 per cent. In contrast, increases in other age

cohorts have no statistically significant effect on GDP growth. A decomposition suggests that two-thirds of the decline in GDP growth is due to lower growth in aggregate labour productivity and one-third due to lower labour force growth. The paper further decomposes the decline in labour productivity and finds that a lower marginal product of labour is the primary source for the decline.[1] In contrast, average hours worked shows no statistically significant response to changing demographics.

As the composition of a population changes, spill-over effects can also arise. A rising share of one age cohort can have an effect on other cohorts or aggregate variables. Maestas' paper explores spill-over effects on aggregate labour productivity.[2] The authors find that a higher share of older workers reduces productivity across all age cohorts. The paper points to two interaction effects at play. A decline in productivity of the older age cohort suggests that the older workers that retire tend to be more productive than those who continue to work. In addition, the negative spill-overs to younger cohorts suggest that younger and older workers are complements in the production process, with the experience of older workers benefitting the output of younger workers.

Changes in aggregate productivity growth can also affect other economic aggregates. Fischer (2016) suggests that lower long-run productivity growth affects the balance of savings and investment. A decline in productivity growth reduces the future income of households. If this is anticipated, households compensate lower expected income growth with reducing their consumption and increasing savings. In an aging population, the share of workers with a higher-than-average savings rate increases and leads to a rise in aggregate savings. This has implication for real interest rates and inflation (see below).

Effects on industry composition

Demographic change can also influence the composition of aggregate demand and, by extension, aggregate productivity in an economy. In an aging population demand typically shifts to the services sector, which tends to be more labour intensive than the goods sector and has a lower rate of labour productivity. The Productivity Commission (2013) (PC) expects that aging population will lower aggregate productivity growth over the next 50 years. This is despite the PC projecting labour productivity growth at the industry level to return towards their historical average. This implies that the compositional shift towards industries with comparatively low productivity more than offsets the projected rise in by-industry labour productivity.

Maestas et al explore which industries are most affected by demographics change. They find that the construction, wholesale, retail trade and services industries experienced statistically significant declines in productivity as the share of older people increased. This finding is consistent with Liu and Westelius (2016) who, in their case study for Japan, find that productivity is more sensitive to demographic change in regions with a large services sector.

However, there are challenges in measuring the impact of demographic change on economy aggregates. First, sectors that are most affected by aging, such as caring services, are excluded from Australia's GDP. Second, measuring productivity in non-market based industries, such as health, is particularly challenging. Growing importance of these sectors as the population ages could lead to a larger degree of mismeasurement of real GDP growth.

Wages

Research approaches the effect of demographic change on nominal variables either empirically or by drawing on economic theory of the relationship between the capital-to-labour ratio and workers' marginal product of labour. The literature generally agrees that the occurring demographic change leads to an increase in the capital-to-labour ratio. This is a result of labour becoming relatively scarcer and capital becoming more abundant; aging reduces aggregate labour supply and increases the wealth-to-income ratio. However, there is disagreement about the direction of the effect on wages growth.

Goodhart and Pradhan (2017) take a conceptual approach to analysing the effects of demographic change, through the lens of global labour supply and the relative prices of labour and capital. The paper draws on the impact of China's integration into the world economy and infers lessons for the future. The paper argues that the positive shock for global savings (relative to investment) and labour supply (relative to

1 The marginal product of labour is proxied by output per earnings and earnings per hour.
2 An individual's productivity is proxied for by wage growth, which is a strong assumption.

capital) from China's integration has contributed to a decline in real interest rates, the marginal product of labour, wages and inflation.

The authors argue that current demographic change will reverse these effects, with wages growth, inflation and real interest rates all projected to rise. The authors acknowledge that their claim of a rise in real interest rates is controversial. They posit that aggregate savings will fall by more than aggregate investment. The argument hinges on the assumption that a social safety net remains in place and is able to fund a larger share of retirees and a higher life expectancy. As a result, there is no need to increase precautionary savings before retirement and the savings rate can remain constant or decline.[3]

A decline in global labour supply will increase workers' bargaining position and raise the capital-to-labour ratio as firms substitute scarce labour with relatively cheaper capital. This leads to a higher marginal product of labour, which is expected to increase wages growth.

