The London School of Economics and Political Science

Demographic Transition, Pension Schemes' Investment, and the Financial Market

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I declare that my thesis consists of 98,270 words.

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Abstract

There have been lots of theoretical and empirical debates about the impact of demographic transition on the financial market. The main economic theory that is often cited to explain the causality is the lifecycle hypothesis. Since this hypothesis suggests that a lifetime saving pattern of individuals will have an inverted U-shape profile, there is a widely concern for the 'market meltdown scenario' whereby the stock market might collapse following the retirement of baby-boomers who will begin to dissipate their accumulated wealth. However, the actual dissaving rates of retired households appear to be relatively low. Therefore, no consensus regarding the actual causality of the demographic impact on asset prices has been reached.

This thesis attempts to solve this puzzle by arguing that the strong relationship between asset prices and demographic variables observed since the 1960s may primarily result from a shift in the institutional structure of the financial market. The emergence of financial institutions, particularly pension schemes, has changed the way that the financial market operates. Instead of directly holding assets themselves, households have been using financial services provided by these institutions to manage their investments. By using a panel data from the Family Expenditure Survey, lifetime households' participation rates in occupational pension schemes and personal pension plans are shown to significantly exhibit a strong hump-shape age pattern with a peak at 35-45. Interestingly, this age group has further been proved to have a long-term significant impact on UK equity prices. After analysing DB pension schemes employed by FTSE100 firms, the long-term asset allocation of these investors appears to significantly be influenced by the age structures of their policyholders. Therefore, the insight gleaned from this thesis strongly suggests that the investment behaviour of pension schemes may represent the underlying mechanism explaining the strong correlation between asset prices and demographic patterns.

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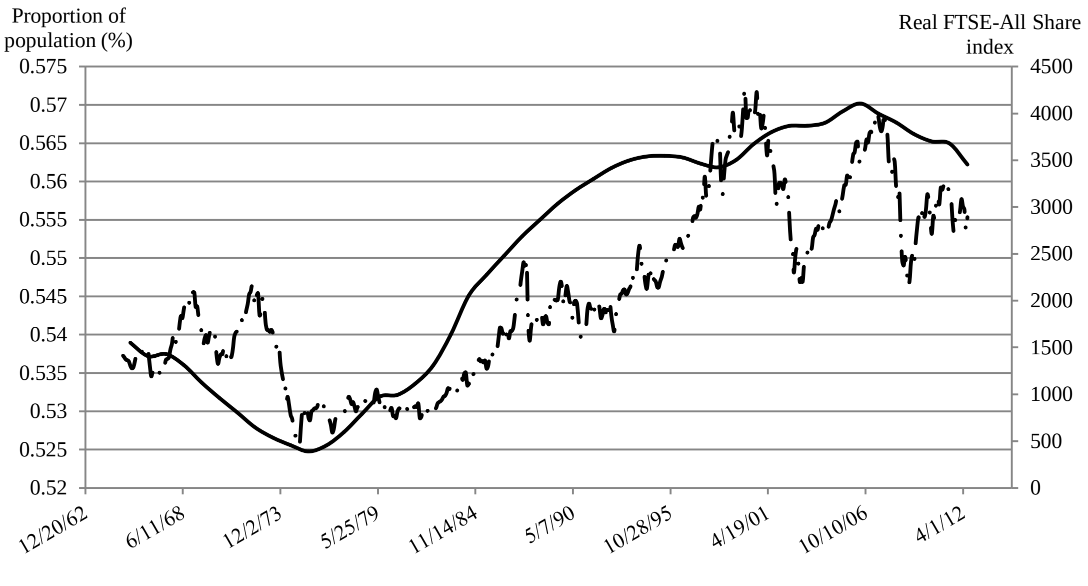
Chapter 1: Overview of the thesis

The main topic of this thesis is to investigate the underlying mechanism that explains the high correlation between the movement of demographic structures and financial asset prices over the past 50 years. As can be seen from Figure 1.1, the evolution of the proportion of adult population (20-60/65[1]) appears to have a strong positive correlation with the long-term fluctuation of real equity prices[2].

