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How Demographics Affect Asset Prices

Global Demographics and Pensions Research

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We examine the links between asset prices and demographic characteristics, reviewing previous academic and policy studies, conducting regressions and reflecting on the various channels through which demographic variables affect asset (stocks, bonds and house) price variables.

- Changing trends in asset accumulation and portfolio choices of financial market participants over the **life cycle** lead to **changing supply-demand dynamics for assets and affect asset prices.** Borrowing at young age, asset accumulation at middle age and asset decumulation at old age to finance retirement affect asset prices through the life cycle. Asset allocation decisions and prices are also influenced by differing levels of **risk aversion,** which vary with age and other demographic characteristics.

- We explore quantitative links between stock and bond price related variables and demographic variables. Using regressions, we document **strong relationships between long-term government bond yields and demographics** for five developed countries (US, UK, Japan, France and Germany). For P/E ratios of stocks, the results are strong only for the US.

- We find large differences across countries for the predictability of equity index price-earnings ratio based on demographic variables. We believe that these differences emanate from a mix of **demographic and institutional features. Investors** in countries differ in terms of the following: stock and bond market participation, size and length of baby boom, retirement ages, retirement income provision, risk aversion, institutional structure, etc. These **investor differences affect asset allocation and asset prices**.

- We use our statistical estimations based only on demographic variables to forecast up to 2025, broad trends of **P/E ratios** in the US, as well as **long-term bond yields** for the US, Germany, Japan, France and UK. A strong note of caution that **many other variables, which we do not quantitatively include in our estimations (**both demographic and non-demographic), also have an influence on asset price variables.

- As people live longer, different stages of the life cycle are delayed; asset accumulation and decumulation patterns are likely to differ significantly from the past. We believe that **age ranges typically used in past** studies to represent savers and dis-savers will not work as well in the future. We show the links between **demographics and house prices**, mainly on the demand side, while relating asset prices across countries to their pensions structures.

- Demographics affect **fundamental macro-variables and drivers of asset prices**. We conduct a basic **building block exercise** relating demographic variables to the underlying drivers in stock and bond valuation. The **future challenge** is getting data/conducting experiments to check these intuitive but indirect linkages between valuations and demographics.

1. Introduction

There is a general belief amongst many investors, analysts and academic researchers that demographic factors influence both economic variables and asset prices. There are many references in daily and financial news, too, which allude to the relationships between financial asset prices and demographic variables and trends. Several academic studies have tried to explain the relationship between asset prices (such as equity index, equity returns, bond yields, equity premium, real estate prices, commodity prices, etc.) and demographic variables. We selectively review and summarize the results of a few of these academic research papers. We quantitatively test some of the relationships between demographic variables and asset prices across major developed markets, shedding light on why results across countries are similar for some assets, yet different for others.

Our perspective on demographics (***differs from the conventional emphasis on aging***) strongly emphasizes people characteristics, stressing that **consumer and worker characteristics** are the channel through which we ought to consider demographic effects on economic aggregates (like GDP, consumption expenditures, budget deficits, capital flows, etc.) and asset prices. We caution against considering demographics as a "people-count" exercise and **focusing on age alone as the dominant demographic summary characteristic.**

In our view, demographics affect asset prices through a number of channels. A **direct channel** is through the asset accumulation and portfolio choices of financial market participants over the life cycle. The **life cycle hypothesis**, developed by Modigliani and Brumberg (1954), states that a consumer's consumption and saving decisions aim to smooth consumption over their lifetime. The changing trends in asset accumulation and portfolio choices over different phases of the life cycle lead to a changing supply-demand dynamic for assets, contributing to variations in asset prices.

In this report, we present the life cycle theory for the U.S. and explore quantitative links between population structures and stock and bond prices in five developed markets (US, UK, Japan, France and Germany). We develop ratios based on the age structure of the population and find that the middle age ratio (40- 49 year olds/ 60-69 year olds) has a strong correlation with stock price/earnings ratios in the US but not so in France, Japan and Germany. On the other hand, the yuppie nerd ratio (20- 34 year olds/ 40-54 year olds) has a strong correlation with bond yields in the US, UK, France, Germany and Japan. We examine reasons why the results are different for different assets and across countries.

We draw attention to a previous report[1] where we emphasized the need for attention to changing life cycles and changing consumers by the financial community similar to what is done by retail companies, consumer goods companies and travel services. We stress that micro-foundations based macroeconomic models, based on data, should be fundamental to analysis, rather than aggregative representative agent models. It is misleading to look only at aggregate population, aggregate labour force or even 65+ aged people based on past trends, as micro differences are significant, reflecting vast differences in preferences, native heterogeneity and other socio-economic characteristics, as well as changes in the same.

Unprecedented improvements in life expectancies have been accompanied by changes in behaviour over the life cycle. While life expectancy and longevity increases are noted and discussed abundantly, there has been relative lack of attention to the extension of different stages of the life cycle as well as the delayed transition from one stage of the life cycle to another. Even across seemingly similar countries in terms of size and geography, we showed in an earlier report that France, Germany and Italy belong to different stages of

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[1] See Credit Suisse Demographics Research, "Longer Lives, Changing Life Cycles: Exploring Consumer & Workers Implications" (2011) for more details.

demographic transition. So, consumers and workers in these countries are also likely to exhibit differences in consumer and worker behaviour. School entry age, labor market entry age, age at marriage, age at child-bearing and retirement age all differ across countries and relative to similar cohorts a decade ago. In general, people are spending more years in education, entering the labor force later, delaying marriages and child rearing, and enjoying longer and uncertain post-retirement periods. **These changes can and do affect the asset accumulation and portfolio decisions of investors.** The age ranges, which were typically used to represent savers and dis-savers in the 1950s, 1960s and 1970s, are not appropriate in the current context and are unlikely to be relevant as a representation for the future either. Asset accumulation and decumulation patterns today are very different from the past, too. **We suggest the need to redefine age ranges used traditionally to explain asset prices and economic variables in the future; this will become more urgent over time, in our view**.

Demographic variables affect fundamental macro-variables, which influence asset prices. In this report, we attempt to draw explicit links between demographics and basic valuation models for stocks and bonds. We conduct a basic building block exercise where we look at the underlying basic drivers of stock and bond valuation and then relate demographic variables to those valuation drivers. For example, sovereign bond yields are determined by the real risk-free rate, expected inflation, and risk premium, which are affected by demographic characteristics such as population structure, labour force growth, fiscal burden of aging, geopolitical risk, etc. We go through this thought process in order to show the conceptually intuitive links which exist but are hard to demonstrate in a quantitative framework due to explicit data limitations on age specific portfolios and age-specific savings and investments, particularly over time. There exist fairly sophisticated but stylized over-lapping generations and stochastic life cycle models developed by academic researchers but their direct applications to the practical investment world is difficult because of limitations owing to the data availability or lack of directly testable implications.

Apart from stock and bond price related variables, demographic variables affect house prices, too. We devote the final section to a better understanding of the links between demographic trends and house prices. The report is organized as follows: Section 2 reviews and summarizes results from a few academic research papers. Section 3 reviews the relevant demographic variables and trends. Section 4 presents the Life Cycle and Asset Allocation Theories. Section 5 examines the links between demographic variables and Asset prices in the G5. Section 6 presents our analysis on the Demographic Drivers of Fundamental Asset Valuation. Section 7 presents empirical evidence for US, Japan and Germany of Demographic Variables on stock and bond variables. Section 8 presents demographic links to house prices. Section 9 provides our conclusions.

2. How Demographics Affect Asset Prices: Academic Literature

Several academic studies have investigated the relationships between demographic variables and asset prices (stock and bond prices). Several of these studies focus on the US and attribute some part of the increase in stock prices in the 1980s and 1990s to the increasing demand for financial assets by the baby boomers, who were in their prime saving years during this period.

Bakshi and Chen (1994)[2] studied and tested the relationship between demographic changes and asset prices in the US during 1900-1990. They tested two hypotheses. The **first** is the life cycle investment hypothesis: *investors allocate a larger part of their wealth to housing when they are young and to financial assets as they grow older*. They related the decline in the real S&P stock index and the increase in the real housing

[2] Bakshi and Chen, "Baby Boom, Population Aging and Capital Markets", Journal of Business (1994)

price during 1966-1980 to the fact that baby boomers (born between 1946 and 1964) then entered their 20s and 30s, starting investments in housing. After 1980, the baby boomers entered their saving years and started investing in the stock market, which drove up stock prices. The **second** hypothesis is that an ***investor's risk aversion increases with age and thus risk premium should be positively correlated with average age***. They used average age, along with consumption growth data, to explain stock and T-bill returns (thereby risk premium) and found that **average age had a significant effect**. It confirms that the risk behavior of financial market participants changes with age and they become more risk averse and prefer less risky assets as they grow older. Thus **age dependent risk aversion affects asset returns**.

Cohn et al (1975) found that an individual's **risk aversion is related to demographic** variables such as age, gender, marital status and **socioeconomic** variables such as education, income and wealth[3]. **Morin and Suarez (1983)[4]** found that an investor's life-cycle plays a prominent role in portfolio selection behaviour and risk aversion increases uniformly with age. **Schooley and Worden (1996)[5]** found that investment in risky assets is also related to the desire to leave an estate and expectations about the adequacy of Social Security and pension income.

Kocherlakota and Jagannathan (1996)[6] investigated reasons why people shift investment away from stocks and towards bonds as they age. The three reasons commonly given are: **a) stocks are less risky over a young person's long investment horizon; b) stocks are often necessary for young people to meet large financial obligations and c) younger people have more years of labour income ahead of them and can recover the potential losses associated with stock ownership- as they age, the value of their human capital falls and the best way for them to respond is to shift away from stocks to bonds.** The paper found that the first two arguments do not make economic sense and the last argument is valid only for people with labour income that is relatively uncorrelated with stock returns.

Ang & Maddaloni (2003)[7] investigated the link between demographic changes and equity risk premium across developed markets. They used changes in three demographic variables: 1) **average age of the population** above 20 years, 2) the **fraction of adults over 65 years**, and 3) the **proportion of population in working ages** 20-64 years. They found weak evidence in the US that demographic changes predict future equity risk premium, but **strong evidence in favour of predictability for other countries.** Further, they found that the **demographic variables that predict equity risk premium in the US are different from those that predict the equity premia in other developed markets**.

The **Asset Price Meltdown Hypothesis** states that when baby boomers retire, they will reduce their asset holdings and asset prices will be adversely impacted. **Poterba (2001)[8]** rejected the **Asset Price Meltdown Hypothesis;** using data on the age wealth profile of US households, he showed that while asset holdings increase sharply when households are in their peak saving years, **they fall slowly when households are retired**. He projected that asset demand will not decline sharply between 2020 and 2050. **Abel (2001)[9]** re-examined the **Asset Price Meltdown Hypothesis,** based on Poterba's work (2000), noting that even if the demand for assets does not fall in the future when baby

3 Cohn et al, "Individual Investor Risk Aversion and Investment Portfolio Composition", The Journal of Finance, Vol. 30, No. 2 (1975)

4 Morin and Suarez, "Risk Aversion Revisited", The Journal of Finance - Vol 38, No 4 (Sept 1983)

5 Schooley and Worden, "Risk Aversion Measures: Comparing Attitudes and Asset Allocation" (1996)

6 Kocherlakota and Jagannathan, "Why Should Older People Invest Less in Stocks Than Younger People", Federal Reverse Bank of Minneapolis Quarterly Review Vol 20, No 3 (1996)

7 Ang and Maddaloni, "Do Demographic Changes affect Risk Premiums? Evidence from International Data" (2003)

8 Poterba, "Demographic Structure and Asset Returns" (2001)

9 Abel, "Will Bequests Attenuate the Predicted Meltdown in Stock Prices when Baby Boomers Retire" (2001)

boomers retire, that does not imply that the price of assets will not fall. Taking into account both supply and demand of assets, he showed that the **equilibrium price of assets may fall** when baby boomers retire, even if the demand for assets by retired baby boomers remains high.

