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Financial Demography

How Population Ageing Affects Financial Markets

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Abstract

Financial demography analyzes effects of demographic change in general, and population ageing in particular, on financial markets. These effects are multiple and complex. This chapter reviews the academic literature focusing on three key areas: long-term real interest rates, equity markets, and pension systems. The impact of an ageing population on long-term real interest rates is ambiguous. While lower savings due to the retirement of baby boomers put upward pressure on interest rates, increasing scarcity of labor pushes real interest rates down. Population ageing affects equity markets in four major ways: 1) stock market participation, 2) relative demand for shares of companies active in particular industries, 3) risk aversion and risk premia, and 4) the demand for dividend yielding stocks. Both main types of pension systems – pay-as-you-go and fully funded systems – are negatively affected by population ageing. Pay-as-you-go systems become unsustainable due to a decrease in the number of contributors relative to the number of recipients. Fully funded systems rely on asset market returns. If asset market returns in an ageing society fall due to baby boomers selling their stocks and real estate, the sustainability of “fully funded” systems is at stake as well. These observations highlight the importance of international capital mobility: the capital stock of ageing societies should be invested where the return on capital remains high, i.e., in countries with younger populations. To conclude, sustainable financial markets cannot afford to ignore demography.

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1. Introduction

Demographic change is without a doubt a global megatrend. Its effects on labor supply, the sustainability of pension systems and other aspects of society are undisputed. However, one aspect of demographic change – and especially population ageing – is often neglected: the linkage with financial markets.

Demographic change around the world

The world is currently going through an unprecedented demographic transition. This demographic transition is characterized by ageing (a shift in the age distribution of populations) and longevity (an increase in individual life expectancy). However, not all regions and countries are affected by this in the same way. Japan, where a baby boom happened a decade earlier than in the rest of the world, has already seen the retirement of baby boomers and now struggles with baby boomers entering phases in life in which labor income is non-existent and healthcare costs become overwhelming. Globally, the number of adults aged 65+ will exceed 1.1 billion by 2035, an increase of nearly 60% in just 15 years (Eberstadt et al. 2022). And this increase will not be equally distributed. The greatest change will play out in countries that are relatively young today, for example in China – the world's fastest ageing society – where the ratio of old to young will nearly double from under 20% in 2020 to around 35% by 2035.

The United States, Germany and many other OECD countries are in the early stages of baby boomer retirements and are experiencing a drastic reduction in labor supply, although the United States much less so than most European countries due to higher levels of immigration. China is facing the most rapid and dramatic change in age structure. Due to the one-child policy implemented between 1980 and 2015, fertility has been lower in China than in the OECD. The contrast between this small younger cohort and the baby boom generation born after the "Great Leap Forward" in the 1960s who are now nearing retirement age will lead to an increase in the old age dependency ratio (OADR) by 90% between 2020 and 2035 (Eberstadt et al. 2022). On the opposite side of the spectrum are countries like India, Indonesia and Nigeria, whose massive young cohorts are currently entering the labor market (India, Indonesia) or will do so in the near future (Nigeria). The population growth of sub-Saharan Africa in particular is bound to change international markets.

To better compare ageing dynamics around the world, Eberstadt et al. (2022) divide the old population into two age groups: the "Young-Old" and "Oldest-Old". The "Young-Old", aged 65–79, can play a more active role and could potentially remain in the labor force during at least some of these years. The "Oldest-Old", aged 80 and above, are less likely to be able to actively participate in the labor force; they are the ones who are more likely to require social services, frequent and extensive medical care, round-the-clock assistance and the like. For the purposes of analyzing the impact of demography on financial markets, it is reasonable to introduce another age group: the "Future-Old". They are aged 50–64, are largely still in the labor force, earn a high wage and are preparing for retirement. They are therefore net savers. Figure 1 summarizes these demographic changes.