Figure 1.1 The time-series relationship between the proportion of adult population and the real FTSE-All Share index

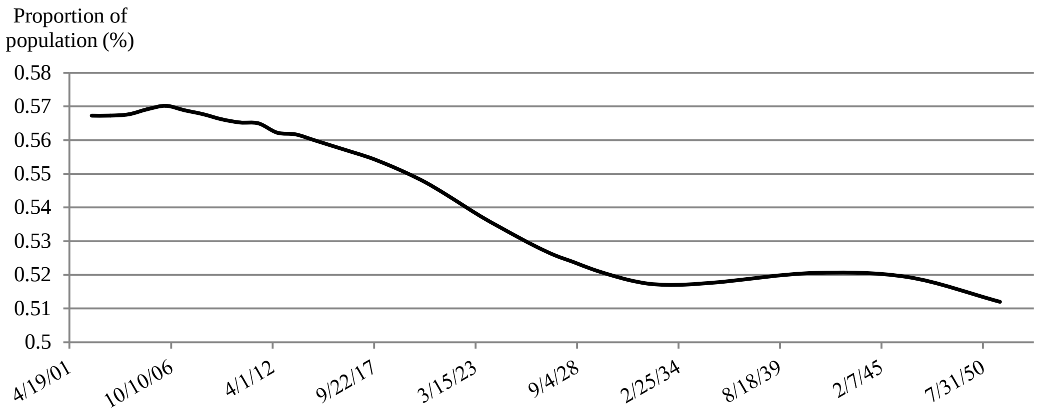


Source Global Financial Data; Office of National Statistics

[1] Retirement age is 65 for males and 60 for females
[2] Nominal equity prices are deflated by the consumer price index in order to get the real price level.

If there is a causal relationship between these two parameters, the long-term outlook of equity prices may not be bright over the next decades. This is because the proportion of adult working-age population is projected to steadily decline. The 2010-based demographic projection estimated by the Office of National Statistics (ONS) shows that the fraction of UK working-age population will decline from 57 per cent to around 50 per cent by 2050 (Figure 1.2).

Figure 1.2 Demographic projection of the proportion of adult population over the next 40 years



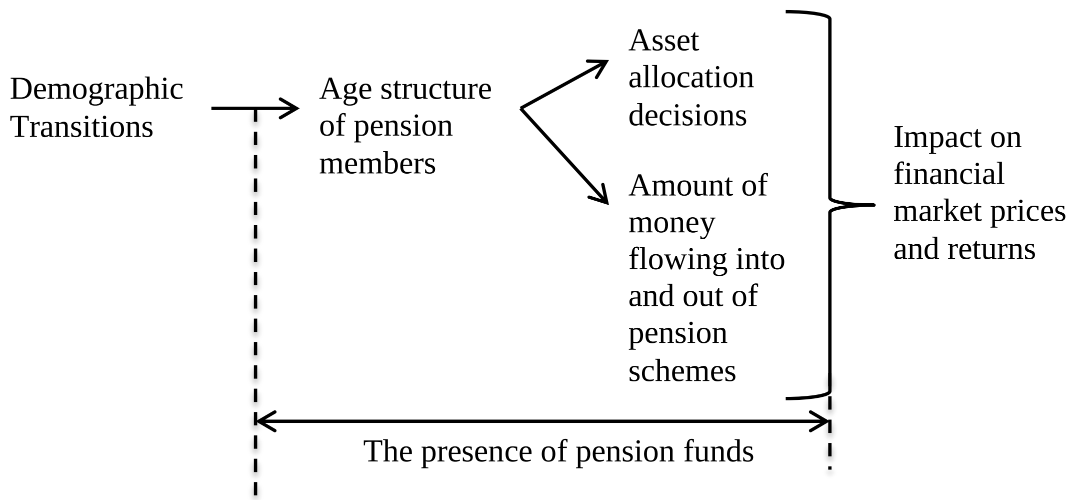
Source Office of National Statistics

Most previous literatures attempt to explain this strong relationship by arguing that the lifecycle saving behaviour of households exhibits a hump-shaped profile. Based on the lifecycle hypothesis proposed by Modigliani and Brumberg (1954), the saving rate of households is expected to reach a peak during the 45-55 years old because the real households' labour earnings tend to be highest during this age group and their saving motives may also be highest as they approach retirement. However, there are many empirical studies finding that the direct investment of households in the financial markets during the retirement period does not decline at the rates suggested by the lifecycle hypothesis. The dissaving rates of households during retirement appear to be fairly low. Therefore, no consensus regarding the actual causality between demographic transitions and the financial markets has been reached.

This thesis proposes an alternative explanation for the strong correlation between asset prices and demographic variables. The graphical analysis shown in Chapter 4 of this thesis illustrates that real asset prices and the proportion of adult population have a significantly positive correlation only after the 1960s. Prior to this period, the correlation coefficients between these two factors were insignificant. Moreover, the valuation of asset prices (as measured by the price-to-earning ratio or the price-to-dividend ratio) tends to increase significantly after the 1960s. This suggests that financial asset prices over the past 50 years have become much more expensive than the long-term historical average. Based on those observations, this thesis proposes that the strong correlation between demographic variables and financial asset prices may result from the presence of pension schemes which has grown significantly after the 1960s.