Jeremy Siegel[10] noted that the aging population of the developed world will put downward pressure on stock prices. His model showed that if the productivity rise is modest and taxes, retirement age, immigration and life expectancy are as currently expected, **retirees wont be able to maintain the living standard they seek and hence would try to sell their assets**. However, there **will not be enough young Americans to demand all the stocks that baby boomers will want to sell** during retirement and that could drive stock prices downward, unless foreign buyers step in. Siegel stated that the rich young people in the developing world (China, India, Mexico, Brazil) will buy the stocks American baby boomers will want to sell, creating enough demand to increase stock prices. The developing world is getting richer faster and if it continues to grow faster and buy the shares wanted, **asset prices in the developed world will not fall**.

Robin Brooks[11], in contrast, stated that wealthy individuals who own a large share of US stock won't need to sell and companies may boost dividends so retiree investors can maintain their shares. He contended that the hit to retiree living standards would be to those without savings and depending on government assistance. **Milton Friedman** also expressed the view that rather than selling assets, typical retirees will be happy to hold their stocks and bonds and live off whatever dividends, interest, and pensions they receive.

Bergantino (1998)[12] examined the effect of changes in the age distribution of the US population on housing, stock, and bond prices in the US. According to him, tests of the correlation between the constructed demographic asset demand variables and corresponding asset prices suggest a **statistically significant link between demographic changes in the US population and observed long run movements in housing, stock and bond prices**. He found that demographic factors can account for approximately 59% of the observed annual increase in real house prices between 1966 and 1986 and 77% of the observed annual increase in real stock prices between 1986 and 1997.

Ameriks & Zeldes (2004)[13] examined the empirical relationship between age and portfolio choices for allocation to the US stock market. They were interested in how individuals adjust their exposure to the stock market as they age. Using data from the large university teachers pension fund TIAA-CREF (Teachers Insurance and Annuity Association-College Retirement Equities Fund), they found **no evidence supporting a gradual reduction of portfolio shares in equity**. They noted that there was a **tendency for older individuals to shift completely** out of the stock market around annuitizations and withdrawals.

Goyal (2004)[14] studied the link between population age structure, net outflows from the stock market and stock market returns in an overlapping generations framework. Using US data, he found that stock market **outflows are positively correlated with changes in the fraction of old people** (65 and over) **and negatively correlated with changes in the fraction of middle-aged people** (45 to 64). The population age structure also adds significant explanatory power to excess stock return predictability regressions. He also found that the **outflows over the next 50 years are not expected to rise to levels that cause concern** even with the retirement of baby boomers. His regressions confirm that, in

[10] Siegel, J., "The Future for Investors- Why the Tried and the True Triumph Over the Bold and the New" (2005)

[11] Wall Street Journal, " As Boomers Retire, a Debate: Will Stock Prices Get Crushed?"- ES Browning (May 5, 2005)

[12] Bergantino, "Life Cycle Investment Behavior, Demographics and Asset Prices", MIT (1998)

[13] Ameriks and Zeldes, "How do household portfolio shares vary with age?" Working paper, Columbia Business School (2004)

[14] Goyal A., "Demographics, Stock Market Flows, and Stock Returns, Journal of Financial and Quantitative Analysis" (2004)

addition to a **decrease in outflows from the stock market with an increase in the middle-aged population, the stocks prices are posited to rise.** Moreover, in the absence of fundamental changes, there are declining expectations for future stock returns.

Liu and Spiegel (2011)[15] examined the extent to which aging of the US population creates headwinds for the stock market. They looked at the ratio of the middle age cohort (aged 40- 49) to the old age cohort (aged 60- 69) -**M/O ratio**. They estimated that the **M/O ratio explains about 61% of the movements in the P/E ratio of the S&P 500 from 1954 to 2010 and concluded that the M/O ratio predicts long-run trends in the P/E ratio fairly well**. Their **model-generated path for real stock prices in future implied by demographic trends is quite bearish.** Real stock prices are expected to follow a downward trend until 2021, cumulatively declining about 13% relative to 2010. Real stock prices are not expected to return to their 2010 level until 2027. Their calculations suggest that by 2030, the real value of equities will be about 20% higher than in 2010.

3. Demographic Trends and Variables

In this section, we summarize the broad demographic trends and patterns followed by variables, which we believe might explain movements in asset prices and include variables used in studies we summarized in the section above. This will serve as background for our analysis in the rest of this report.

Demographics is about "*consumer and worker*" characteristics. The core demographic indicators we consider include fertility rates, population growth, life expectancy, age structure, dependency ratios, etc. More importantly, we focus on *worker characteristics,* such as labour force growth, productivity, economic activity rates, unemployment, wages, education, retirement ages, pensions, etc. and *consumer characteristics,* such as family size, consumption baskets, household finances, etc.

Exhibit 1 presents core demographic indicators for the world, including the less developed regions and the more developed regions. Fertility rates are declining throughout the world and the decline is faster for less developed regions compared to the more developed regions. Currently, the less developed regions have higher fertility rates as well as younger and faster growing populations compared to the more developed regions. The more advanced countries have low population growth, which can lead to low labour force growth and GDP growth. They have also experienced **major improvements in life expectancy, leading to longer and more uncertain post retirement periods**. The more developed regions are facing extreme population ageing, with an overall old-age dependency ratio of 24 people aged 65+ per 100 people aged 15-64 compared to 9 in the less developed regions. The old age dependency ratio indicates the burden of the ageing population on government finances, as it tends to increase age-related government expenditures on pensions, health care and long-term care[16].

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[15] Liu and Spiegel, "Boomer Retirement: Headwinds for US Equity Markets?", FRBSF Economic Letter (August 22, 2011)

[16] See Credit Suisse Demographics Research (2010), "Not Just the Long-Term Matters--A Demographic Perspective of Fiscal Sustainability"

Exhibit 1: Core demographic indicators: World, less developed and more developed regions

Total Fertility Rate

Old-Age Dependency Ratio

Population Growth

Life Expectancy at Birth

■ World ▢ More developed regions ▢ Less developed regions
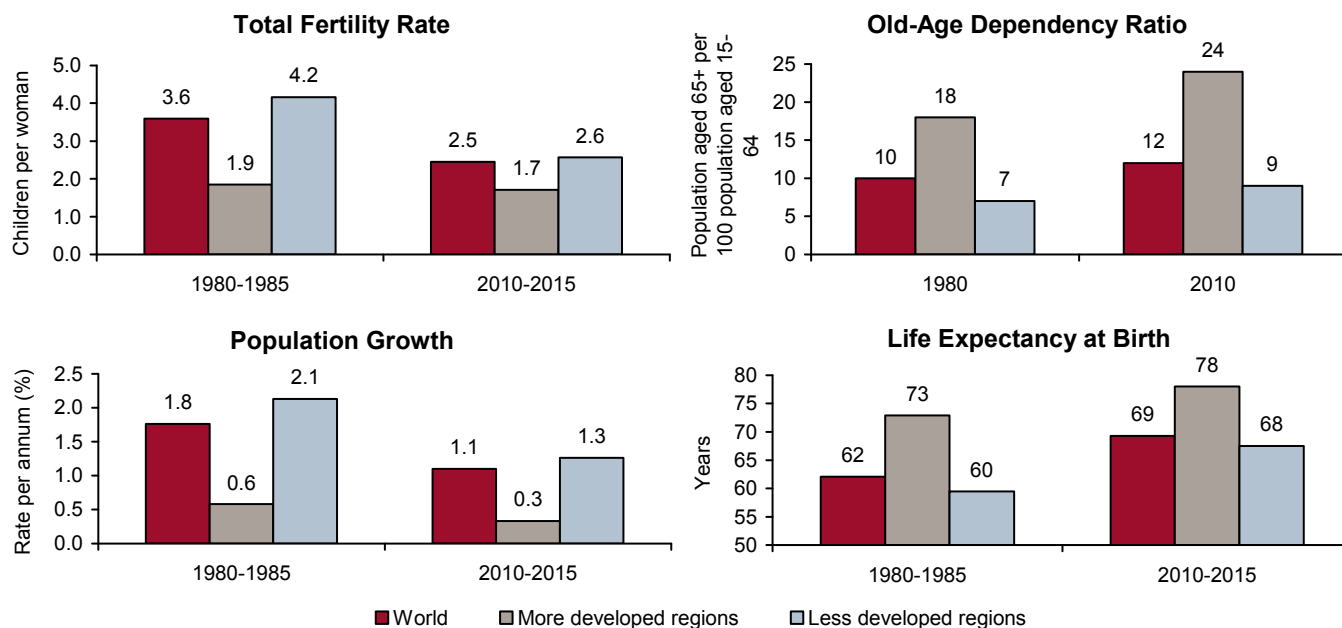
Source: UN, Credit Suisse

We next view the demographic trends in the US, as most academic papers on asset prices and demographics tend to focus on the impact of the US baby boom generation. Exhibit 2 shows the annual number of live births in the US along with the year in which they turn 65. The baby boom generation refers to those born during 1946-1964 (illustrated by the grey shaded area). 75.9 million babies were born during this period. The oldest baby boomers are expected to start retiring from 2011 onwards.

Exhibit 2: Annual number of live births and the year they turn 65: US

Live births in millions. The year they turn 65 marked on top of the line.
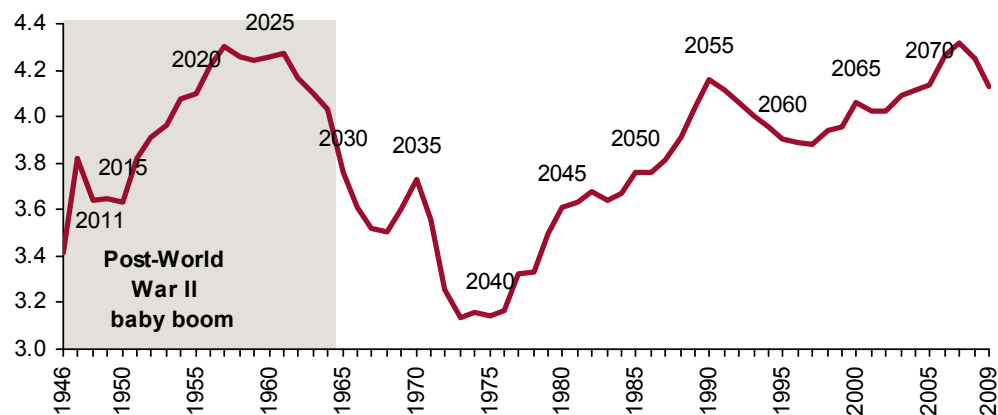
Source: US Census Bureau, Centers for Disease Control and Prevention, Credit Suisse

Exhibit 3 and Exhibit 4 present the **annual number of live births in Japan and Germany**. It is **important to note the stark differences**, relative to the US chart above.

Exhibit 3: Annual number of live births and the year they turn 65: Japan

Live births in millions. The year they turn 65 marked on top of the line.
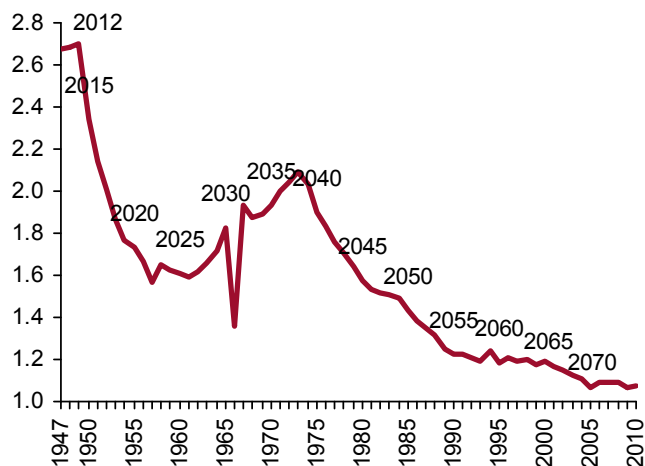
Source: Japan Ministry of Health, Labor and Welfare, Credit Suisse

Exhibit 4: Annual number of live births and the year they turn 65: Germany

Live births in millions. The year they turn 65 marked on top of the line.
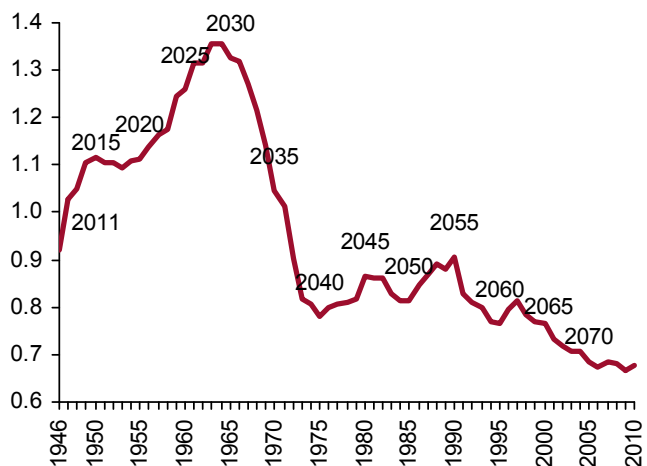
Source: Germany Federal Statistical Office, Credit Suisse

There was a sharp jump in births from **1947- 1949 in Japan** and this set of baby boomers known as the "dankai" generation was due to retire in 2007 (with a retirement age of 60). At the end of World War II, as Japanese soldiers returned home from overseas, an unprecedented number of them married and hence between 1947 and 1949, about 8.06 million babies were born. After this period, post-war devastation and reconstruction posed hardships that contributed to families having fewer children. The decline in fertility was facilitated by the legalization of abortion in 1948, which led to a steep rise in the number of abortions. Currently in Japan, unlike in the US, which is at the foothill of the retirement mountain, the number of 65 year olds is expected to decrease over the next few years.