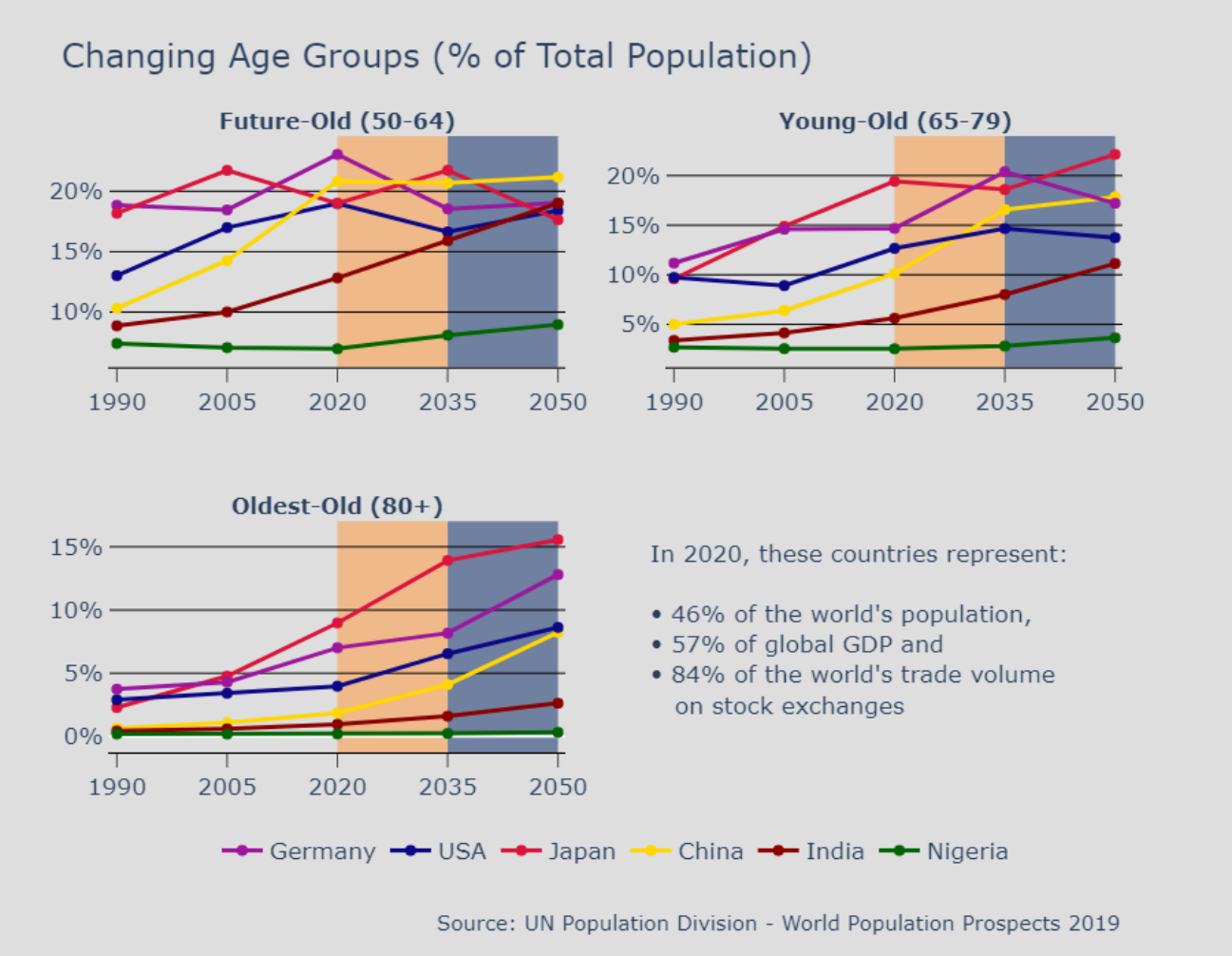

Figure 1: Change in the share of "Future-Old", "Young-Old" and "Oldest-Old" age groups in Germany, the United States of America, Japan, China, India and Nigeria, 1990–2050. Source: UN Population Division – World Population Prospects (2019)

The link between demographics and financial markets

On its most basic level, the link between demographics and financial markets is described by Milton Friedman's permanent income hypothesis (Friedman, 1957) and Modigliani's life cycle theory of savings (Modigliani and Brumberg, 1954; Ando and Modigliani, 1963; Modigliani, 1986). The key idea is that a person's temporal consumption and income pattern changes during the life cycle. Children have no income and young adults' income is low and increases as they gain experience and human capital. Income is highest among the "Future-Old" age group. After retirement, labor income drops to zero, leaving only income from capital and transfer payments. With the goal of smoothing consumption over the life cycle, people save when their income is highest and dissave when income is lowest. Thus, the propensity to save varies over the life cycle.

Mason, Lee and members of the NTA Network (2022) show how income and consumption are distributed over the life cycle empirically. Their estimation confirms that in high-income countries, labor income before the age of 15 is close to zero, starts increasing slowly and peaks around age 45. It then starts decreasing, first slowly, then more rapidly due to early retirement schemes. At the age of 65, labor income in high-income countries is one fifth of peak income. It further decreases slowly and reaches zero around age 80. Low-income countries are described by a flatter income profile: notably, children earn some labor income, retirement happens much more progressively, and labor income never reaches zero. Per capita consumption is not completely smooth over the life cycle. In high-income countries, a first peak in consumption happens between age 13 and 20, due to education expenses. After the age of 20, per capita consumption decreases and remains low until the age of

50. At this point it starts increasing until the age of 65; from there it remains at a constantly high level until the age of 75. After this age, consumption increases steadily until the end of life, clearly a consequence of public and private spending on healthcare and long-term care. In low-income countries on the other hand, consumption decreases steadily after the age of 20, a strong indicator of a lack of social safety nets, low access to financial markets and low life expectancies.

These patterns of life cycle income and consumption, particularly in high-income countries, imply drastic changes in the propensity to save over the life cycle. Young adults save very little, as they consume all their income in order to invest in housing and fund themselves and their offspring. Middle-aged adults, especially the “Future-Old”, have a very high propensity to save; they have the highest labor income and must prepare for retirement. The “Young-Old” and even more so the “Oldest-Old” have a very low propensity to save. Their only income is capital income and/or pensions, which in most cases will not be enough to sustain their standard of living. Therefore, they start dissaving to maintain a permanent level of consumption.

If these assumptions are true, a demographic transition as monumental as the one taking place in the 2020s and 2030s will have serious effects on financial markets. Three of the most important effects concern interest rates, stock market returns and the pension system. An economy’s desired aggregate savings are a core determinant for long-term real rates of interest. A large cohort of “Future-Old” may have contributed to the persistently low interest rates since the mid-2000s – what happens once this massive cohort of savers stops saving or starts dissaving? Will the asset market “melt down” once baby boomers start selling their stocks to finance retirement or readjust the riskiness of their portfolio? Does knowledge about demographics improve investment decisions or are these developments already priced into the market? How sustainable are pension systems and how can they be salvaged? These effects and more are discussed in the following chapter. The goal is to give an overview of the literature on the most important effects of demographic change on financial markets and identify open research questions.

2. How demography affects long-term real interest rates

Theoretical relationship

Expansionary monetary policy in the wake of the Global Financial Crisis (GFC) has led to a decrease in short-term nominal interest rates; in many countries short-term rates of zero or even negative rates have been observed in the past decade. Meanwhile, the long-term risk-free real rate of interest has also been declining, leading to not only a lowering but also a significant flattening of the yield curve. This decline in long-term rates started well before the GFC and has been puzzling economists around the world (Bean et al. 2015). Quickly, it was attributed to an increase in the global supply of savings, or as coined by Ben Bernanke, a "saving glut". The cause of this increase in savings is argued to lie in demographics (baby boomers saving for retirement) and the rise of emerging markets – in particular China – who have transitioned from being net borrowers to becoming net lenders on international capital markets (Bernanke, 2005).