The diagram illustrated in Figure 1.3 explains how this institutional factor links the movement of demographic structures with the financial market. Demographic shifts will determine the age structure of pension members. Because households at different age groups may exhibit different saving motives through pension schemes, the amount of money flowing into and out of pension schemes will be directly affected. During the period of the high proportion of adult population, there will be substantial positive net cashflows into pension schemes. Pension fund managers will have to invest these funds in the financial market. This substantial amount of saving may create an upward pressure on asset prices leading to a situation where the equity valuation may be higher than the historical average.

Figure 1.3 Diagram illustrating the mechanism that the presence of pension schemes links the evolution of demographic variables with the movement of financial asset prices



In addition, the asset allocation of pension schemes may also significantly be influenced by the movement of the age structure of pension members. Pension schemes with the high proportion of active members, who have not yet retired, may be in a better position to invest a large proportion in risky assets in order to generate high expected returns compared to the schemes with the large fraction of retired members. This is because pension schemes with the young age structure of policyholders have longer investment horizons (as measured by the duration of their pension obligations) and the need for short-term cash outflows to support pension benefits is lower. Based on this line of reasoning, the ageing of pension members may influence the asset allocation of pension schemes by reducing the investment in risky assets such as equities and increasing the investment in safe assets such as long-term government bonds or short-term money market instruments.

This thesis will attempt to provide robust and reliable analyses to prove the proposed hypothesis shown in Figure 1.3. The outline of this thesis is as follows. Chapter 2 will provide background knowledge relevant to the types of pension provisions offered by governments and private sectors. It will also analyse the challenges posted by the population ageing which have led to the transformation of the national pension systems in most developed countries. Chapter 3 will show the evolution of demographic structures in some developed and developing countries. The comparison between developed and developing countries suggests that the problems of population ageing are severe and urgent particularly in the developed regions (Europe and North America). Chapter 4 will present graphical illustrations of the historical relationship between demographic patterns and financial variables. These observations have led to the hypothesis proposed in this thesis. However, care should be taken in asserting any strong conclusions from the graphical illustrations shown in this chapter because they only show a few trends between different variables. They do not either support or reject any causality. Therefore, three research projects designed to robustly test the proposed hypothesis are presented in Chapter 5, 6, and 7.

Chapter 5 statistically analyses the time-series relationship between a range of age groups and asset prices through the time-series regression models. The Chow test statistic is used to test whether the period during the 1960s is the structural breaking point in the time-series relationship. It will also investigate which age groups have the most statistically significant relationship with financial asset prices. Chapter 6 will present the analysis of household saving behaviour through a range of saving opportunities. To my knowledge, this is the first research which analyses household saving decisions on all available existing investment opportunities that they can choose, namely direct ownership in financial markets, investment in mutual funds, savings in occupational pension plans and private saving in personal retirement plans. The historic nature of the Family Expenditure Survey used for this research provides a rich source for an analysis of changes in household saving decisions based on the time, age, and cohort effect. After the hump-shaped age pattern of household participations in each investment opportunity has been specified, it will then be compared with the age group that exhibits the highest significant relationship with financial asset prices found previously in chapter 5 in order to prove the main hypothesis about the importance of pension schemes in the financial market. Chapter 7 attempts to analyse the investment behaviour of pension schemes. The investment decisions of DB schemes are expected to have a direct association with the age structure of their plan members because they need to manage their assets in the way that can generate sufficient returns to support their pension obligations. Therefore, greater understanding of the investment principles of demographically-sensitive financial institutions such as pension funds is necessary in order to prove that the asset allocation of these funds are the interconnecting mechanism linking the impact of demographic patterns on the financial market.

The thesis will end with discussions and policy implications in chapter 8. Because the proposed hypothesis in this thesis tends to suggest that the demand curve of financial asset prices may be downward sloping, chapter 8 will discuss a number of literature that develops theoretical models and finds empirical evidence consistent with the price pressure effect of institutional trading on asset prices. The direct fundamental impact of population ageing on the aggregate economy and the use of overlapping generation models to test the fundamental impact are also discussed. A range of policy implications that can help to mitigate the price pressure impact of pension schemes' asset allocation on asset prices will be proposed at the end of the chapter.