In **Germany,** the baby boomers are defined as those who were born between 1955 and 1967. The size of the baby boom is 16.4 million. **The oldest baby boomers are due to retire in the near future.**

As shown above, the timing and the patterns followed by baby boomers differ across these countries. Also, the evolution of other core demographic variables differs.

Various studies attribute some part of the stock market boom in the 1980s and 1990s to the increasing demand for financial assets by the baby boomers, who were in their prime saving years during this period. *As the baby boomers are starting to retire, will they dis-save and sell their assets during retirement and will that cause asset prices, particularly the stock market, to fall?* This is an issue of great interest and debate as discussed before.

Exhibit 5 and Exhibit 6 show the trends in median age and old age dependency ratios in France, Germany, the USA , UK and Japan.

Exhibit 5: Median age
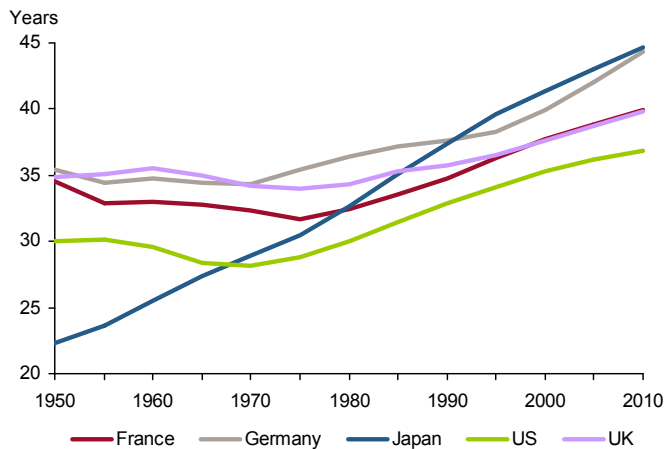
Years

Source: UN, Credit Suisse

Exhibit 6: Old age dependency ratio

Ratio of population aged 65+ per 100 population
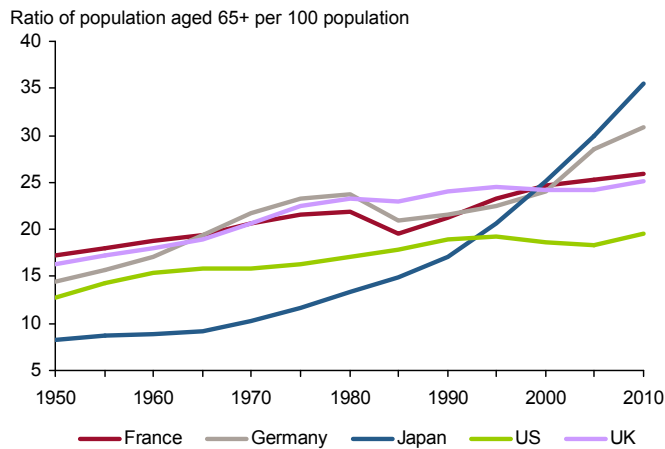
Source: UN, Credit Suisse

Currently, the US has the lowest median age (36.9 years) while Germany (44.3) and Japan (44.7) have amongst the highest in the developed world. Japan has also seen the highest increase in median age from 22.3 years (1950) to 44.7 (2010). Japan has seen the largest increase in its old age dependency ratio, rising from 8.3 people aged 65+ per 100 people aged 15-64 years in 1950 to 35.5 people aged 65+ per 100 people aged 15-64 years in 2010. The median ages and old age dependency ratios are rising because people are living longer.

As per Exhibit 7, life expectancy is rising at an unprecedented rate in Japan, and also in France, Germany, UK and the US.

Exhibit 7:Life Expectancy at birth: Men

Years
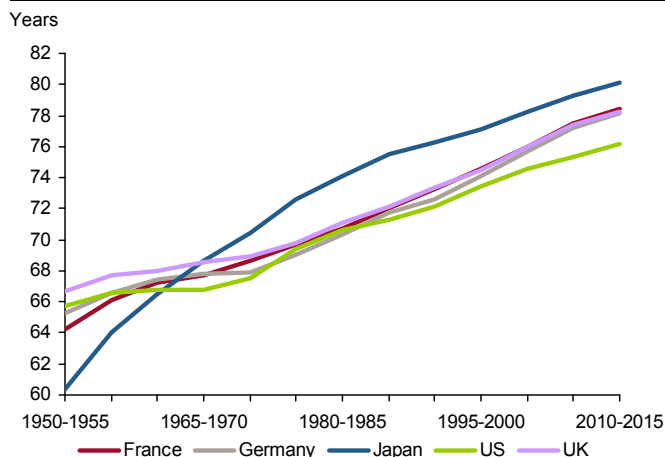
Source: UN, Credit Suisse

Exhibit 8: Average effective age of retirement: Men

Years
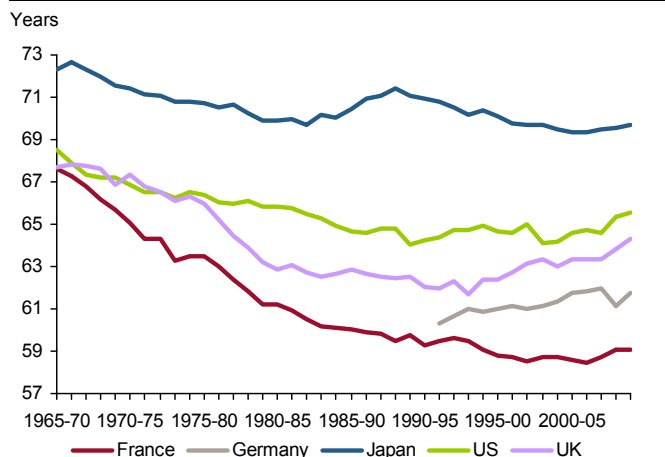
Source: OECD, Credit Suisse

On the other hand, the average effective retirement age for men is falling as compared to historical levels (Exhibit 8). The average effective retirement age is calculated as a weighted average of (net) withdrawals from the labour market at different ages over a five-year period for workers initially aged 40 and over. For instance, in France, the average effective retirement age for men fell from 67.6 (1965-70) to 59.1 years (2004-09). Japan[17] has always had the highest average effective age.

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[17] Reasons for later Effective Retirement Ages are also discussed in an earlier Credit Suisse Demographics Research report, "Macro Fiscal Sustainability to Micro Economic Conditions of the Old in the Oldest Five Countries".

Due to rising life expectancy and falling effective retirement ages, post retirement life spans are increasing and this has implications for the saving and dis-saving behaviour of investors, especially the middle aged and the elderly.

We chart two ratios in Exhibit 9 and Exhibit 10, which reflect the age distribution of the population in these five countries. We will use these ratios later in this report to try and explain variations in asset prices. The two ratios are the **Middle/Old ratio** (40-49/ 60-69 year olds) and **Yuppie/ Nerd** ratio (20-34/ 40-54 year olds).

Exhibit 9: Middle Old Ratio

Number of 40-49 year olds/ Number of 60-69 year olds
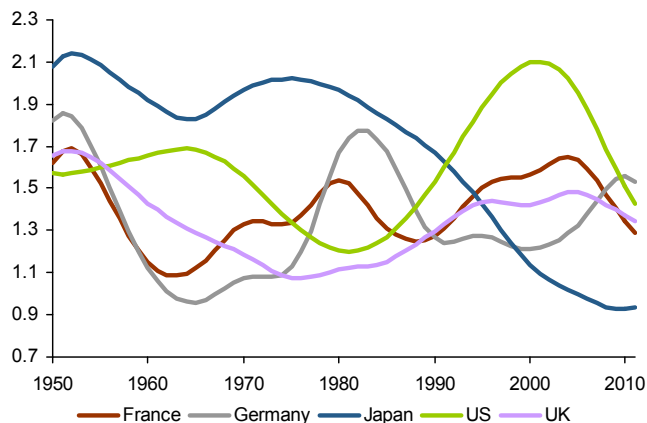
Source: UN, Credit Suisse

Exhibit 10: Yuppie/ Nerd Ratio

Number of 20-34 year olds/ Number of 40-54 year olds
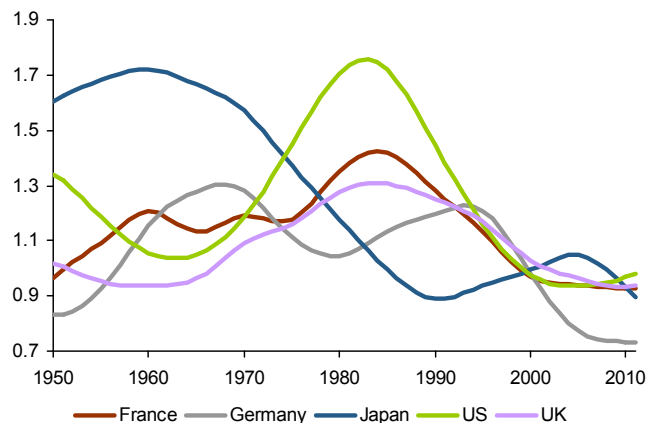
Source: UN, Credit Suisse

The **evolution of these ratios is different across these countries**. Japan traditionally had a high middle old ratio but that ratio has declined to the lowest level with a dramatic increase in the number of old people. The middle age ratio in the US, France and UK has started declining recently, while that in Germany is rising.

The trends in population age structure and evolution of demographic variables vary in these countries[18], hence the **implications of demographics on asset prices are bound to differ**. A very important question in this context is: what is the definition of "middle aged" and "old"? These definitions need to change over time for countries as well as the definitions of middle-aged and old because behaviour of individuals is conditioned on labour and pensions norms and practices as well as available investment choices.

As discussed in section 2 above, previous studies have looked at different sets of demographic variables to explain asset prices. Some examples include average age, median age, fraction of adults over 65 years, proportion of population in working ages 20-64 years, middle old ratio etc. The selection of these variables depends on the theoretical motivation, data availability and other quantitative constraints that may exist..

We now consider some of the theoretical motivations behind the relationship between asset prices and demographics and then present some quantitative and econometric analysis.

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[18] See Credit Suisse Research reports:"Macro-Fiscal Sustainability to Micro-Economic Conditions of the Old in the Oldest Five Countries" (Aug 2011) and "From the Demographic Lens: US is Definitely not Japan and Neither is Germany" (July 2010)

4. Life Cycle of Asset Accumulation and Portfolio Choice

The life cycle theory is critical to understanding how demographic changes influence the asset markets. In a **simple form of the life-cycle model[19]**, individuals live for three phases (young age, middle age and old age). **Each individual is a consumer in all three stages**. In the **first** stage, the young consumers start to participate in the labour market and earn labour income. The income may, however, be insufficient and hence the young are often borrowers. In the **second** stage, the middle-aged consumers earn more labour income than their consumption. They save and accumulate assets. In the **third** stage, the elderly consumers have no labor income and finance their consumption through de-cumulating their assets.