As outlined by Lunsford and West (2019), there are three principal secular drivers of real interest rates that can coexist in economic models. However, the importance of each of these factors is open to debate. First, secular movements in growth can affect real interest rates, i.e., downward trends in growth lead to lower real rates, at least in the long run (steady state). Second, the Mundell–Tobin effect predicts that real interest rates decrease when inflation increases. Third and perhaps most importantly, real interest rates are affected by aggregate desired savings and investment. The remainder of this section focuses on this last phenomenon. The hypothesis that real interest rates are mainly driven by the supply of credit (savings) and the demand for credit (investment demand) is also known as the Loanable Funds Theory (Robertson, 1934). Aggregate investment must always be equal to aggregate savings and the real interest rate acts as an equilibrating force. If aggregate desired savings increase, the real rate decreases. If aggregate desired investment demand increases, the real rate increases. See also Figure 2, panel a) for this theoretical relationship. It should be noted that this relationship only holds for a closed economy. In a world with free international capital markets, this argument must be made for *global* desired savings and investment.

Changes in aggregate desired savings and investment can have a variety of causes. The largest and most predictable changes in aggregate savings are caused by baby boom and baby bust cycles in combination with the life cycle theory as outlined in Section 1 of this chapter. The 1980s were characterized by baby boomers entering the labor market. A large cohort of young adults decreased aggregate savings and an abundance of labor induced strong investment demand. This resulted in a strong upwards pressure on real interest rates (see also Figure 2, panel b)). In the first two decades of the 2000s, baby boomers in most of the developed world moved into the "Future-Old" age group, started preparing for retirement and therefore saving a lot (see also Figure 2, panel c)). Beginning in the late 2010s, the first baby boomers started to retire. The brunt of baby boomer retirements is expected to happen in the late 2020s and early 2030s, with only small differences between developed countries (Japan being the notable exception). This means that a huge cohort of previous savers will largely stop saving, leading to a projected decrease in aggregate desired savings, thus exerting an upward pressure on real interest rates (c.f. Carvalho et al., 2016; Gagnon et al., 2021; Eggertsson et al., 2019; Föllmi et al. 2021). This effect is mitigated by the increase in life expectancy in almost every country in the world (c.f. Eberstadt et al. 2022). A longer life expectancy leads to a longer retirement (assuming the retirement age remains unchanged) and thereby higher desired savings per capita (Gagnon et al., 2021). It may also induce an increase in labor market participation, i.e., fewer early retirements and a higher likelihood of working past the retirement age (Cooley and Henriksen 2018). A longer life span also means that the process of dissaving takes longer and is much slower – under the assumption of constant retirement ages.

Despite a potential increase in labor market participation, the demographic transition will lead to an increasing scarcity of labor and an abundance of capital. If it is firms' goal to maintain a given capital–labor ratio, this causes aggregate investment to decline and decreases both real interest rates and the rental rate of capital relative to the price of labor (Gagnon et al., 2021; Ferrero et al., 2019). This is the main effect counteracting the upwards pressure on interest rates due to a decrease in desired

savings. It is this tradeoff between an upwards pressure on interest rates due to a decrease in desired savings and a downwards pressure on interest rates due to a decrease in aggregate desired investment that makes a forecast of the effect of demographic change on interest rates complicated. The net effect of an increase in the share of retirees on real rates is unclear. Much depends on how much global desired savings decrease and how the corporate sector adjusts its investment demand. This ambivalence is also depicted in Figure 2, panel d).

Empirical evidence

Whereas the theoretical expectations of the effect of demographics on interest rates in the past decades are very clear, it has proven to be surprisingly difficult to verify this relationship empirically.

Borio et al. (2017) for example, do not find there to be a statistically significant effect of non-monetary variables (such as demography) on real interest rates. Busetti and Caivano (2019) find that total factor productivity is the most important driver of long-term real interest rates, but demographics are also an important determining factor. Lunsford and West (2019) find a positive long-run correlation between safe real interest rates and labor force hour growth, and a negative correlation with the proportion of 40–64-year-olds. They do not find strong evidence for long-run correlations with non-demographic variables (such as productivity). Fuhrer and Herger (2021) differentiate between population growth due to a birth surplus and population growth due to migration. They find a statistically significant, positive relationship between the birth surplus and real rates but not between migration and real rates. This might explain the difficulties of finding a significant relationship between demography and interest in the past: confounding the effects of migration and birth surplus may weaken the statistical relationship, particularly in countries with a high share of migration.

Aksoy et al. (2019) estimate that the number of workers positively affects investment, savings and real interest rates, whereas the number of retirees negatively affects all three variables. Projecting this model into the future yields a decline in investment, savings and real rates in all OECD countries. Building on Aksoy et al. (2019) but focusing on the euro area, Ferrero et al. (2019) show that an increase in dependency ratios exerts downward pressure on real interest rates. Föllmi et al. (2021) study the relationship between demographics and real interest rates in Switzerland and find a significant negative relationship between the share of 40–64-year-olds and interest rates and a significant positive relationship between the share of 15–39-year-olds and interest rates, whereas no significant relationship between the share of 65+ and interest rates is found. These results are calculated for short-term risk-free interest rates (government bonds with durations of less than a year). The results do not change significantly if long-term rates are used instead. Projections into the future predict no further downward pressure but also no upward pressure on interest rates due to demographics. These results appear to confirm the theoretical expectation that the effects of “Young-Old” and “Future-Old” cohorts on interest rates are well-defined whereas the effects of 65+ cohorts are ambiguous.

Because it is difficult to translate past relationships between interest rates and demographics into the future, where demographics are so different that countervailing effects are expected, many economists have tried to develop overlapping generations (OLG) models which, when calibrated to actual demographic and economic developments, reproduce interest rate developments. Most of these models predict interest rates to remain low during the demographic transition.