The main contributions that this thesis purports to make to the existing literature regarding the impact of demographic transition on the financial market are as follows. Firstly, instead of only proving a significant relationship between demographic variables and asset prices, an additional institutional mechanism linking these parameters is proposed. Secondly, by analysing the investment behaviour of pension schemes, it seeks to distinguish the relationship between demographic variables and the financial markets under the decumulation process as opposed to the accumulation process. Although there tends to be a strong association between rising asset values and the population ratio of prime working-age individuals (45-50), the question as to whether the dissaving behaviour of these cohorts will lead to a decline in asset values still remains. Thirdly, the market meltdown hypothesis will be tested. This paper will concentrate on the investment behaviour of those demographically-linked financial institutions needing to finance the large pension benefits from the retirement of baby boom generations which are expected. These large accrued benefits would represent the decumulation process of baby boom cohorts from their accumulated financial resources. Fourthly, this paper provides analysis that separates the impact of demographic transitions throughout different asset classes. The risk-return characteristics of bonds and equities may be affected by demographic transition differently, owing to the shifts in demand intensity from one asset class to another. Finally, it is hoped that this research will also provide a complete picture of household savings in the capital market, primarily by investigating the lifetime household participation in the financial market according to the variety of options currently offered. Most existing literature focuses on household investment through either their personal accounts or through unit or investment trusts. Employee occupational pensions are normally omitted from the analysis due to the unavailability of data regarding the estimation of wealth in this part of saving.

Chapter 2: The current pension crisis and the consideration of the risk and return trade-off for different pension funding systems

2.1 Introduction

Recently, there has been a prevalent concern about difficulties in ensuring adequate retirement incomes for all pensioners over the next few decades. A rise in life expectancy, a decrease in fertility rates, and the retirement of the baby boom generation are the three main factors that threaten the sustainability of the existing pension system, particularly in developed countries, where the old-age dependency ratio (the ratio of the retired to the working-age population), is projected to increase significantly over the next few years. For example, in the UK, the proportion of the population aged 65 and over is expected to increase from 20 per cent of all adult population in 2007 to 30 per cent in 2050. This demographic shift has created challenges for both employers and governments regarding the funding of existing systems. A greater awareness and consciousness of the inherent risks within pension systems, which greatly affect the distribution of wealth and risk among different economic agents, have engendered a variety of proposals on the best way to manage those risks so as to alleviate this crisis.

Alternative arrangements for pension provisions have been proposed by policy makers in order to make the national pension system sustainable both in term of preventing retirees from falling below the poverty line and in maintaining a healthy financial balance sheet for the whole nation. Proposals to reform the pension systems while maintaining the basic design of the system may take a number of factors into considerations, such as reducing pension benefits, increasing contribution rates, or raising the earliest age for full pension benefits. Other more drastic reforms include the transformation of public pension funding from unfunded defined-benefit (DB) social security arrangements to a funded defined-contribution (DC) system through the establishment of a 'National Account' or some form of privatisation. Professionally-managed funded DB occupational pension schemes have also, increasingly, been replaced by the two main schemes, namely individually-managed funded DC pension schemes and hybrid arrangements. The former transfers most of the risks from a pension-providing sponsor to individual households, whereas the latter contains features from both DB and DC pension funding schemes, the intention of which is to reduce some of the financial burdens of the sponsoring entities.

In this chapter, fundamental characteristics of the existing national pension system in both public and private sectors will be discussed in the first section. It will also demonstrate policy implementation being undertaken by most countries as an approach to tackle the pension crisis, namely that DB pension schemes have been widely replaced by funded DC pension arrangements. The second section will provide a detailed analysis on underlying risks of each type of pension schemes. Advantages and disadvantages of DB and DC pension arrangements will be examined. The chapter will end with a research proposal that will be conducted later in this paper in order to investigate whether the transformation from the DB to DC pension arrangement would be a sustainable solution to the problems posted by demographic shift.

2.2 The Existing Pension System: 3-Pillar explanation

Broadly speaking, national pension systems have a multi-pillar system, also known as the 'three-pillar system'. According to a policy report by the World Bank (1994), retirement income can be financed by a mixture of government, employer, and private pension provisions. Pension incomes from the first pillar – the government – are typically in the form of unfunded social security provisions, which are composed of the two main features: the basic universal entitlement and the earning-related component. Occupational pension schemes in the second pillar are normally funded by contributions from employers and/or employees. These schemes may be structured as either a DB plan, a DC plan or a hybrid of the two. Personal savings in the third pillar whose objective is to fund retirement benefits are usually financial products offered by the insurance industry, which may have tax-exemption components. These savings can be in the form of DC personal pensions or annuity contracts. This World Bank's perspective on the national pension systems focuses on the major objectives of social security at different levels: the first pillar as the universal safety net, the second pillar as the wage incentive for labour productivity, and the third pillar as the encouragement of capital development.