Empirical analysis by the Rich, Tracy and Fu (2016) comes to the opposite conclusion, with aggregate real wage growth slowing as the population ages. Using hourly wage rate data, the authors find that real wage growth is the highest for young age cohorts. It declines with age, before turning negative for cohorts aged 40 and older.[4] The compositional effects of a larger share of older workers implies a decline in real wage growth for an increasing share of the workforce as the population ages. Maestas, Mullen and Powell (2016) come to similar conclusions from their analysis on labour productivity. Lower aggregate labour productivity is projected to lower average wages growth across the age distribution as the population ages.

Inflation

Research on the effect of demographic change on inflation is considerably more limited than the literature discussing the effect on GDP growth and real interest rates. The impact of demographic change on inflation operates through various channels and, similar to wages growth, the literature comes to contradictory conclusions about its direction. Given the multitude of dependencies, most papers approach the impact on inflation empirically.

A number of papers investigate the impact on inflation from the life-cycle hypothesis and its implications for real interest rates. Vlieghe (2016) discusses the offsetting effects of longer life expectancy and slowing growth in the working-age population. All else equal, the former results in a rise in aggregate savings to spread consumption over a longer expected life. In addition, a decline in the working age population reduces firms' incentives to invest in the capital stock. The increase in aggregate savings and a decline in investment both lower real interest rates and imply lower inflation.

Working in the opposite direction is a compositional effect of a larger share of retirees, who typically draw on their savings, and a smaller working-age share that accumulates savings. The compositional effect of lower aggregate savings, combined with a reduction in aggregate supply from a smaller work force, increases real interest rates and inflation. There is no consensus in the literature which effect dominates.

Higher inflation resulting from lower labour supply and a rise in aggregate demand

Literature that concludes that demographic change is inflationary derives these results from a reduction in labour supply from a smaller working-age population or increased aggregate demand from a larger population share of retirees with higher consumption. The underlying assumption for many of these papers is no change in retirement age, which is predicated on the adequacy of the social safety for a larger population share of retirees. This allows consumption to remain constant or increase with age.

Juselius and Takats (2015) use a panel of 22 advanced economies to estimate the effect of a rising dependency ratio on inflation. Contrary to their expectations, the authors find that aging increases inflation. They find a positive relationship between inflation and the dependency ratio, with cohorts under 30 and older than 64 associated with higher inflation. Conversely, working-age cohorts are found to lower inflation. The authors explain their empirical findings with dependents' (young and old) higher propensity to consume out of income and a lower contribution to aggregate supply than that of working-age cohorts. The demographic change observed over the most recent decades globally appears to have offsetting

3 With most retirees preferring to continue living in their long-term houses, rather than downsize, demand for housing investment will be supported by younger age cohorts.

4 The analysis abstracts from business cycle effects.

effects, with the increasing share of older people not large enough to offset the disinflationary pressures from a declining share of young people. However, the authors expect that the projected rising share of older people to increase inflation. Using projections from the United Nations, the model suggests that demographic change could increase inflation in Australia by 2.4 percentage points in total until 2050.[5] Caveats to the paper's approach is the assumption of fixed age cohort effects over time, implying no change in retirement ages, time spent in education, or women having children at a later age.

Goodhart and Pradhan (2017) and Aksoy, Basso, Grasl and Smith (2016) also find that demographic change increases inflation. A decline in productive capacity as the working-age population declines is unable to offset increasing demand from the rising share of individuals outside the labour force who only consume and don't produce. While Aksoy et al comes to similar conclusions about investment and savings, their findings differ with respect to the response of real interest rates in a general equilibrium. Aksoy et al assume that the propensity to consume declines in an aging society, as longer life expectancy requires workers to accumulate higher savings during their working life. This highlights the sensitivity of the results to the existence and adequacy of the social safety net.

Lower inflation through a reduction in aggregate demand

The literature that concludes that demographic change lowers inflation argues that aging reduces the propensity to consume and invest. Households and businesses expect their income to grow more slowly which they seek to offset by increasing their aggregate savings. An obvious candidate to test this hypothesis is Japan whose population has aged rapidly since the early 1990s. Indeed, Liu and Westelius (2016) find that the resulting decline in aggregate demand has lowered inflation in Japan, in particular since 2000 when aging coincided with slowing population growth.

Both Vlieghe (2016) and Carney (2017) come to the conclusion that demographic changes lower real interest rates. They argue that the rise in the stock of precautionary savings for a longer expected life more than offsets the reduction in the flow of savings from a larger share of the population in retirement. The resulting decline in real interest rates reduces the extent to which monetary policy can be accommodative and lowers inflation.