Cooley and Henriksen (2018) develop an OLG model with endogenous labor supply and savings decisions based on life expectancy and calculate that about a sixth of the level of per capita economic growth in the United States and Japan is explained by changes in demographics (age structure and life expectancy). Gagnon et al. (2021) show that the developments in GDP growth and the real interest rate since 1980 could have been predicted using an OLG model with a rich demographic structure. The same model projects that GDP growth and interest rates will remain low in the coming decades. This is due to the growth of labor supply being as low as that of aggregate investment. Ikeda and Saito’s (2014) model for Japan predicts that a decline in the ratio of workers to the total population

lowers the real interest rate and is a quantitatively important factor for projections of the real rate. Carvalho et al. (2016) develop a model which confirms that the demographic transition contributed to a decrease of the real interest rate by at least 1.5 percentage points in the OECD between 1990 and 2014. Their model predicts a further decrease of the real interest rate by 50 basis points over the next 40 years. Carvalho et al. (2016) make the argument that the increase in life expectancy is the most important channel through which demographics affect the real interest rate because it induces agents to save more at all stages of the life cycle. Meanwhile, Goodhart and Pradhan (2020) argue that increasing life expectancy does not necessarily induce more desired savings due to social safety nets. If the old can rely on the state to provide for them, particularly in terms of healthcare expenditures, the prospect of a longer life does not fully translate into higher savings before and during retirement. What should matter however, is the healthy life expectancy, i.e., the years of retirement where a high standard of living is particularly desirable and generally not guaranteed by social safety nets. The World Economic Forum (2019) discusses potential problems arising from retirees outliving their savings.

What can we conclude?

Economic literature largely agrees that demographics have an important effect on the long-term real rate of interest. The projected net effect of population ageing on real interest rates, however, is an open debate. This is because there are two important, counteracting effects. On the one hand, the retirement of baby boomers leads to a decrease in aggregate desired savings. This has a positive effect on interest rates. On the other hand, labor becomes scarcer, leading to capital becoming relatively more abundant and therefore reducing its marginal product. Less capital is needed to maintain a given capital–labor ratio, reducing investment demand. In the past few decades, i.e., after the baby boomers' entry into the labor market and before their retirement, the direction of this effect has been unambiguous: a slowly increasing propensity to save as retirement approaches as well as ample but slowly declining labor supply (with the retirement of the first baby boomer cohorts) have led to an immense downward pressure on real interest rates, particularly since around 2005. This has coincided with heavily expansionary monetary policy since the Global Financial Crisis. The end results are historically low short-term nominal as well as long-term real interest rates and a remarkably flat yield curve.

The direction of the net effect of demographics on interest rates in the past decades has been undoubtedly negative – the only point of discussion in the literature is whether the effect has been quantitatively significant or not. Most evidence points towards the answer being yes, with the effect of demographics on long-term real rates being estimated between 0.75 and 5.8 percentage points since the 1980s and 0.5 to 1.5 percentage points since the 2000s. The projection of this relationship into the future is more complicated because it is now not only important to establish whether there is an effect of demographics on real rates but also the exact transmission channel of this effect. Therefore, a significant part of the literature attempts to make such projections using sophisticated theoretical models with rich demographic components, calibrated to real world observations and population projections. An overwhelming number of these models predict a neutral or negative net effect of an ageing population on interest rates, most commonly expressed as the currently observed low real interest rates becoming the "new normal" (see also Figure 2, panel d)). This observation is a central part of the secular stagnation hypothesis, coined by Hansen (1939) and revived by Summers (2013). However, as noted by Goodhart and Pradhan (2020), such models neglect two important factors which might reverse these predictions.

First, none of the models discussed in this chapter explicitly account for China. Most models implicitly define the United States or the group of OECD countries as closed economies. However, China's influence on global capital markets in recent decades has been immense. In particular, savings demand in China has been extraordinary, leading to a massive current account surplus. This has happened due to a) the rapid growth of its working-age population and b) the insufficiency of the social safety net, which incentivizes the accumulation of personal savings in preparation for retirement. As outlined in Section 1 of this chapter, China's share of "Future-Old", the main saving generation, is about to drop dramatically. This is bound to lead to a further reduction in global aggregate savings,

which in many models is not accounted for. Such a development would correspond to panel e) in Figure 2.

Second, it is not clear how the corporate sector will react to the demographic transition. Due to the way in which production functions are defined, most economic models predict that firms react to an increasing capital–labor ratio by reducing investment demand and thereby maintaining a roughly constant capital–labor ratio. This view corroborates recent developments of unusually low rates of capital investment following the GFC (Gagnon et al., 2021). However, as noted by Goodhart and Pradhan (2020), it may be possible that firms *increase* their investment demand as a reaction to severe labor shortages, replacing the missing (and more expensive) labor with capital. This would imply a change in firms' production functions. In particular, current trends of digitization and robotization might support such a transition (c.f. Acemoglu and Restrepo, 2017). Such a development would correspond to panel f) in Figure 2.