Unfortunately, looking at the national pension system in this way may blur the concept of pension funding and risk transfers. To illustrate this, albeit within the same Pillar II, there is inconsistency whereby occupational pension provisions in the public sector are normally unfunded; however, generally speaking, those in the private sector are funded. Moreover, the pension arrangements under DB schemes (presented in Pillar I, II, or III) entail risk exposure to sponsors and plan members which differ from those involved in DC plans (often presented in Pillar II or III). Last but not least, the unfunded feature of social security provisions (Pillar I) and public occupational pension plans (Pillar II) lead to the distribution of wealth and sharing of risks amongst the whole population which are dissimilar to the funded system under private occupational pension schemes (Pillar II) and private personal savings (Pillar III).

The main considerations of this chapter are those issues relating to risks arising from demographic shifts which have affected the existing pension system. In order to circumvent the potential blurring issues stemming from the three-pillar perspective mentioned above, and to explain the risk distributions of the different types of pension plans, the paper will divide the national pension systems into two categories (i.e. unfunded public pension provisions and funded private pension schemes) in discussing how society is trying to deal with the pension crisis and how the crisis has led to new developments in pension provisions. By separating the national pension system in this way, the risk-sharing elements among different sectors in the economy can be analysed more accurately and, therefore, it will be easier to describe the underlying crisis.

2.3 Trend of shifting from DB to DC schemes

2.3.1 Public pension finances

In an ageing society, the financial burdens on the public sector will eventually become intolerably high resulting from a rising dependency ratio. One of the largest components of government expenditure is the cost associated with health care services and pension benefits. The projected rise in the old-age dependency ratio over the coming years means that the labour supply will be relatively lower than the proportion of the retired population and society's demands for healthcare and pensions will profoundly be increased. This financial burden will be exacerbated if healthcare costs are constantly rising in the future. Even though a rising dependency ratio may lead to a reduction in expenditure related to young people such as a reduction in spending on policing and prisons or on education, it has often been shown that the costs of social welfare for the elderly will be significantly greater. According to the calculations by Boersch-supan and Winter (2001), French workers will have to pay nearly 38 per cent of their wages to the public pension system in 2030, rising from 24 per cent in 1995, if they desire to sustain the current replacement rate[3] at 70 per cent. The costs of the public pension system will even be larger in Germany at 41 per cent, and in Italy at 62 per cent of their total wage bills[4].

Typically, pension benefits from the traditional social security system and public occupational pension schemes are financed by income tax revenue derived from the working-age population. This type of pension structure is unfunded in the sense that there is no explicit pool of assets to generate cash flows for pension benefits. Therefore, this system is normally referred to as the Pay-As-You-Go (PAYG)

[3] The replacement ratio in Boersch-supan and Winter's (2001) calculations is defined as the ratio of pension benefits for retirees with 45 years of working experience to the average earning level of all working-age people.
[4] The substantial pension costs in Italy result from the fact that the replacement rate in the Italian public pension system is very high at more than 100 per cent.

programme. This unfunded feature implies that the social welfare system will no longer be sustainable in the midst of rising dependency ratios because the growth rates of state pension benefits will eventually outpace the growth rates of tax revenue streams. As stated by Regling and Costello (2003), more than half of the EU countries will have an obvious unsustainable path of public government expenditure. Many developed countries are currently struggling with the implementation of new policies to tackle the budget deficits posted by the population ageing.

According to the concept of social welfare enhancement, basic state pensions are designed to protect the elderly from a life below the poverty line. One of the main benefits of this unfunded system is the substantial inter-generational risk sharing and redistribution of wealth. To be specific, the risk of securing reliable pension incomes is not solely dependent on retirees' own lifetime earnings or on the returns of retirees' own lifetime savings, but would be shared by the government and people in other generations. The risk of maintaining pension benefits for the elderly is, therefore, absorbed by the entire country. This feature may be optimal in the sense that retirees are not in a position to return to the labour market. Given the generally-accepted assumption that individuals are risk-averse, those risk-sharing characteristics from the PAYG system are an important element in promoting high social welfare throughout the country. The risk-averse assumption posits that an individual should not bear risks that either cannot be diversified or which would be costly to diversify. The government and society as a whole are in a better position to absorb such risks and disperse them to appropriate economic agents who are willing to be exposed to such liabilities.