Borrowing at young age, **asset accumulation at middle age** and **asset decumulation at old ages** affect asset prices. For example, when a large group of cohorts enters its prime earning years, a large flow of savings is generated and invested in the asset markets, driving up asset prices. After retirement, these people have to sell their assets to the next cohorts, to finance their retirement consumption. If the next cohorts constitute a smaller group, they will be willing to pay less for the assets than what the previous cohorts had paid, driving down asset prices. We note that the elderly may not fully de-cumulate their assets, either acting out of a bequest motive or because they are not sure how long they will live.

The **changing preferences for portfolio choice** over the life cycle also affect the asset markets. With increased age, investors tend to become more risk averse and re-allocate their asset portfolio from, for example, equity to bond. In addition to changes in risk preference, investors may also re-allocate their portfolio because the cash flow of one asset matches their income inflows and consumption outflows better than the others.

We present evidence on some aspects of the life cycle of income, consumption, savings, and portfolio choices in the case of the U.S. The income and expenditure of US households by age in 2010 are shown in Exhibit 11.

Exhibit 11: Average income and expenditure of US households by age, 2010

Thousands of USD, by age of household head
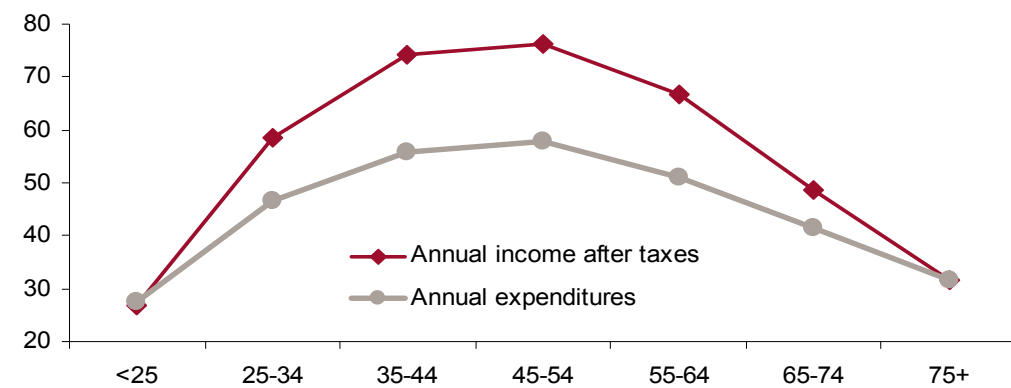
Source: US Consumer Expenditure Survey, Credit Suisse

Household income rose from a young age to middle age and then declined in old age. Note that the income here includes more than labor income. It also includes capital income, pensions, and social benefits. This income has been smoothed by savings. This is called the "smoothing of life cycle income" by consumers by saving and dis-saving over different stages of the life cycle.

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[19] In an earlier CS Demographics Research Report titled, "Longer Lives, Changing Life Cycles", we highlight the need to alter the basic form of Life Cycle Hypothesis as the foundation that we have been used to.

Household expenditures also followed a similar pattern across different age groups but had smaller variations over the life cycle than household income. The smoothing of consumption via savings also gave an impetus to capital markets developments, with different types of consumers choosing to invest their savings based on income, wealth, access to investment products and their preferences.

The average net worth of US households in 2007 rose with age until it peaked at the age group of 65-74, as shown in Exhibit 12. The net worth declined very fast from the age group of 65-74 to 75+. This is consistent with the life cycle theory of asset accumulation and decumulation. The average net worth of all households was 558K USD. **Those aged 65-74 had a net worth of 1.8 times the average, and those aged 75+, 1.1 times.**

Exhibit 12: Average net worth of US households by age, 2007

Thousands of USD, by age of household head
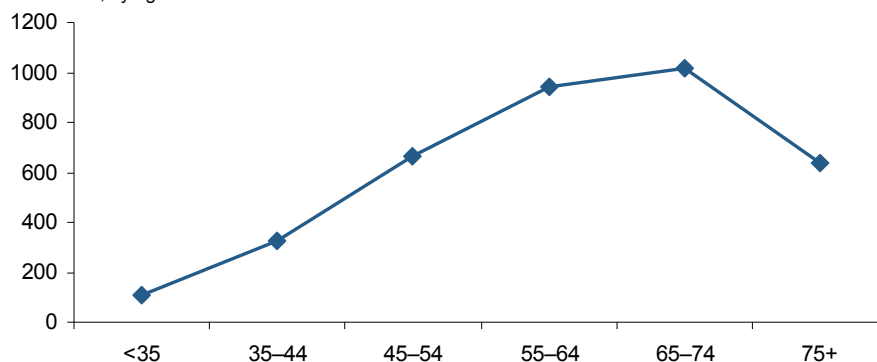
Source: US Survey of Consumer Finance, Credit Suisse

Exhibit 13 shows the financial asset holdings of US households by age in 2007. The percentage of families holding any financial assets didn't change much across the age groups, but the median value of holdings for families holding assets increased from younger to older age groups until it peaked at the age group of 55-64. The value declined in old age, indicating decumulation of financial assets. Similarly, the participation and median value of holdings tended to increase until it peaked at 55-64 for some types of financial assets, such as the pooled investment funds and retirement accounts.

Exhibit 13: Holdings of financial assets of US households by age, 2007

By age of household head.   – indicates value unavailable because there are ten or fewer observations.

	Transaction accounts	Certificates of deposit	Savings bonds	Bonds	Stocks	Pooled investment funds	Retirement accounts	Cash value life insurance	Other managed assets	Other	Any financial asset
						Percentage of families holding asset					
<35	87	7	14	-	14	5	42	11	-	10	89
35–44	91	9	17	1	17	12	58	18	2	10	93
45–54	92	14	19	1	19	13	65	22	5	11	93
55–64	96	21	16	2	21	14	61	35	8	9	98
65–74	95	24	10	4	19	15	52	34	13	9	96
75+	95	37	8	4	20	13	30	28	14	5	97
All	**92**	**16**	**15**	**2**	**18**	**11**	**53**	**23**	**6**	**9**	**94**
						Median value of holdings for families holding asset (thousands of USD)					
<35	2	5	1	-	3	18	9	3	-	2	7
35–44	3	5	1	10	15	23	37	8	24	8	26
45–54	5	15	1	200	19	50	63	10	45	6	54
55–64	5	23	2	91	24	112	100	10	59	20	74
65–74	8	23	1	50	38	86	77	10	70	10	68
75+	6	30	20	100	40	75	35	5	100	15	42
All	**4**	**20**	**1**	**80**	**17**	**56**	**45**	**8**	**70**	**6**	**29**

Source: US Survey of Consumer Finance, Credit Suisse

As a stock can be held either directly or indirectly, Exhibit 14 shows more clearly the trend of investment in stocks over the life cycle in the US. **The percentage of families holding stock (direct or indirect) in 2007 increased from 39% at age below 35 to 61% at the age group of 45-54 and then declined to 40% at age above 75**. The median value among families with holdings peaked at the age group of 55-64 and declined in old age. This confirms the theory that **the middle-aged households are net buyers of stock and the elderly net sellers**.

Exhibit 14: Direct and indirect holdings of stock by age in the US, 2007

	Families having stock holdings, direct or indirect (%)	Median value among families with holdings (thousands of USD)
<35	39	7
35–44	54	26
45–54	**61**	45
55–64	59	**78**
65–74	52	57
75+	40	41
All	**51**	**35**

Source: US Survey of Consumer Finance, Credit Suisse

Many US workers participate in a 401(K), a type of retirement savings account. The profile of the 401(k) plan participants further confirms the life cycle theory of asset accumulation and portfolio choice. Exhibit 15 shows that the average 401(k) account balances increase with participant age and tenure. The allocation to equities declines with age (Exhibit 16). For example, 18% of the 401(K) participants in their 60s had zero percent of their account balance invested in equities in 2010 compared to 9% of participants in their 20s. However, Poterba[20] found post 2002 that individual investor behaviour is not fully rational and indeed is affected by biases. A key example is that many corporate employees hold their own company's stock in their 401(K)s.

Exhibit 15: Average 401(k) account balance by participant age and tenure, US, 2010

Thousands of USD

Years of tenure	Age group				
	20s	30s	40s	50s	60s
0 to 2	4	10	16	22	27
>2 to 5	11	22	30	36	38
>5 to 10	16	38	52	57	53
>10 to 20		55	88	98	90
>20 to 30			132	180	160
>30				194	202

Source: The national association of US Investment Companies, Credit Suisse

Exhibit 16: Allocation to equities of 401(K) participants by age, US, 2010

Percentage of participants
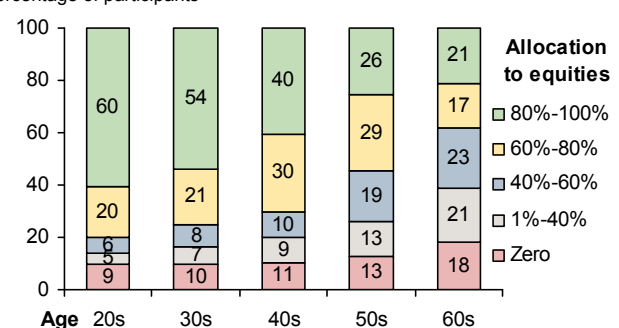
Source: The national association of US Investment Companies, Credit Suisse

The National Retirement Risk Index (NRRI) from the Center for Retirement Research at Boston College measures the percentage of working-age households that are at risk of being unable to maintain their pre-retirement standard of living in retirement in the U.S. Under the baseline assumption, 51% of the households were at risk in 2009. Pension risks are vastly different for various age groups - the early baby-boomers are exposed to lesser pension risks relative to the late baby-boomers or Generation Xers (Exhibit 17).

Exhibit 17: Percent of households "at risk" at age 65 by cohort in the US- NRRI

Cohort		2004	2009
All		43%	51%
Early boomers	1946-1954	35%	41%
Late boomers	1955-1964	44%	48%
Gen Xers	1965-1972	49%	56%

Source: Center for Retirement Research, Credit Suisse

Exhibit 18: Percent of households "at risk" at age 65 by income group in the US- NRRI

Income group	2004	2009
All	43%	51%
Low income	53%	60%
Middle income	40%	47%
High income	36%	42%

Source: Center for Retirement Research, Credit Suisse

[20] Poterba, "Employer Stock and 401(k) Plans", The American Economic Review, Vol 93, No 2 (2003)

Pension risks also differ by income as shown in Exhibit 18; those with low income face a much higher pension risk compared to middle and high income households. Note also that the retirement risk has increased over time for all the groups. The perceived risk of availability of retirement income affects the behaviour and asset allocation decisions of the middle aged and the elderly.

As Exhibit 19 shows, gross pension replacement rates for the average male earner are the lowest in the UK and the highest in France across the G5 countries that are presented here.

Exhibit 20 and Exhibit 21 show how household portfolios change across different age groups in Germany and Japan. We note that the highest wealth (real and financial) is held by the 55-64 year old age group in Germany, whereas in Japan, the richest age groups are 60-69.

Exhibit 19: Gross pension replacement rates for the average male earner, 2008

Gross pension entitlement divided by gross pre retirement incomes, %
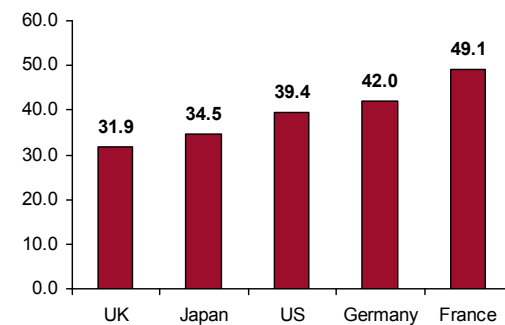
Source: OECD, Credit Suisse

Exhibit 20: Household portfolio by age in Germany, 2008

Average per household, 100 EUR

	Overall	under 25	25 - 35	35 - 45	45 - 55	55 - 65	65 - 70	70 - 80	80+
Gross financial assets	477	93	203	377	506	682	573	627	668
Net financial assets	457	77	171	348	480	666	565	620	666
Market value of real property	964	(99)	401	1 051	1 191	1 260	1 152	964	653
Total gross assets	1,441	192	604	1 428	1 697	1 941	1 725	1 591	1 321
Total debt	265	34	224	470	371	254	145	69	21
Total net assets	1,176	157	380	958	1 325	1 687	1 580	1 522	1 300

Source: Federal Statistical Office, Germany, Credit Suisse

Exhibit 21: Household portfolio by age in Japan, 2009

Thousands Yen

	Overall	Under 30	30-39	40-49	50-59	60-69	70+
Savings	13,969	2,132	5,939	10,228	14,762	19,935	18,166
Liabilities	4,258	1,314	6,983	8,872	5,337	2,243	942
Savings breakdown (%)							
Demand deposits	18%	49%	32%	21%	16%	16%	18%
Time deposits	44%	32%	34%	36%	41%	46%	50%
Life insurance, etc.	22%	10%	22%	30%	28%	21%	16%
Securities	14%	6%	7%	9%	11%	17%	17%
Stocks and shares, unit and open-end trust	8%	4%	5%	6%	7%	9%	9%
Public and corporate bonds, open-end bond trust	5%	2%	2%	2%	3%	6%	6%
Loan trust, money in trust	1%	0%	0%	1%	1%	1%	2%
Others	2%	3%	5%	4%	3%	1%	0%

Source: Statistics Bureau of Japan, Credit Suisse

Consumer and savings behaviour of individuals differs across countries, influenced by both demographics and institutional structures. Product availability, tax codes, and institutions are also important determinants of differences across countries.