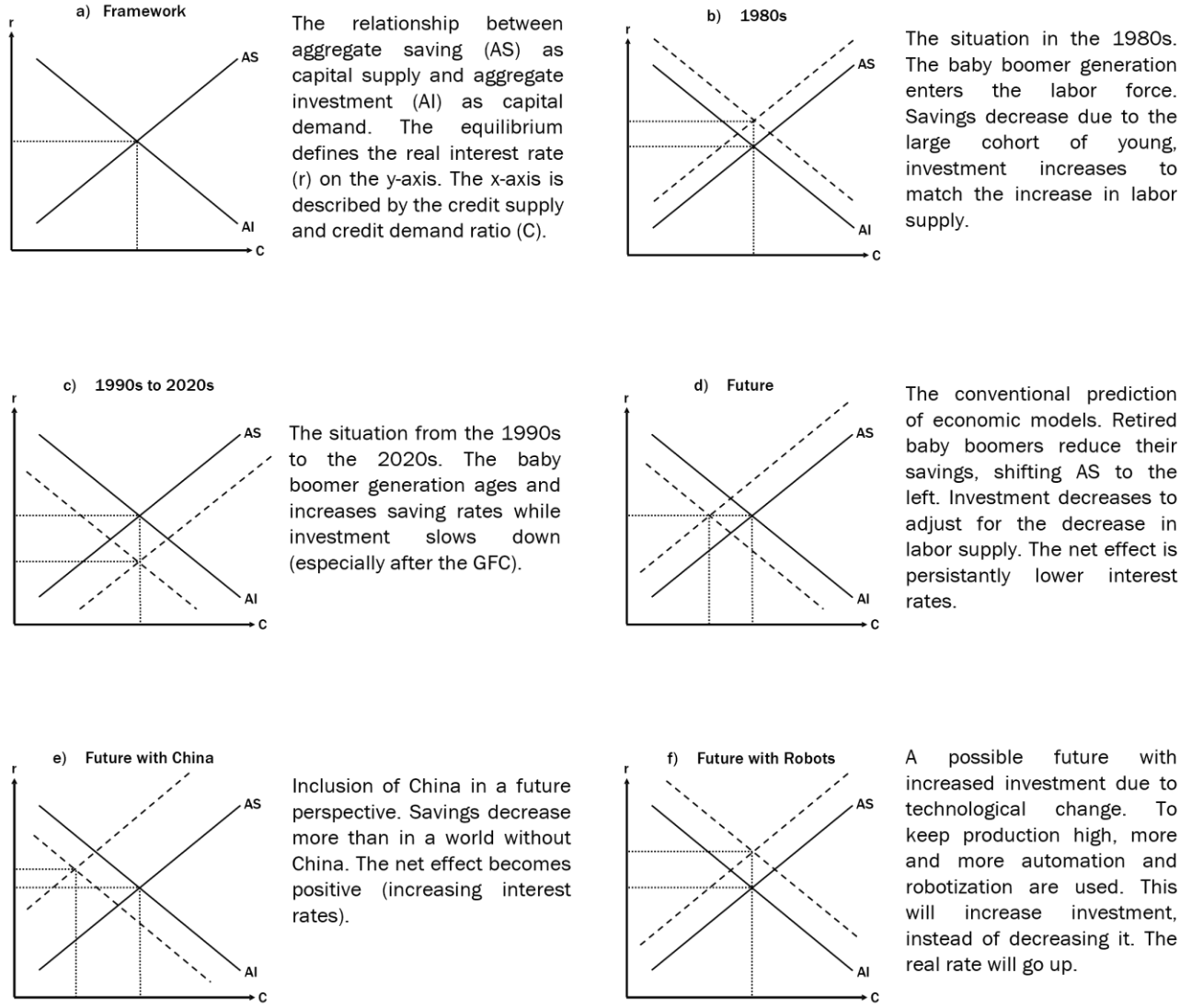

Figure 2: Effects of shifts in aggregate saving and aggregate investment on real interest rates.

3. The return on equity

Theoretical relationship between ageing and return on equity

Following the life cycle theory outlined in Section 1, one can determine four major ways in which an ageing population might affect stock markets and particularly stock market returns. First, mirroring the discussion on interest rates in Section 2, post-retirement cohorts invest less or start to divest, as labor income decreases, and consumption remains at a high level. This is particularly true for the "Oldest-Old", whose expenditures on health and old-age care increase significantly. But the "Young-Old", who remain increasingly healthy and lead an active lifestyle with more free time, are also expected to consume a lot. An ageing population – be it healthy or in need of care – is thus expected to lead to an increase in the supply and a decrease in the demand for stocks and should therefore result in a downward pressure on stock prices. This theoretical prediction is also known as the "asset market meltdown hypothesis" (Poterba, 2001; Krueger and Ludwig, 2007)

Second, the age structure of a society does not only affect its demand for stocks but also goods and services. For example, demand in sectors such as toys, bicycles, life insurance and nursing homes is very age sensitive. Therefore, demographic change should predictably affect profitability in many sectors and thereby the return on specific stocks (DellaVigna and Pollet, 2007).

Third, conventionally it is assumed that older people are more conservative and less likely to take risks (Okun, 1976). In terms of investment decisions, this is not only reflected by a more cautious mindset, but also a naturally shorter investment horizon as well as a decline in human capital. As shown by Merton (1971), abundance of human capital (i.e., at young and middle age) creates a strong incentive to invest in risky assets whereas a reduction of human capital (older age) increases incentives to reallocate savings to safe assets. It is therefore expected that "Young-Old" and "Oldest-Old" generations reallocate their portfolio towards less risky assets, such as government bonds, or leave the asset market entirely (c.f. life cycle risk aversion hypothesis; Bakshi and Chen, 1994).

Fourth, it is also expected that dividend-paying stock becomes more attractive with growing age, as short-term cashflow becomes more important than long-term growth (as first proposed by Miller and Modigliani (1961)). More recently, behavioral aspects have also been theorized to play a role in the preference towards dividends. For example, Shefrin and Statman (1984) introduce the idea of "mental accounting", i.e., dividend income and capital gains are seen as two separate accounts that are not treated equally. Particularly older investors find a regular income stream as a replacement for labor income very attractive and use this income to finance their consumption in place of divesting. This also helps avoid regret of selling the principal (Shefrin and Thaler, 1988).

Empirical evidence

Stock market participation and stock prices

Empirical evidence on the effect of demographic change on stock prices is mixed. Notably, Poterba (2001) finds that while assets are accumulated rapidly between ages 30 and 50, the drawdown in retirement is much slower than would be expected from a standard life cycle model. He uses these findings to project asset demand and does not find a sharp decline between 2020 and 2050. Quayes and Jamal (2016) on the other hand, find that in the United States, the proportion of "Future-Old" positively affected stock prices whereas the proportion of retirees negatively affected stock prices. Analyzing aggregate investment flows, Goyal (2004) finds a negative correlation between outflows from the stock market and "Future-Old" and a positive correlation for the retired. Important however, are the *changes* in age structure, not levels. Guiso et al. (2002) confirm that participation in the stock market follows a hump-shaped pattern.