The other main benefit of the PAYG programme is the intra-generational risk sharing between different socio-economic classes of the society. Universal flat-rate pensions provide a minimum safety net for all regardless of their wealth and employment history. For low-income workers, a minimum standard of living during their retirement can be achieved despite the fact that they may experience earning shocks or possess insufficient lifetime savings. This is because flat-rate pensions provide higher replacement ratios to low-income workers than to the wealthy. The wealthy transfer some of their wealth to support pension incomes for low-income members of the society.

However, because of the risk sharing between different generations, the PAYG programme provides immediate extra benefits for generations who have already retired but made little or no contribution to the programme when it was initially implemented at the expense of those who were of working-age. In addition, the substantial inter-generational risk-sharing characteristic in the unfunded public pension finances will make the pension system more vulnerable. The extent of this vulnerability will depend on the overall demographic structures of the countries and on their economic prosperity, as driven by current working-age generations. It is projected that in the near future the proportion of the working-age population will decline relative to the proportion of pensioners. This demographic shift is the result of both the retirement of baby-boomers and an increase in the life expectancy resulting from innovative medical treatments and changes in lifestyle activities (Finch & Crimmins, 2004). Insufficient tax contribution to support accruing pension benefits is clearly a scenario that most ageing countries will face. Furthermore, it has been posited that the expected scarcity of labour combined with a rise in the average age of workers may lower productivity and limit economic growth rates (Werding, 2008; Feyrer, 2007). If the governments decide to increase payroll and income tax rates to support the increasing budgetary burdens, the level of aggregate incomes in the economy and the accumulation of physical capital will greatly be reduced (Feldstein, 1974). This reduction in real wage levels will eventually limit the growth of national productivity and GDP. If a lower than average real growth rate of GDP is experienced in the coming decades, the pension crisis will be exacerbated since existing pension benefits in most developed countries are too generous and are defined *ex ante* with the expectation that an average high historical economic growth rate can be sustained. When debt financing to support the PAYG system increases while the growth rate is falling, a serious fiscal insolvency can potentially occur as deficits built up. The larger deficits in the government's balance sheet will aggravate the problem by increasing the future costs of refinancing government debts. As a result, it is threatening to keep a generous PAYG pensions in the face of a significant rise in the dependency ratio.

Owing to the fact that population ageing does not only create substantial costs of providing pensions and healthcare services but also have a profound impact on the overall macroeconomic balances of the ageing nations, structural reforms are necessary to make the whole welfare system sustainable. Without structural reforms in the public pension finances, overall standards of living are expected to be reduced in the next decades. In an attempt to tackle the current pension crisis, policy makers in many developed countries are proposing reforms that drastically change the funding and benefits structure of the current system. Instead of merely increasing the earliest age of retirement at which full pension benefits can be received, or reducing the replacement ratio of the current generous PAYG system, governments in many European and North American countries are planning to transform the whole pension system from one which has unfunded DB characteristics to one which is a funded DC plan. Based on the macroeconomic simulation model from Boersch-supan (2000) and Boersch-supan, Heiss, Ludwig, and Winter (2003), the transitional costs of shifting from the unfunded PAYG system into the funded system may not be excessively high. A national DC pension system has been regarded as an alternative arrangement to provide adequate pension benefits and reduce the risk of the large fiscal deficits which have accrued from current DB social security and public pensions. The general funding structure of the national DC account can be summarised as follows. The payroll tax that the government previously used to finance the PAYG programme will instead be directed to a personal retirement account. In addition, compulsory or voluntary extra contributions will be made by pensioners themselves while they are in the working-age period. These contributions will accumulate over time and will earn compounded rates of returns from being invested in the financial market.

The following paragraphs will show some examples of pension policies implemented by governments in developed and developing countries to tackle the fiscal problems posted by demographic transitions. The United States and the United Kingdom are chosen to represent the situation faced by most developed countries in which the population ageing is severe and urgent. Policy makers in these developed countries tend to solve the problems by transforming the public pension systems from an unfunded PAYG system into a funded DC plan. The pension systems in Australia and New Zealand are explained because their main public pension benefits are currently based on nation-wide superannuation DC plans. Chilean pension system is discussed in order to show that retirees in most developing countries tend to receive low levels of public pension benefits. The benefits are also volatile depending on the investment returns of DC schemes. An alternative pension system implemented by Swedish government will also be explained. This new type of pension provisions is argued to provide a cost-efficient and sustainable system.

In the US, the proposal to replace part of the current PAYG public pension scheme with Personal Retirement Accounts (a plan originally proposed by the Clinton administration) is currently being vigorously debated. In 2005, during the George W. Bush administration, the President's Commission to Strengthen Social Security was established with the purpose of analysing and proposing alternative sustainable pension arrangements. It proposed that DC personal accounts should be offered and that participation would be voluntary. If an individual decided to opt into the new pension account, he or she would sacrifice some part of the benefits from the traditional Old-Age, Survivors, and Disability Insurance (OASDI).