Recently, with the extension of life-spans, different stages of the life cycle are being delayed to later ages. In 1975, an average Japanese woman would leave school and join the labour market at the age of 18.2, spending 12.2 years in education, enter marriage at 24.7 years old, have her first child at 25.7, retire effectively at 65.8, and spend 15.8 years in retirement. However, in 2009, a typical Japanese woman would leave school and start working at the age of 21, spending 15 years in education, enter marriage at 28.6, give birth to her first child at 29.7, exit fully from the labour market at 67.3, and enjoy 21.7 years of post-retirement life.

These life cycle changes, which include longer years in education, delayed marriage and parenthood, school-breaks, college-breaks and career breaks, multiple jobs, phased retirement, caring for children and older parents and extended retirement periods, result in changes in the behaviour of consumers and investors.

Younger individuals might borrow for longer due to late entry into the labour market. Middle age groups, accumulating assets, might extend beyond the 50 year olds because they now face longer and more uncertain retirement periods and may choose to save for longer. Early retirees might continue to save not only as bequests for their children, but also because of uncertainties pertaining to the length of post retirement period or to support their parents who are now living longer.

As Exhibit 22 shows, the ratio of number of people 80 years and above and number of people aged 55- 79 years is increasing. This is evidence of the increasing existence of multiple generations within old people—a dramatic difference compared to the past. This has implications for savings, bequests and asset allocation behaviours of the old.

Exhibit 22: Multiple generations within old people

Number of people 80 years and above/ Number of people aged 55- 79 years

Country	1950	1980	2010
US	0.070	0.122	0.183
UK	0.076	0.115	0.194
Japan	0.042	0.085	0.204
France	0.080	0.141	0.223
Germany	0.052	0.125	0.185

Source: UN, Credit Suisse

Hence, accumulation and decumulation of assets are likely to occur in a pattern different from what has occurred in the past and there may be a need to redefine age ranges used traditionally to explain asset prices. A point that we stress in our report, examining the five oldest countries of the world, is that **their debt profiles are very different and reflect the differences in consumer, saving, borrowing and investment behaviours**. In addition, the retirement and health promises in different countries along with differing institutional structures, **influence largely the asset accumulation and decumulation at individual and aggregate levels.**

5. Asset Prices and Demographics in the G5 Countries

We conduct a quantitative assessment of the historical link between stock and bond prices and demographic indicators. We focus on the five developed markets (the US, UK, France, Germany and Japan) from as early as 1950 to 2011.

Stock Price and Middle/Old Ratio

The link between stock prices and demographic trends is impacted by the life cycle theory of asset accumulation/decumulation and portfolio choice. The middle-aged individuals are in their peak savings years and invest heavily in stocks, driving up stock prices. The old-aged individuals decumulate assets and sell stocks to finance their retirement, depressing stock prices. In addition, the investors become more risk averse and prefer less holdings of stocks as they grow older. In similar spirit, as discussed in the paper by Goyal (2004) that we discussed earlier, we construct and compute a ratio of the middle-aged population to old-age population, known as the "**Middle/Old ratio,**" to explain the price-earnings ratio of the stock index. The middle/old ratios should be positively correlated to stock P/E ratios.

For the US, we use the 40-49 age groups as the middle-aged population and the 60-69 age groups as the old-aged population, based on the results from the Survey of Consumer Finance. **The Middle/Old ratio and the real S&P500 P/E ratio have a strong correlation, at 0.73, during the period 1950-2011 as shown in Exhibit 23**.

We also show the demographic projections for the Middle/Old ratio from 2012 to 2025 using data from the United Nations. The Middle-Old ratio in the US is expected to continue to fall. Using this projected data for the Middle-Old ratio, we forecast a declining P/E ratio for the US from 16.1 currently to 5.2 in 2025. This is consistent with the findings in the paper by Liu and Spiegel of the San Francisco Fed (2011), but differences could be due to different demographic sources as well as differences in the regression specification.

So, the drop in the P/E ratio based on the Middle-Old Ratio is quite dramatic. Post-1950, the US has not seen such a sharp drop in the middle-old ratio. We want to strongly caution against taking forecasts based on single demographic age variables too seriously because of other important factors through the business cycle, which may lead to much higher P/E ratios such as technological breakthroughs, innovation, cheaper resources and efficient labour practices as well as management. As we stressed earlier too, while the number of Middle-aged to Old may be projected to decrease, the savings/dis-savings decisions of the old may be very different than what we have seen from the old n the past. This could also result in delayed dis-saving and postponement of stock sales.

Will the increasing number of elderly people in the US dis-save and sell their assets during retirement and will that cause the stock market to fall? As we have already discussed, this is an issue of great debate and has divided academic researchers in the fields of finance and economics. We believe that the 65-year olds cannot be dis-saving like the 65-year olds of the past as they face a longer and far more uncertain post-retirement life.

Exhibit 23: S&P 500 P/E ratio and Middle/Old ratio, US

2011-2025 data are forecasts for P/E based on UN demographic projections
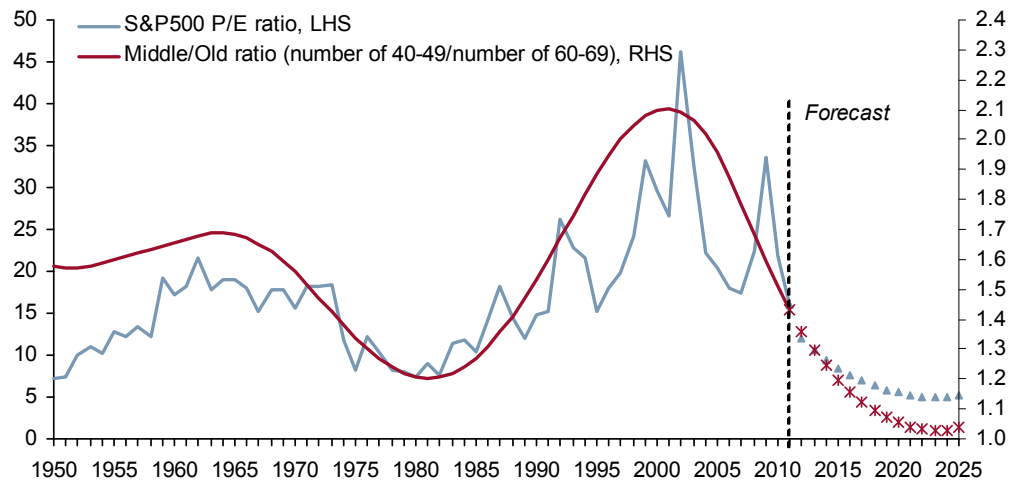
Source: Online Data Robert Shiller, UN, Credit Suisse

For **France, Germany and Japan,** we show the correlation of the stock P/E ratios and the Middle/Old ratio (defined the same way as in the case of the U.S., i.e., ratio of the number of 40-49 year olds and the number of 60- 69 year olds). As is evident in Exhibit 24, the **relationship is not very strong** in the case of France, with a correlation of 0.20.

Exhibit 24: France SBF-250 Index P/E ratio and Middle/Old ratio, France
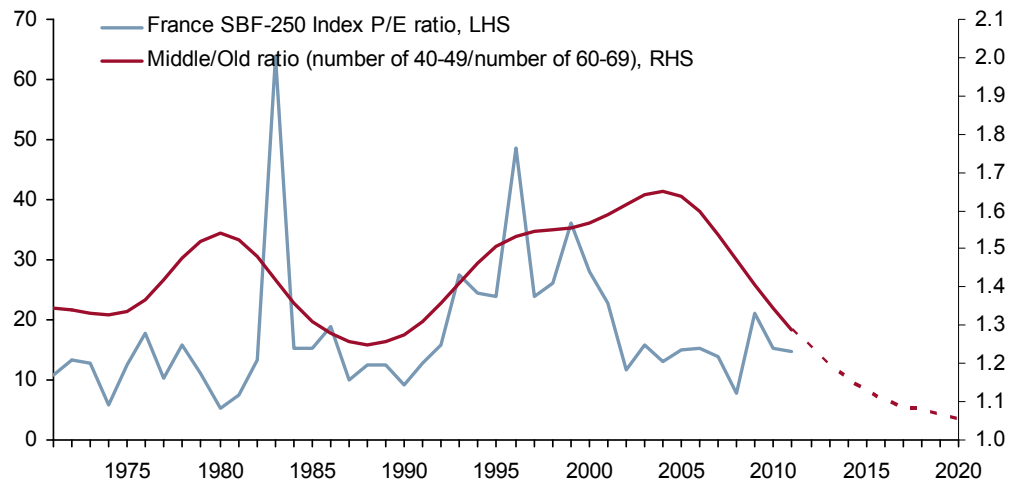
Source: Global Financial Data, UN, Credit Suisse

The relationship is weak for Japan and Germany as in Exhibit 25 and Exhibit 26.

Exhibit 25: Tokyo SE P/E ratio and Middle/Old ratio, Japan
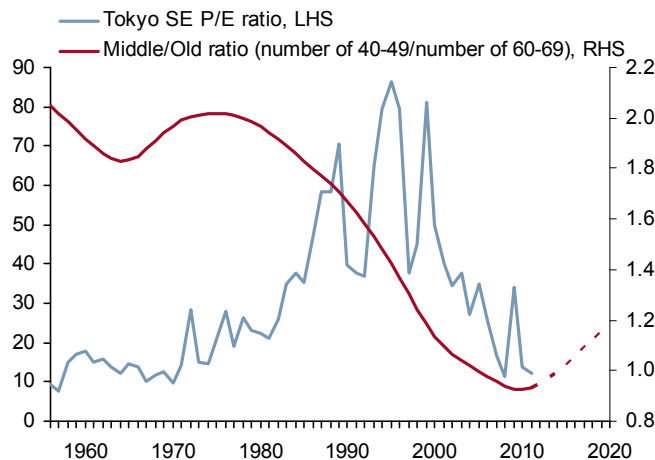
Source: Global Financial Data, UN, Credit Suisse

Exhibit 26: Germany CDAX Composite Index P/E ratio and Middle/Old ratio, Germany
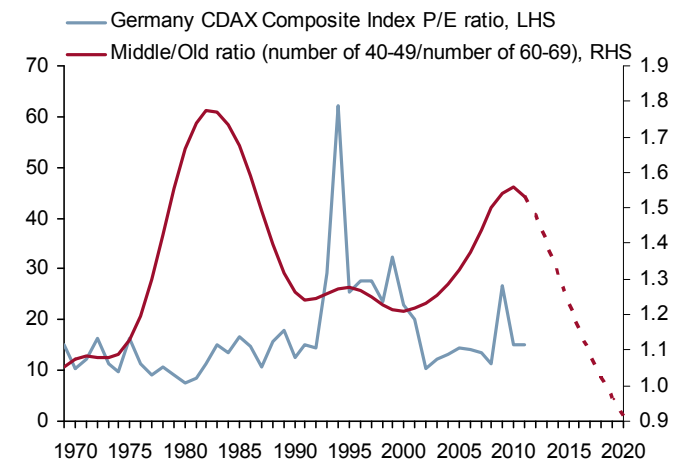
Source: Global Financial Data, UN, Credit Suisse

A possible reason for this weak relationship can be **low stock market participation**. If most of the investors are actively investing in asset classes such as bonds, then their saving/dis-saving behaviour should not affect the stock market in a significant manner. In Exhibit 27, we present the financial market structure in the US, Germany, France and Japan in 2010. We can see that the stock market capitalization as a share of GDP is the **lowest in Germany followed by Japan and France** and high in the US and UK. Bond market capitalization, on the other hand, is very high in Japan as a share of GDP. The relative values of stock and bond market capitalization give us an idea of the relative importance of the two assets for investors and can help us also understand the links between investor characteristics and asset prices.