One major argument against the asset market meltdown hypothesis is the bequest motive, i.e., that the old do not intend to consume all their wealth but instead bequeath it to their heirs. This is one explanation for Poterba's (2001) finding, that retirees draw down their wealth much slower than theoretically expected. Abel (2001) considers this argument and develops a general equilibrium model with a strong bequest motive. However, this model still predicts a significant fall of stock prices upon

the retirement of baby boomers. Notably, the dynamic behavior of the price of capital is not affected by the strength of the bequest motive. Abel (2001) notes that while the demand for capital may not decrease by much when baby boomers retire with a bequest motive, changes in the supply of capital might still lead to a reduction in the price of capital. In a world with a bequest motive, the capital stock and therewith the supply of capital will be higher than in a world where all savings are consumed before death. This increase in supply of capital compensates for the increase in demand from baby boomers and leads to the price of capital being unaffected by bequest motives. This theoretical finding shows that making stock market predictions based on the demand side alone – without considering supply side effects – may be misleading.

Besides a potential bequest motive, there are other possible explanations for the slower than expected drawdown of assets in old age. For example, wealth accumulation itself is a motive (Brunner, 2014; Hurd, 1987; Carroll, 1998). Thus, wealth accumulates throughout the lifespan, even in old age. In the case of diagnosis of a severe disease which would lead to an inevitable death, even more intense wealth accumulation can occur. This behavior can be linked to the human need for security. Even in the face of death the individual wants to hold on to wealth (Kopczuk and Lupton, 2007). A third motive is that of precautionary saving, i.e., an increase in savings due to uninsurable uncertainty in the future or due to “public care aversion”, i.e., an aversion to simultaneously running out of wealth and needing long-term care (Ameriks et al. 2011).

The drawdown of retirement assets also depends on the institutional framework. For example, Poterba et al. (2011) show that in the United States only 7% of households aged 60–69 who own a PRA (personal retirement account) withdraw more than 10% of their PRA balance annually. However, after the age of 70½, i.e., the age at which required minimum distributions have to begin, the rate of distributions rises sharply.

Sectoral effects

DellaVigna and Pollet (2007) show that fluctuations in cohort size predict profitability by industry. However, there is a significant amount of inattentiveness in the market: changes in forecasted demand predict excess industry stock returns 5–10 years in the future, such that a trading strategy exploiting long-term demographic forecasts can generate a significant positive (risk adjusted) excess return of around 6 percentage points. Ammann et al. (2011) find similar results concerning changes in demographics on pharmaceutical stock returns. Their research on data from 1986 to 2006 on age-sensitive drugs and changes to the demographic structure suggest that 3–5% of stock returns for each percentage point in annual demand growth can be predicted by demographic change. Costinot et al. (2019) also analyze sales of age-sensitive drugs and the home-market effect. They conclude that countries tend to sell abroad those drugs that are most in demand domestically. Zanon et al. (2013) predict that in Brazil, sectors with higher demand among the elderly are those with the highest growth rates.

Furthermore, DellaVigna and Pollet (2013) show how demand shifts due to demographic change are anticipated by the affected industries. Such industries are issuing more equity now in order to increase their capacity in production lines to meet this demand. However, as more equity is not yet met with higher sales these industries tend to be undervalued. Therefore, timing the demand shift with the change in demographic structure is important. Results show how positive demand shifts within the next 5 years affect the stock market positively while more distant shifts have a negative effect now.

Risk-taking

Understanding investors’ risk preferences is important for asset valuation because risk preferences directly affect expected risk premia (Sharpe, 1964). There is some evidence that risk aversion increases with age, however the effect on investment decisions is an ongoing debate. Guiso et al. (2002) find that the risky share of financial wealth tends to vary little by age. However, Calvet and Sodini (2014) show strong support for a positive relationship between human capital and risk-taking for panel data on the investment decisions of Swedish twins. Calvet et al. (2021) confirm that the risky

portfolio share decreases with age. Korniotis and Kumar (2011) find that older and more experienced investors tend to hold less risky portfolios and that the degree of risk further (slightly) decreases in the age group above 75.

While there seems to be little asset decumulation *after* retirement, there is evidence on a decrease of the share of risky assets just before retirement. Fagereng et al. (2017) find a high and constant share of around 50% of risky assets until age 45, followed by a steady reduction by 1% p.a. until retirement, after which it remains constant at around 30%. Dohmen et al. (2017) confirm the finding that the willingness to take risks decreases over the life course and that the slope of this decrease becomes flatter after the age of 65.

Dividend Clienteles

There is some evidence for the existence of age-based dividend clienteles. For example, analyzing data from 60,000 retail investors during the period 1991–1996, Graham and Kumar (2006) find that the preference for dividend yielding stock increases with age and decreases with income. Becker et al. (2011) show that firms respond to local clienteles' preferences for dividends. That is, firms located in areas with a larger share of retirees are more likely to pay dividends. Korniotis and Kumar (2011) find that older investors are likely to prefer high dividend yield stocks whereas more experienced investors – all else being equal – are less likely to favor such stocks.

What can we conclude?