In the UK, occupational pension plans were originally created in the 18th century, long before other European countries. The first occupational pension scheme in the public sector was established by HM Customs and Excise in 1712. East India Company and the Bank of England were among the first who offer pension schemes to their employees in 1762. These provisions occurred after the availability of actuarial tables constructed by the Equitable Life Assurance Society. The modern state pension provision in the UK began in 1948 after the enactment of the 1946 National Insurance Act. It was later modified by the 1975 Social Security Act which had led to the two main types of state pension provisions, namely, the basic state pension (BSP) and the second-tier State Earning Related Pensions (SERPs), the latter of which can be contracted out[5]. Entitlement of the BSP is based on the payment of National Insurance Contributions (NICs), while enrolment into the SERPs is automatic if employees receive labour earnings higher than the lower earning limit

[5] Contracting out can only be taken if an occupational pension scheme offers pension benefits that are above the Guaranteed Minimum Pension (GMP). This GMP is uprated annually depending on the level of inflation.

for the NICs payment. As the name suggests, pension benefits from the SERPs are related to the level of earnings within a certain band. In 1980, there were major reforms in the state pension provisions under the Thatcher Conservative Government in the following areas: increasing the age of the state pension age, reducing the replacement ratio, and indexing the state pension with the growth rate of the retail price index. Following the introduction of the 1986 Social Security Act and the 1995 Pension Act, pension benefits from the SERPs were reduced significantly. The UK national pension system has been regarded as one of the most complex among developed countries; as such, the Blair Labour Government later established the Pension Commission to analyse and propose a new pension regime which would simplify and alleviate the financial burdens of the existing system. The commission proposed a funded national account scheme in their May 2006 White Paper. This new scheme, known as the National Employment Savings Trust (NEST), has been passed by the UK parliament and will be implemented from 2012 onwards, replacing SERPs. The law makes it mandatory for all UK employees and employers to make a contribution of 4 and 3 per cent respectively of the employees' band earning to the fund. The Government will contribute a further 1 per cent in the form of tax relief. The automatic enrolment to this scheme, however, can be contracted out if there is another occupational scheme that meets the benefit tests.

In Chile, pension provisions were formerly dependent on DB state-run pension plans. In the 1950s, the plans covered only three types of employees: salaried workers, police officers and the armed forces. Even though the coverage rate was extended in the 1970s to other occupations, the Chilean pension system still suffered from financing problems and an uneven distribution of pension benefits. Therefore, in 1981, Pinochet's military government replaced this unsustainable system with new investment-based individual account plans. It is mandatory for workers to make contributions of around 10 per cent to their selected privately managed pension funds, which are governed by the Administrator of Pension Funds (APFs). On average, the annual rates of return of the plan's assets have been over 9 per cent for the last two decades[6]. In recent years, there has been a substantial consolidation among Chilean pension schemes from 21 plans in 1994 to 13 plans in 1998 and 10 plans in 2004. This successful implementation of a new pension regime has encouraged other Latin American countries, such as Argentina, Peru, Mexico and Columbia, to consider implementing DC pension plans. However, because of the large risk exposure to the stock market, Chilean pension assets experienced a significant plunge of 20 per cent in 2008 primarily due to the global financial crisis, which began in 2007.

The governments in Australia and New Zealand also offer a funded DC pension plan as the main social welfare provisions to their residents. In Australia, the state DC pension system is introduced and mandatory for all workers. Each worker is required to pay an annual contribution of around 9 per cent of their wages to the "Superannuation Guarantee". This DC scheme can only be paid out when workers are aged over 55 or 60 depending on the date of birth. Apart from this mandatory DC scheme, the Australian government also offers mean-tested pension benefits on both assets and incomes, known as the Age Pension, for all over the age of 65. This poverty benefit is fixed at a quarter of the average male' salaries for a single and 40 per cent for a couple, irrelevant of their work history. This mean-tested benefit covers approximately 80 per cent of the retired population. One main concern of the Australian Superannuation Guarantee is its relatively young structure. Generations that are expected to retire in the next 5 to 10 years tend to receive low pension benefits as a result of a short accumulation period. For example, current retirees are expected to receive pension benefits at A$68,000 whereas those in their late 50s may receive A$83,000 at retirement. In New Zealand, the government introduced a partial pre-funding of the New Zealand Superannuation fund since October 2001. The establishment of this fund with contribution levels that are assumed to meet the current pension benefits at 2001 levels is expected to decrease the costs of the existing PAYG system by around 14 per cent (Finance and Expenditure Select Committee, 2001).