Exhibit 27: Market depth, 2010

% of GDP

	Stock market capitalization	Bond market capitalization	Public bond market capitalization	Private bond market capitalization
US	117.5	172.8	76.5	96.3
UK	138.3	73.3	59	14.4
Germany	43.2	79.5	52.6	26.9
France	75.3	122.3	64.9	57.4
Japan	74.6	251.6	213.1	38.5

Source: World Bank, BIS, IMF, Credit Suisse

In Exhibit 28 and Exhibit 29, we show the historical levels of stock and bond market capitalization as a share of GDP in the US, UK, Germany, France and Japan. The UK and the US have historically had high levels of stock market capitalization as a percent of GDP while France and Germany have had low levels. Japan had the highest level of stock market capitalization as a share of GDP in 1988, but the share has declined. Historically, the US had the highest level of bond market capitalization as a share of GDP, but now Japan has the highest level. The UK continues to have the lowest share of bond market capitalization.

Exhibit 28: Stock market capitalization, 1988-2010

% of GDP
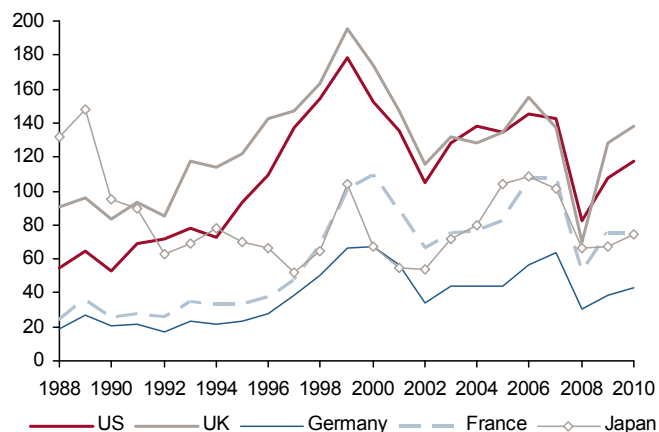
Source: World Bank, Credit Suisse

Exhibit 29: Bond market capitalization, 1989-2010

% of GDP
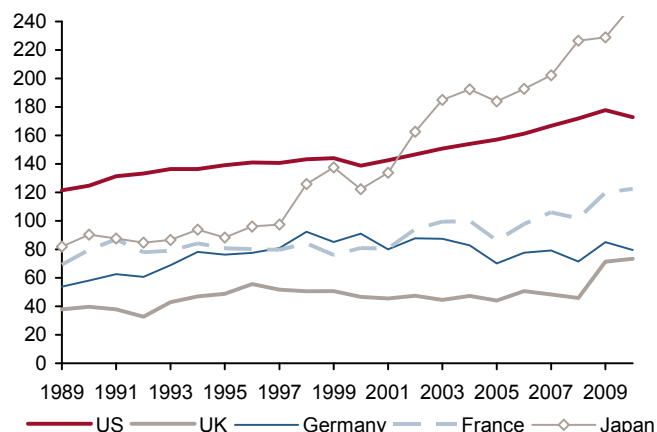
Source: World Bank, BIS, Credit Suisse

Additionally, **demand and supply mechanics of foreign investors** can also affect the domestic stock exchange if the degree of market openness is high and foreigners invest actively in the domestic stock market.

Another reason for the weak relationship between stock P/E ratios and the Middle/Old ratio for France, Germany and Japan **could be that the age ranges used to define the Middle/ Old ratios might be different for these countries**. As shown in the previous sections, these countries are different in terms of their demographic characteristics and the saving/dis-saving patterns of one country might differ from the other. For example, in the case of France, **a better fit (correlation of 0.41)** can be found between French SBF-250 Index P/E ratio and Middle/Old ratio, if we define the Middle/ Old ratio as the ratio of the number of 35-49 year olds and the number of 55- 69 year olds.

Hence, differences exist in the stock and bond market participation, evolution of demographic variables, size and length of baby boom, retirement ages, retirement income provision, risk aversion, taxes, institutional structure, product availability, etc., across these countries and hence the behaviour of investors also varies.

Bond Yield and Yuppie/Nerd Ratio

Higher amounts of borrowing and lending are likely to occur at the young and middle ages for individuals. The Yuppies (the 20-34 year olds) borrow to purchase houses and cars, placing upward pressure on the cost of borrowing. Nerds (the 40-54 year olds), on the other hand, save and invest in bonds for college education of children as well as their own retirement needs, leading to higher bond prices and lower interest rates/bond yields. The "Yuppie/Nerd ratio" is the ratio the number of 20-34 year olds to the number of 40-54 year olds. For yields, we select the nominal long-term government bond yield (10 year) as it has a longer and more reliable data history. Based on theory, the Yuppie-Nerd ratio should be positively correlated to the bond yields.

Exhibit 30 presents the correlation between Yuppie/Nerd ratios and nominal 10-year government bond yields in the US, UK, Japan, France, and Germany from 1950 to 2011.

Exhibit 30: Correlation between Yuppie/Nerd ratio and nominal 10-year government bond yield

Country	Time Period	Correlation
US	1950-2011	0.80
UK	1958-2011	0.81
Japan	1972-2011	0.57
France	1950-2011	0.83
Germany	1950-2011	0.69

Source: Global Financial Data, UN, Credit Suisse

The correlations are high, particularly in the US (0.80), UK (0.81), and France (0.83).

In Exhibit 31, we plot the historical 10-year government bond yield against the Yuppie/Nerd ratio in each of the five markets up to 2011. Government bond markets are older and are more familiar to the traditional family with savings habits in Europe and the other markets. So the accumulated savings of a saver typically found a home in domestic government bond markets and that is a reflection of both direct as well as indirect bond investments through commercial banks, rural banks and cooperatives.

In all five markets, the bond yields tend to go up when the Yuppie/Nerd ratios rise, and go down when the Yuppie/Nerd ratios fall. The decline of yields in the past decades and the current low yield environment in these markets are well associated with the decline in the Yuppie/Nerd ratio.

In Exhibit 31, we present projections of the Yuppie/Nerd ratio from 2012 to 2025 for the five countries that we focus on. The ratio in the US started to increase in the late-2000s and is expected to continue the upward trend. Similarly, the ratios are starting to increase in the UK, France, and Germany, however, will likely continue to decline in Japan. Based on these projections, in 2025, we expect the 10-year bond yields to rise towards 4.49% (US), 6.48%(UK), 4.1% (France) and 4.63% (Germany). In Japan, the 10-year yield based on our pure demographic projection should decrease to 1.1%. We want to strongly caution against taking forecasts based on single demographic age variables too seriously because of other important factors through the business cycle, which may lead to active monetary policy exercises like QE, especially during crises and recessions.

In our view, **age ranges used to define the Yuppie/Nerd ratio and Middle/Old ratio will undergo changes in the future** as people are living longer and consumers and workers are changing their behaviour.

Exhibit 31: Yuppie/Nerd ratio and 10-year government bond yield

Yield is nominal (%), 2011-2025 data are our yield forecasts based on UN Demographic projections.
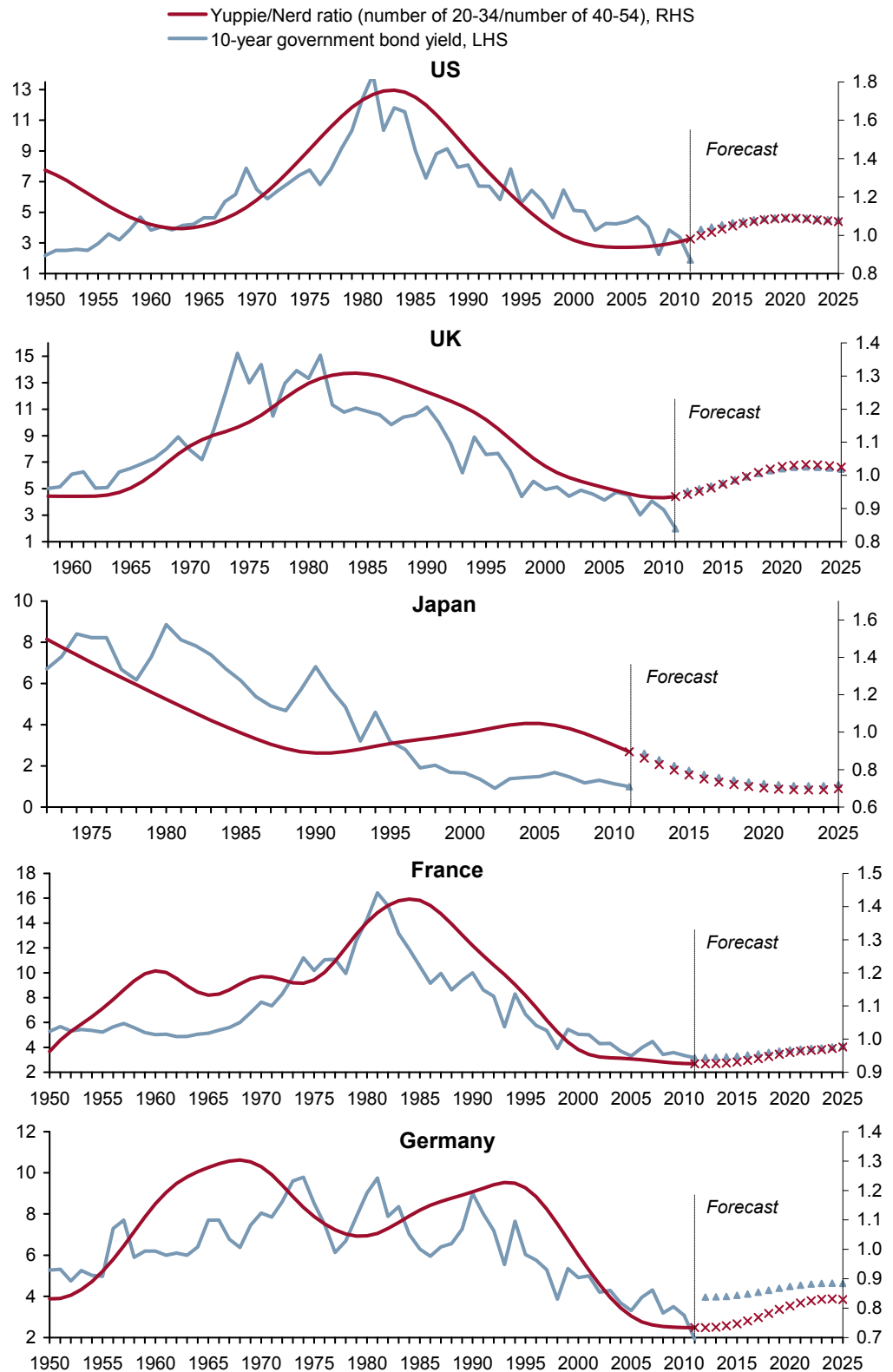
Source: Global Financial Data, UN, Credit Suisse

In today's globalized world, however, a substantial amount of government bonds is held by foreign investors. For instance, 31.4% of the U.S. Treasury securities outstanding are in the hands of foreign holders. China is the largest holder, with a share of 7.5% of total treasury securities outstanding, followed by Japan, with a share of 6.9%. For the long-term U.S. Treasury, an even higher proportion is held by foreigner investors (53.0% in mid 2010). China's holdings are mostly long term, equal to 17.6% of total long-term Treasury. Hence, the demand for government bonds from foreign investors also plays a role in determining how demographics affect bond yields in open economy financial markets such as the US, UK, Japan, Germany, etc..