An empirical paper by Yoon, Kim and Lee (2014) finds that aging and a decline in population growth both lower inflation. The authors argue that aggregate supply responds with a lag to a decline in aggregate demand as population growth slows, resulting in lower inflation. However, after controlling for the effects of population growth and aging, an increase in life expectancy is found to increase inflation. This is surprising considering that a longer life expectancy would typically entice individuals to increase savings and spread consumption over a longer period. The paper does not provide any theoretical intuition for this dynamic, though one explanation could be that workers delay retirement as their life expectancy increases. If the population works longer on average, this would partly offset the need to accumulate savings faster and reduce consumption.

To account for the slow-moving nature of demographic change, Bobeica, Lis, Nickel and Sun (2016) use a cointegration framework to assess the long-run relationship between growth in the working-age population and inflation in the euro area, Germany and the US.[6] Their analysis finds a deflationary impact from smaller working-age population, which leads the authors to conclude that demographic change has been a structural contributor to the low inflation environment in advanced economies. While the model is unable to shed light into the mechanism of how demographic change influences inflation or provide any quantitative estimates, the authors suggest that their findings are consistent with theory that a declining share of the working-age population increases savings and lowers investment, which reduces real interest rates.[7] To the extent that the decline in real interest rates is substantial, it would limit the ability of central banks to ease monetary policy and increase inflation.

5 These estimates exclude the effect from changes to monetary policy.

6 The model imposes weak exogeneity of the demographics variable, such that only inflation adjusts to the long-run equilibrium but there is no adjustment in demographic change.

7 Consistent with Vlieghe and Carney's, this implies that the stock effect of larger savings for retirement is larger than the flow effect from a larger share of retirees that draw on their savings.

Discussion and avenues for future work by EA

The literature review has highlighted a number of complexities in capturing the impact of demographic change, in particular for nominal variables. I find the papers arguing that demographic change lowers wage growth and inflation more compelling. The assumption that the social safety net can cover more retirees seems contradictory to behavioural changes observed in many advanced economies. In Australia, participation rates for older workers have increased, which may reflect workers' perceived need for higher retirement savings. To draw a conclusion on the net effect of the consumption and savings response, further work is required. Before attempting a holistic, full-system approach, I propose that Economic Analysis explore the effect of demographic change on the Australian economy on a by-variable level.

- By-industry analysis could shed light on demographic change as a determinant of labour market **productivity**. Industries, such as health and household & other services, are expected to grow at a comparatively faster rate with an aging population. Measures of demographic change, such as the dependency ratio, are also likely to have a closer relationship these industries than for others. ABS data for labour productivity by industry or industry-GVA could be used for this exercise.
- Microdata from the HILDA survey could be used to explore the effects on proxies for labour productivity, such as educational attainment, health, entrepreneurship, risk tolerance, days of leave and training. Any found relationships by age cohort could then be aggregated using population projections to produce forecasts for the effect of demographic change on productivity aggregates.
- PWL's models for **wages growth** are based on WPI. Unlike AENA, the WPI abstracts from any compositional effects, which are more likely to reflect any influence of demographic change. A model-based analysis of the relationship of demographic change and wage growth in PWL's current framework is therefore difficult.
- Microdata provides an alternative to exploring the sensitivity of wages growth to demographic change. Using HILDA data, Carroll (2018) found that wage growth was statistically significantly lower for workers older than 60 compared to 35-44 year olds. Access to the ABS' WPI microdata may allow us to verify this finding at a higher frequency and with a longer history than the HILDA data.
- The effects on **inflation** depend on the response of households' savings and consumption behaviour to demographic change. As a first step, we could test how consumption, savings and investment in Australia responds to a longer life expectancy and changes in the working-age population.[8] A challenge will be the sensitivity of the results to the perceived adequacy of households' superannuation balances.
- Berger-Thomson, Chung and McKibbin (2009) use HILDA data to estimate individuals' marginal propensities to consume. Their approach could be extended by using households' demographic characteristics to explore how MPCs change with age or with a larger share of dependents.
- We could test if any measures of demographic change help explain the residuals of the inflation models. Because of the slow-moving nature of demographic change, I expect that Macro Modelling's inflation ECM is more likely to identify a relationship with demographic variables than PWL's Phillips Curve and Mark-up models, which don't account for any deviations from long-run equilibria.
- Components of the Bottom-up inflation model that are likely exposed to demographic change, such as administered prices, could be augmented with demographic variables if we are able to find a statistically significant relationship.

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8 This analysis would have to control for the business cycle.

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