After reading all these arguments, one could raise the question: if demography is so predictable and the effects of demography on aggregate saving so strong and obvious, should investors not foresee the effects of demographic change on stock markets and act accordingly decades in advance? And should this not lead to the effects manifesting much earlier? This is an argument that is also raised by Poterba (2001) as a potential explanation for the lack of empirical evidence on this topic. Two arguments speak against this hypothesis: 1) As has been shown by DellaVigna and Pollet (2007), there is a severe lack of long-term investment decisions. Particularly, they show that demographic forecasts beyond a time horizon of 4 to 8 years are not incorporated in investment decisions, even though they are very likely to materialize, and a significant excess return could be gained by doing so. Many explanations have been brought up to explain this issues, the authors' favorite explanation being one of inattentiveness. Weber's (1834) model, which predicts a neglect of slow-moving variables, explains this effect particularly well. 2) Even with complete foresight it is not true in every case that rational agents make investment decisions that counter the direct effect of demographics. For example, Geanakoplos et al. (2002) develop a model in which the investment decisions of fully rational agents with perfect foresight *reinforce* the effect of demographics on stock prices, i.e., during a baby boom prices grow more than proportionally to the "Future-Old" cohort.

The evidence for an increase in risk aversion during the life cycle is strong, in psychology as well as economics. However, the fact that there is little evidence of a reduction in the risky share of the portfolio in later stages of life remains puzzling. Fagereng et al. (2017) present three potential explanations for this lack of evidence: 1) Most studies rely on cross-sectional data, which makes it difficult to distinguish between age and cohort effects. 2) The risky share is usually only defined for stock market participants, which could lead to a selection bias if the choice of stock market participation is dependent on age. Older investors might simply choose to withdraw from the stock market entirely instead of adjusting the riskiness of the assets. 3) Many results rely on household data: these are notoriously prone to measurement and reporting errors which are likely to be correlated with age.

A different explanation is presented by Heimer et al. (2019). They show that the young underestimate their remaining life expectancy whereas the old overestimate it. In a theoretical life-cycle model this leads the young to undersave by 26% and leads to a reduction of retirees' drawdown speed by 27%. This observation helps to explain some of the puzzling evidence on life cycle saving and dissaving.

Poterba (2001) concedes that extrapolating large future changes in asset values based on historical data with few “effective degrees of freedom” should be interpreted with caution. The upcoming demographic transition is orders of magnitude larger than demographic transitions in the past.

4. The role of pension systems

Generally speaking, there are two types of pension systems: fully funded systems and so-called "pay-as-you-go" (PAYG) or unfunded systems. In fully funded systems, current contributors save for their own retirement. In PAYG systems, current contributors fund the pensions of the currently retired. Most OECD countries employ a mix of both systems to secure pension income for their population. However, participation in funded pension plans is often voluntary (e.g., 401(k) and IRA in the United States) and coverage with funded plans is unevenly distributed across the population. Particularly, there is a need for increasing coverage for the young and middle-to-low income classes (Antolín, 2008).

The weakness of PAYG pension systems in an ageing economy is obvious: a decreasing share of contributors must fund the pensions of an increasing share of retirees. The sustainability of PAYG pension systems has been under scrutiny for many years. Blake and Mayhew (2006) conclude that the United Kingdom's state pension system is unlikely to continue paying out current pension levels. China's unfunded pension system is already running at a deficit since 2015 and is being subsidized by the state to the amount of roughly 1% of GDP, with a large wave of retirements on the horizon (Fang and Feng, 2020). The World Economic Forum (2017) predicts that China's total savings gap will grow with a rate of 7% per year, the second highest growth rate behind India and with a shortfall of $119 trillion the second highest projected savings gap behind the United States ($137 trillion).

Samuelson (1958) showed in his seminal contribution that the implicit rate of return on contributions into an unfunded system is equal to the rate of growth of the tax base, i.e., usually, the growth of aggregate wages. Therefore, as long as the sum of all wages in an economy keeps growing rapidly – as it has during the peak economic activity of the baby boomer generation – an unfunded system is a very attractive proposition. However, once growth of the tax base starts to slow down (or even becomes negative), the system is not sustainable anymore. For this reason, some authors have called unfunded systems "Ponzi schemes" (c.f. Friedman, 1999). This raises the question how such a system can be financed during the demographic transition.

Generally, there are three ways of dealing with this problem: cutting benefits, increasing contributions and prefunding (Campbell and Feldstein, 2001). The first two options are straightforward. Cutting benefits for the current or future retirees reduces the burden for the contributing generation now. Increasing contributions of current contributors reduces the need to cut benefits for the current retirees. Both can inflict intergenerational resentment. The idea behind prefunding a PAYG system is to set aside resources in the present in order to prevent funding gaps in the future, thus introducing a mixture between fully funded and unfunded systems. This has two benefits. First, it increases intergenerational justice due to current workers paying for their own retirement. Second, the total cost incurred is lower compared to the benefit, due to the real rate of return on savings in most cases being higher than the implicit rate of return of a PAYG system. However, this depends on the realized rate of return on savings. In any case, a transition to a prefunded system will always initially increase savings and the capital stock. Börsch-Supan et al. (2003) present a scenario for Germany with a mixed system. Initially, a shift towards more prefunding leads to an increase in the capital stock as savings go up, followed by a decrease in the capital stock as savings are consumed to finance retirement. This decrease also results in a small decrease in the rate of return on capital in the closed economy case. Investing abroad, specifically in younger countries, improves the rate of return on capital.

Pension reforms are politically very difficult to carry out and widely opposed (c.f. Boeri et al., 2002), particularly in economies with a large share of "Future-Old". From a political economy perspective, this is not surprising. Tabellini (2000) presents an OLG model in which agents vote on the size of the unfunded system. The greater the share of retired in an economy, the higher the size of the unfunded system and the greater the pre-tax income inequality within the economy. This prediction is empirically confirmed in the same paper. Despite these issues, all EU member states have reformed parts of their pension systems in the past 30 years. Mostly, these reforms have been in favor of multi-pillar

systems, combining unfunded with funded schemes as well as a general move towards more fully funded systems (Hinrichs, 2021).