6. Demographic Drivers of Fundamental Asset Valuation

In the previous section, we conducted a quantitative assessment of how demographic factors affect asset prices through the life cycle theory of asset accumulation and portfolio choice. We now consider fundamental equity and bond valuation models and highlight links between demographic variables and the underlying valuation drivers. We go through this thought process in order to directly show, from a conceptual and theoretical angle, how demographic variables influence drivers of valuation. It is worth noting that it will still be difficult to demonstrate quantitatively the direct links between the intuitive and conceptually appealing arguments and demographic variables, **due to lack of direct age specific asset holdings over time**. This ought to be part of a research agenda that focuses on better data for the future to explicitly test some of the hypotheses or conjectures.

A) Equity valuation

Equity value is obtained by discounting expected future cash flows to equity (the residual cash flows after meeting all expenses, tax obligations and interest and principal payments) at the cost of equity (the rate of return required by equity investors in the firm).

$$Value\ of\ Equity = \sum\nolimits_{t=1}^{\infty}(CF\ to\ Equity)_t \Big/ (1+k_e)^t$$

where

$(CF\ to\ Equity)_t$ = Expected Cash flow to Equity in period t

k_e = Cost of Equity

The inputs for equity valuation are:

1) Current cash flows to equity

2) Expected growth in equity earnings (to get future cash flows)

3) Cost of equity

Current cash flows to equity and expected growth in equity earnings

For any particular company, current and expected future cash flows to equity are determined by the overall cash flows, expenses, tax, interest and principal payments. Some of these factors are in turn affected by demographics, to various degrees and extents.

A firm's cash flows (both current and future) are affected by the current and future demand for the product or services the company provides. **Consumers** affect the revenues of any firm and their behavioural characteristics influence their consumer demand, which affects revenue generation for any given company. Consumer demand and revenues for a company are impacted by overall GDP per capita growth as well as GDP growth of an economy. Past research on macro links with demographics by other researchers and Credit Suisse have shown quantitative links between demographic variables and GDP growth as well as GDP per capita growth. There are other *important factors that affect consumer demand*—such as substitutes, price of the product, income, manufacturing costs, delivery costs, advertising, promotions.

The demographic characteristics of consumers influence the demand for a particular product. In our previous report[21], we analyzed how certain sectors are positively affected by demographic trends. For example, the demand for pharmaceuticals and biotechnology and retirement real estate is expected to be strong due to the increasing number of old people and retirees and increasing life expectancies in ageing countries. Sectors such as emerging markets, infrastructure and commodities are expected to grow, due to the younger and growing population of emerging markets, increased purchasing power of their consumers as well as their increased urbanization and growth of mega cities.

The costs and expenses for a firm are determined by the **labour and capital structure** arrangements in place, which in turn are affected by macroeconomic demographic indicators such as labour supply, wages, productivity, etc. Tax structure is also affected by demographics, as illustrated by the rise of taxes in advanced ageing countries necessary to reduce the fiscal deficits caused by the pension and health care obligations.

The expected growth rate in equity earnings is **affected by the GDP growth rate,** too, as it is correlated at a macro level. Other factors that affect it are demand for that company's stock, stage of business, future income and growth prospects.

Cost of capital

The cost of equity is calculated by:

$$Cost\ of\ Equity = Risk\ Free\ Rate + Equity\ Beta \times Equity\ Risk\ \Pr emium$$

The risk free rate of interest is affected by real economic growth, which is determined by demographic variables. It reflects the marginal productivity of capital in equilibrium pricing models and is affected by the overall capital-labour ratio. We have shown in our earlier report[22] how GDP growth can be decomposed into factors that reflect changes in the labour force structure, thereby establishing a link between real GDP growth and worker characteristics. Hence, the labour structure affects real GDP growth, which in turn affects the risk free rate. Another potential link is that the older the population, the higher is the compensation required for forgoing consumption, leading to a higher risk free rate. This has been discussed earlier in the context of the Kocherlakota-Jagannathan paper.

The equity beta measures the correlation of historical returns of the stock and the broad equity market. It is a characteristic particular to the riskiness of the stock and depends on the type of business, operating leverage and financial leverage.

The risk premium is a premium for an average risk investment. The equity risk premium is the excess return that the overall stock market provides over a risk free rate. **Bakshi and Chen (1994)** [23] in their paper tested the hypothesis that an investor's risk aversion increases with age and thus risk premium should be positively correlated with average age. They confirmed that risk behavior of financial market participants changes with age as investors become more risk averse and prefer less risky assets as they grow older. This age-dependent risk aversion affects asset returns. The results are discussed in more detail in the following pages.

In a recent paper, **DellaVigna and Pollet (2007)**[24] show how demographics affect profits and returns across industries. They look at the fluctuations in cohort size that produce forecastable demand changes for age-sensitive sectors, such as toys, bicycles, beer, life insurance and nursing homes. They show that forecasted demand changes five to ten years in the future induced by changes in age structure predict annual industry stock returns.

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[21] Credit Suisse Demographics Research, " Global Demographic Change and Sector Implications" (May 2007)

[22] Credit Suisse Demographics Research, "A demographic perspective of economic growth" (2009)

[23] Bakshi and Chen, "Baby Boom, Population Aging and Capital Markets, Journal of Business" (1994)

[24] DellaVigna and Pollet, "Demographics and Industry Returns", The American Economic Review (2007)

Vassalou (2003)[25] showed that a model that includes news related to future GDP growth along with the market factor can explain a cross section of equity returns in addition to other models such as Fama and French. We have shown in earlier reports how GDP growth can be decomposed into factors that reflect changes in the labour force structure. Hence, the labour structure affects real GDP growth, which in turn can affect the cross section of equity returns.

B) Sovereign Bond Yields

Interest rates or bond yields can be measured by:

Bond Yield/ Interest Rates = Real risk-free rate of interest + Expected rate of inflation + Risk premium

Real risk-free rate of interest

We have already discussed that the risk free rate of interest may get affected by GDP growth (which in turn is affected by demographics), capital-labour ratio and population ageing.

Expected rate of inflation

Higher population growth and greater urbanization can lead to increased consumer demand and higher inflation. Demographics also feed into inflation through wages, which are determined by population and labour force growth.

Risk premium

In case of sovereign bonds, the risk premium will rise due to differences in the creditworthiness of the sovereigns. This, is in turn, gets affected by the state of government budgets and fiscal sustainability. We have established in a previous report[26] the role that demographic indicators such as old age dependency ratios have to play in determining the pensions, health and other age related expenditures of the governments. Population ageing in the advanced countries and some of the older emerging markets have put a strain on public finances, which in turn affects their creditworthiness and risk premium.

Yield Curve

Demographics affect the term structure of interest rates. Pension funds, life insurance companies and reinsurers may increase their allocations to longer-dated bonds in order to match the duration of their liabilities, which need to be paid out a few years in the future. This drives down long bond yields. The demand-supply imbalance of long bonds is expected to worsen with increased ageing unless bond supply of longer maturities is increased by governments, states, agencies and quasi-sovereigns/multilateral institutions.

7. Revisiting Empirical Results

In the previous sections, we have shown how asset prices are affected by demographics through two channels:

a) Asset accumulation and portfolio choices over the life cycle

b) Drivers of Fundamental asset valuation

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[25] Vassalou, "News related to future GDP growth as a risk factor in equity returns, Journal of Financial Economics" (2003)

[26] Credit Suisse Demographics Research," A Demographic Perspective of Fiscal Sustainability: Not Just the Immediate-Term Matters" (2010)

Exhibit 32 and Exhibit 33 present results of regressions that attempt to explain the variation in the Price-Earnings Ratio of the Standard & Poor's 500 Index of stocks based on demographic variables followed by including economic variables. Please note that while we estimated other alternate regression specifications, due to space constraints, we present a chosen regression based on good fit. Population growth rate, the Middle-Old ratio (the ratio of the number of 40-49 year olds to the 60-69 year olds), and GDP per capita growth can effectively explain the variation in the S&P500 P/E ratio for the US market.

Exhibit 32: Regression results of S&P 500 P/E ratio on population growth and middle old ratio- US

1951- 2010

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	-10.2	-2.3
Population Growth	-759.6	-3.4
Middle Old Ratio	22.3	6.8
Adjusted R-squared	0.61	
F-statistic (prob)	46.90 (0)	

Source: Online Data Robert Shiller, UN, Credit Suisse

Exhibit 33: Regression results of S&P 500 P/E ratio on population growth, middle old ratio and per capita GDP growth- US

1951- 2008

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	-12.4	-3.0
Population Growth	-644.4	-3.1
Middle Old Ratio	22.4	6.6
Per capita GDP growth	26.8	1.5
Adjusted R-squared	0.66	
F-statistic (prob)	37.95 (0)	

Source: Online Data Robert Shiller, UN, GGDC, Credit Suisse

Exhibit 34 and Exhibit 35 present the results of regressions for the Tokyo Stock Exchange's P/E ratio. We note that the results are a bit weaker than the US results, but the same set of variables for population growth, the Middle-Old ratio and per capita GDP growth jointly explain the variation in the dependent variable TSE's P/E ratio. The rationale for the differences in regression fits across stock markets has been discussed earlier in sections 3 and 4 of this report. Broadly, they have to do with risk preferences, stock market access, stock market development, education and other socio-economic characteristics of investors.

Exhibit 34: Regression results of Tokyo SE P/E ratio on population growth and Middle/Old ratio- Japan

1956- 2010

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	9.9	0.5
Population Growth	-5049.1	-4.7
Middle Old Ratio	32.9	2.2
Adjusted R-squared	0.39	
F-statistic (prob)	18.04 (0.000001)	

Source: Global Financial Data, UN, Credit Suisse

Exhibit 35: Regression results of Tokyo SE P/E ratio on population growth, Middle/Old ratio and per capita GDP growth- Japan

1956- 2008

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	18.7	0.8
Population Growth	-4469.7	-4.1
Middle Old Ratio	27.8	1.7
Per capita GDP growth	-85.2	-1.7
Adjusted R-squared	0.42	
F-statistic (prob)	13.62 (0.000001)	

Source: Global Financial Data, UN, GGDC, Credit Suisse

Exhibit 36 and Exhibit 37 present the results of regressions for the German Dax's P/E ratio. We note that the specification that correlates well for the German market includes the following regressors: median age, population share of 40-49 year olds and GDP per capita growth. Again, differences in risk preferences, stock market access, stock market development, education and other socio-economic characteristics of investors are plausible factors that explain the strength of results and specifications across the three markets.

Exhibit 36: Regression results of Germany CDAX Composite Index P/E ratio on median age and share of population aged 40-49 years- Germany

1969- 2010

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	-39.1	-2.3
Median Age	4.2	3.0
Share of population aged 40-49 years	-7.5	-2.6
Adjusted R-squared	0.31	
F-statistic (prob)	10.40 (0.00024)	

Source: Global Financial Data, UN, Credit Suisse

Exhibit 37: Regression results of Germany CDAX Composite Index P/E ratio on median age, share of population aged 40-49 years and per capita GDP growth - Germany

1969- 2008

Dependent Variable: Price Earnings Ratio		
Variable	Coefficient	t-Statistic
Constant	-39.3	-1.9
Median Age	4.3	2.8
Share of population aged 40-49 years	-7.7	-2.6
Per capita GDP growth	27.9	0.7
Adjusted R-squared	0.31	
F-statistic (prob)	6.84 (0.000192)	

Source: Global Financial Data, UN, GGDC, Credit Suisse

Regressions for Bond Yields

In Exhibit 38, we illustrate the results from regressing 10-year government bond yields for the US, Japan and Germany on their respective Yuppie-Nerd ratios (the ratio of the number of 20-34 year olds to the number of 40-54 year olds) and, as shown, inflation provides a good regression fit. Also, it is worth reiterating that the development and access of government bond markets for both individuals as well as pension funds, directly and indirectly, are similar across the three developed markets that we have studied.

Exhibit 38: Regression results of nominal 10 year government bond yields on Yuppie- Nerd ratio and inflation- US, Japan and Germany

1980-2010

Dependent Variable: Nominal 10 year government bond yield								
US			Japan			Germany		
Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic	Variable	Coefficient	t-Statistic
Constant	10.0	3.1	Constant	45.1	6.2	Constant	12.2	4.0
Yuppie Nerd Ratio	2.9	2.0	Yuppie Nerd Ratio	-9.3	-2.1	Yuppie Nerd Ratio	1.7	1.2
Inflation	0.0	-4.1	Inflation	-0.3	-9.2	Inflation	-0.1	-4.7
Adjusted R-squared	0.85		Adjusted R-squared	0.84		Adjusted R-squared	0.78	
F-statistic (prob)	87.63 (0)		F-statistic (prob)	81.81 (0)		F-statistic (prob)	55.76 (0)	

Source: Global Financial Database, UN, IMF, Credit Suisse

As we discussed earlier, life cycles are changing and so are consumers, savers and investors in a modern ageing and globalised world. The implications for life cycle asset allocation and consumption are complex in a multi-generation dynamically evolving world where careers, personal lives, retirement and health paradigms are undergoing radical shifts. We have discussed the impact of pensions for long-bond yields as well as for an individual's retirement savings and bequest motives. One of the biggest financial decisions for individuals, households and families is home ownership. Real estate markets have done well and investors have gained from real estate appreciation in the Western world over the last four decades. Real estate has been used by ageing retirees to help provide income/collateral when their liquid retirement savings have been strained and stretched by financial needs in a longer post-retirement phase than they had actually planned for or anticipated. In the section below, we summarise some observations related to US and global Demographics and Real estate prices.

8. Demographics and the Housing Market

The effects of demographic factors on the housing market have also been studied in past academic and policy studies. A house is the biggest asset for a typical individual or household.

Mankiw & Weil (1989)[27] found that large demographic changes induce large (and mostly predictable) changes in the demand for housing, and these fluctuations in demand appear to have a substantial impact on the price of housing in the U.S. They also concluded that the recent demographic patterns (from baby boom to baby bust) imply that housing demand will grow more slowly over the next twenty years. If the historical pattern continues, their estimates suggest that real housing prices will fall substantially. As we now see, the housing bust as suggested turned out to be a housing boom and eventual bust.

Previous Credit Suisse Research[28] also highlighted the interaction between US demographics and the real estate market. Around 1965, a critical mass of baby bulgers (born 1935 or soon after) began buying real estate to house their families. House prices, which had been falling relative to CPI inflation, began to rise in real terms.

Takats (2010)[29] showed that demographic factors affect real house prices significantly, using BIS real house price data from 22 advanced economies between 1970 and 2009. The paper showed that one percent higher real GDP per capita corresponds to around one percent higher real house prices. Similarly, one percent higher population implies around one percent higher real house prices and a one percent higher dependency ratio is associated with around 2/3 percent lower real house prices. According to the paper, ageing will lower real house prices substantially over the next forty years. The headwind is expected to be around 80 basis points per annum in the United States and much stronger in Europe and Japan.

A paper from the **US Congressional Budget Office (2008)**[30] discussed the underlying demand for new housing units (the demand that prevails when cyclical and financial conditions are normal and vacancy rates are at long-run levels). Over long periods, this underlying demand is the main factor that determines housing starts. It has five components:

- The change in the number of households (that is, occupied units) due to **population growth**;

- The trend change in the number of households due to other factors;

- The trend change in the number of vacant units for sale or rent;

- The change in the number of other vacant units, such as second homes; and

- The net scrappage (or removal) of existing units.

According to this paper, increased household formation due to population growth will cause most of the increase in the underlying demand for new housing units from 2008 to 2012.

Indeed the demand for housing is largely driven by demographics. The growth of population, the movement of people and the formation of households determine the need for housing. Urbanization also plays an important role in shaping the real estate market. In addition, the income and savings trend decides the willingness and ability to pay. For

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[27] Mankiw, N., and Weil, D., "The baby boom, the baby bust, and the housing market", Regional Science and Urban Economics 19: 235-58 (1989)

[28] Credit Suisse Research, "US Economics Digest- The Baby Bulge and Asset Markets" (2000)

[29] Takats, "Ageing and Asset Prices", BIS Working Papers No 318 (2010)

[30] Congressional Budget Office, "The Outlook for Housing Starts, 2009 to 2012" (2008)

instance, the current high unemployment in some developed countries has kept some younger households from living on their own and contributed to lower household formation rates among young adults. We also note that institutional features, such as availability of financing and requirement of down payment, also play a significant role.

US Demographics and the Housing Market

The US housing market provides a case study for analyzing the demographic drivers. For the past decades, the baby boomers (born between 1946 and 1964) have dominated housing market trends at each stage of their lives. They were, as children in the households, a part of the great wave of suburbanization. Then, as young adults, they entered the housing market for the first time and helped the house price boom in 1965-1980. Most recently, the baby boomers, as middle-aged households, traded up to bigger and better homes and helped fuel the homeownership boom of the 1990s and early 2000s. As they approach retirement age, they will once again heavily influence overall housing demand.

These demographic drivers are based on the life cycle of homeownership – households at different stages of the life cycle demand different amounts and types of houses. The homeownership patterns by age of household head in the US are shown in Exhibit 39. The ownership rate rises with age, flattens, and then falls in old age. The young and middle aged households (from age 25 to 44) are the main source of housing demand. The pattern, of course, has changed over time. The rise in homeownership rate is steeper during the late 20s and early 30s in 1982 than in 2010, and the fall starts at an earlier age in 1982 (age group 65-69) than 2010 (age group 75+).

Exhibit 39: Homeownership rates by age of household head, US

%
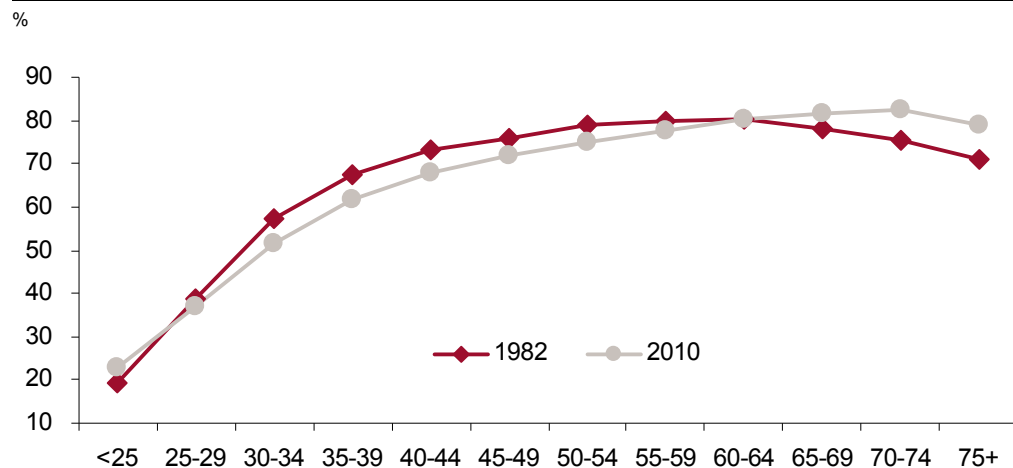
Source: US Census Bureau, Credit Suisse

Exhibit 40 further confirms the demographic impact on housing demand. The young and middle aged households are largely switching from renting to home-owning, as there are many more households switching from renting to home-owning than those switching from home-owning to renting.

The opposite is true for the households aged 75 and above and a greater number of the 75+ households are switching from home-owning to renting.

We show in Exhibit 41 that the share of population aged 30-44 and the real housing price move in similar directions in the US from 1950 to 2010. The correlation between the two series is 0.62 during the period. We use the residential investment deflator relative to the GDP deflator to represent the real housing price. The real housing price declined in the 1950s and started to rise in mid-1960s, when the share of the 30-44 aged population was rising. The housing market peaked in the early 1980s and, after a period of moderation, entered another boom in the 1990s, as the middle-aged baby boomers traded up to bigger and better homes. The housing bust of the late 2000s also closely matches the decline in the share of the population aged 30-44.

Exhibit 40: Households switching between renting and home owning, US, 2009

Number of households (in thousands) by age of household head

	Homeowners Switching to Renting	Renters Switching to Home owning
<25	102	198
25–34	401	1,367
35–44	576	978
45–54	544	766
55–64	250	479
65–74	136	160
75+	203	100
Total	2,213	4,048

Source: US Census Bureau, Credit Suisse

Exhibit 41: Real housing price & share of population aged 30-44, US

Real housing price is the residential investment deflator divided by the GDP deflator
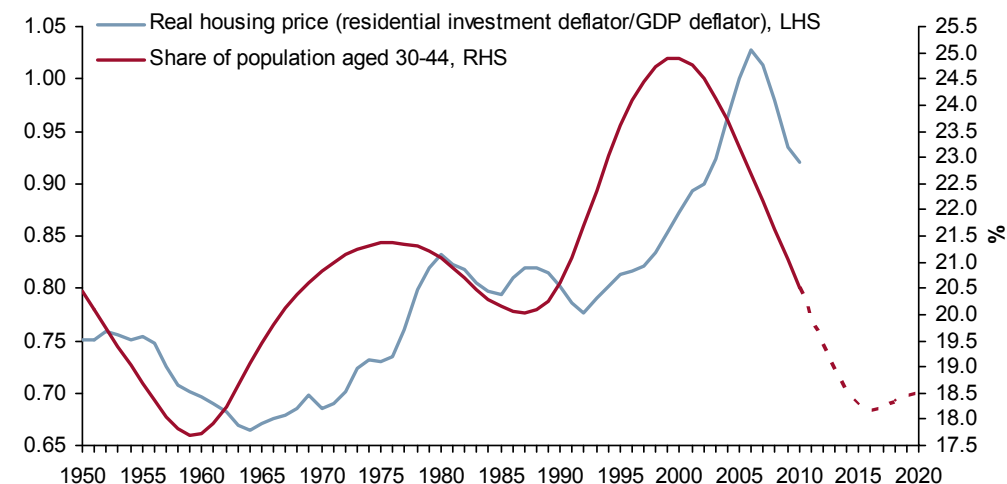
Source: Bureau of Economic Analysis, UN, Credit Suisse

We are now seeing a new generation of echo boomers (born between 1983 and 2001) entering their adulthood and becoming new buyers. In the coming decades, the ageing, retirement, relocation, and withdrawal from the housing market of the baby boomers and the entering of the echo boomers into adulthood will largely shape housing demand. But how much and how soon the demand from echo boomers will be released remain uncertain. It will depend on the employment and economic prospects of the echo boomers, many other social and demographic factors at play in household formation, and ultimately their willingness and ability to become independent homeowners.

9. Conclusions

We have reviewed the research literature for studies that linked demographic variables to asset prices. We believe that it is difficult to merely focus on age-related demographics as the defining feature of demographics; numbers of young, numbers of old and middle-aged are important, but far **more important are their preferences as consumers, savers, workers and investors in a changing world**. We also caution against using fixed age ranges used in past studies as they are neither that appropriate nor do they tell the whole story. These age ranges were derived based on stylized depictions of the Life Cycle Theory in the 1960s and 1970s.

We **study the predictability of P/E ratios for stock markets and long-bond yields** for bond markets. The results of demographic variables predicting bond-yields are strong and fairly similar across countries but predictability is strong mainly for stocks in the US case. We argue that **differences in investor and saver behaviour** across countries are caused by demographic features, differences in risk aversion, size of stock and bond markets, access to financial markets, education as well as institutional features.

Based on statistical estimations, which use demographic variables, **we forecast the P/E ratio of the S&P 500 in 2025** in the US, strongly cautioning that this will be a difficult exercise that is limited both by data availability and variable exclusion issues. A similar exercise for forecasting 10-year bond yields in 2025 indicates that they should rise towards the 4-5% range for US, France, Germany and UK but decline towards 1% for Japan, based solely on demographic variables. We also acknowledge the fact that while we accept demographics features relate to many behavioural characteristics of individuals, data limitations inhibit us from a full inclusion of "complete demographics" to assess the impact on asset prices.

We **highlight the demand side of housing,** which is related to demographics, but even there we need better data that cross-tabulate income, wealth, and savings across demographics to judiciously test the fact that demographic factors explain house prices. The supply side of housing is affected by GDP growth, GDP per capita, land, capital-labour ratios and productivity.

Finally, we have **constructed a building-block exercise** to highlight that demographic variables affect the valuation of stocks and bonds indirectly through underlying macro-variables because intuitively "consumers and workers" affect income statements and balance sheets of every company, every household and every country.

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