However, fully funded pension systems also have drawbacks. As already developed in Section 1 of this chapter, ageing populations have contributed to excessive savings (a “saving glut”) and thereby – arguably – an overaccumulation of capital. It is a well-known feature of many economic models, such as the Solow growth model or overlapping generations (OLG) models that an overaccumulation of capital can lead to “dynamic inefficiency”, i.e., a situation in which it would be possible to improve the situation of one generation without making any other generation worse off (a Pareto improvement). In the Solow model this happens if the savings rate exceeds the Golden Rule of savings and in overlapping generations models, dynamic inefficiency can occur if the growth rate exceeds the real interest rate (see also von Weizsäcker (2014) for more such conditions). Already Abel et al. (1989) have suggested that many OECD countries are dynamically inefficient. The growing importance of fully funded systems in combination with a large “Future-Old” cohort may have contributed to this overaccumulation of capital.

Furthermore, predictions about people’s savings behavior in preparation for retirement are not easy to make and are made even more difficult by the fact that people often do not act rationally. When making pension plans, the complexity of decisions and a wide array of options often lead to irrational decisions. In many cases, people do not make any decisions at all and stick with the default options supplied by the government. It is therefore of utmost importance that pension systems are kept as simple as possible and that default options are picked carefully. Barr and Diamond (2009) offer a thorough discussion of behavioral aspects of choosing pension systems and common analytical errors made when evaluating such systems. Lusardi and Mitchell (2014) provide an overview on the growing body of literature concerning financial literacy.

As opposed to unfunded systems, where the expected implicit rate of return of pension assets is given by the rate of growth of aggregate wages, the rate of return of pension assets in a funded system is not directly dependent on demographics but given by asset market returns (typically bonds, stocks and real estate). However, as Schieber and Shoven (1994) have already asked: is the rate of return of assets really independent of demographics? The literature cited in Section 3 of this chapter hesitantly points towards “no”. Demographics may not only affect stock markets but also real estate prices; as famously hypothesized by Mankiw and Weil (1989), real estate demand is highest for young and middle-aged adults and expected to decrease after retirement. That the predicted effects on housing prices have not materialized so far does not preclude the possibility of lower real estate returns in the future. If population ageing does indeed exert a downward pressure on asset returns, the proposition of a funded system accruing a higher rate of return than an unfunded system has to be put into question.

Already Mackenroth (1952) has argued that funded and unfunded pension systems are in essence not so different after all. In terms of the macro economy, all pension systems are unfunded. Even in a funded system, current pensions are paid for with returns of assets or their sale. Therefore, the only question is *who* pays the cost of population ageing. For the economy as a whole, according to Mackenroth (1952), the choice of pension system should not matter. However, in a globalized world, much of a country’s pension funds are invested abroad. Therefore, this hypothesis does not hold completely (Rürup, 2016).

If population ageing will indeed lower the return on capital in ageing economies, the continued funding of baby boomer’s pensions might become doubly problematic. First, due to the unsustainability of PAYG pension systems and second due to the unsustainability of fully funded pension systems caused by low rates of return. The only solution to this dilemma is for ageing economies to invest where rates of return are high: in younger countries (Barr and Diamond, 2009). In support of this hypothesis, Caballero et al. (2008) develop a model that rationalizes many surprising macroeconomic developments with international capital flows. Particularly, capital flows are motivated by regional differences in growth potential and the quality of domestic financial assets and financial institutions.

However, the model highlights the potential for sharp reversals in capital flows, interest rates and exchange rates. Under some conditions, for example an improvement in the quality of financial assets from developing countries, capital flows can reverse direction with drastic consequences for the United States and EU.

5. Conclusion

The academic literature on the effect of demographic change on financial markets is in many cases inconclusive. To a certain extent this should not come as a surprise. The demography of a region, country or the whole world affects so many different aspects of the economy that true causal effects are very difficult to identify. However, given the scale of the upcoming demographic transition, the potential consequences to financial markets are immense. Under that aspect, Financial Demography appears to be under-researched and is certainly not well enough understood in practice. The best example for this is given by DellaVigna and Pollet (2007), who show that a zero-investment portfolio constructed by going long and short on 48 demography-affected industries solely based on demographic forecasts outperformed the market by 6 to 8 percentage points. Examples like this highlight that financial market participants currently lack understanding about demographic variables – or do not pay enough attention to them.

Academic research is also incomplete in many fields. The role of international capital mobility and the effect of China's imminent dissaving remain open questions. Additionally, the idea that the trend of digitization and robotization might increase demand for capital and change the desired capital–labor ratio has barely been discussed in relation to demographic change. The interaction of these two megatrends is a major open area of research which might change traditional predictions of the effect of population ageing on interest rates. As an added layer of complication, it is not clear how individuals and societies react to an ever-increasing life expectancy in combination with unsustainable pension systems. Options include saving more, working longer, consuming less during retirement or relying on social safety nets. All these options have their own repercussions for financial market returns and stability.

This paper discusses three major ways in which demographic change will affect financial markets: interest rates, stock returns and pension systems. However, there are many other areas of the economy that are potentially affected by demographic change, which can however not be discussed in depth in this publication. One such example is inflation: with the retirement of baby boomers, demand for consumption of goods and – especially important for inflation – services remains high or even increases, whereas production capabilities are limited due to the scarcity of labor. This should add inflationary pressure. Other affected areas include, for example, growth, innovation, public debt and risk premia on government bonds, real estate markets and political economy.

Finally, it should be noted that demography not only encompasses age but also other characteristics such as gender, family status and education. Notably, the developed world's investment decisions are not only made by ever older investors but also more and more by female investors, driven by emancipation and an increasing prevalence of single households. Generally speaking, women have a stronger private saving motive than men: they can expect to live longer and often have gaps in their employment history, due to pregnancy, child rearing and a higher propensity for part-time work. However, empirical evidence suggests that women on average have lower levels of financial literacy and less interest in financial markets than men (Bucher-Koenen et al. 2017). The implications of gender roles for finance are also part an important part of Financial Demography, even though they cannot be discussed at length in this publication.

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