[6] In general, Chilean pension plans are required to generate returns above a prescribed minimum level of 2 per cent annually. Investment returns of Chilean pension schemes are also required to fall within a profitability band at 50 per cent above and below the average annual return of the economy.

Aside from the implementation of the pure DC scheme, there is another innovative pension design that shares similar characteristics of the DC type, but which reduces the investment risk exposure of the system. This new pension system is known as a Notional Defined Contribution (NDC) pension scheme and was initially implemented in Sweden. In this scheme, a notional account is not actually invested in the financial market to earn uncertain returns but instead earns a rate that is determined annually *ex ante* by the expected movement of particular variables which reflects the financial health of the social security system. Under the NDC system in Sweden, the declared rate is the contemporaneous growth rate of the wage per worker. When plan members reach retirement, they can drawdown their accumulated account only through the purchase of an annuity contract. This scheme is considered to be advantageous compared to the traditional PAYG system in many respects. Primarily, the inherent flexibility of the NDC in defining the declared rate of return to reflect the actual internal rate of the underlying public pension system provides fiscal stability. This feature also alleviates political tension in making changes over the benefits and contribution rates under the national pension system. Last but not least, the NDC plan also has a balancing mechanism which can further reduce the growth rate of pension wealth in the event of financial stress so as to stabilize the system. There are many other countries which have implemented the NDC scheme as the first pillar of pension provisions, including Italy, Latvia, Poland and Mongolia. France and Germany are also considering proposing a new pension system that has NDC characteristics.

2.3.2 Private pension finances

The traditional PAYG public pension plan is not the only pension scheme that has proved to be unsustainable. The demographic transition from low to high dependency ratio has played a crucial role in determining the solvency of existing DB occupational plans. DB occupational pension programmes are typically in the form of final salary schemes where pension benefits are defined by a particular function involving the dollar amount of the final salary, the length of employment and the adjustment accrual rates. This can be simplified as Equation 2.1 below.

$$Benefits = accrual\_rate \times Final\_salary \times Tenure\_length \qquad (2.1)$$

The salary-related term in the equation is sometimes based on the weighted average salary of certain years rather than the final salary level. The accrual rate is normally set to be either one sixtieth or one eightieth. For instance, an annual accrual rate of 1/60 and a 40-year term of pensionable service imply that an employee would earn around two-thirds of their salary as annual pension benefits. Some companies may offer additional provisions, such as ill health benefits to those who have to leave work before pensionable age owing to ill health, 'death in service' pensions to those who die before a retirement age, and benefits to a surviving spouse for those who die after the retirement age.

According to the theoretical concept of economic wage incentive, final salary pension schemes provide incentives for employees to work hard and stay with firms until retirement. The provision of DB plans can partly reduce the problem associated with an imperfect verification of employee performances and the trustworthiness of employers in retaining their employees. For example, an investment to develop the firm specific human capital is always a problem from both of the employees' and employers' perspective. In order to make it credible for firms to pay high costs of human capital development for employees, deferred compensations in the form of DB pension provisions can largely mitigate associated agency costs. This is because pension schemes provide an incentive for employees to stay with the firm in the long-term after they have received the firm-specific training. In addition, a deferral of some compensation also reduces the risk of large losses from human capital investment. This incentive function from DB pension provisions will be more credible if employers guarantee a minimum salary level for each specific position and ensure that pension promises will not be reneged in the future by providing regular contributions to the funds which serve as collateral against pension promises.

The economic effect of occupational DB pension plans on organizational performance and workers' commitment is clearly analysed in Burkhauser and Quinn (1983) and Lazear (1983). In these models, workers are assumed to be forward looking with regards to their expected future salaries and pension income, discounting both of these components into the present value and then deciding whether to continue working or to leave (Lazear, 1986). Based on this valuation, if the marginal benefits from occupational pension plans by working one additional year are greater than the marginal costs, workers will optimally decide to stay with the firm, and vice versa. Another economic effect from the provisions of DB occupational plans is that employees will be incentivised to work hard throughout their employment tenure so as to increase their chances of promotion to higher positions as they approach retirement. The reason for this is that DB plans are back loading: the greater the salary towards the end of employment, the larger the pension income will be received. In addition, firms can use their pension schemes to control retirement behaviour of their employees. Empirical evidence on this aspect includes lower turnover rates among workers with pension-covered jobs (Gustman & Steinmeier, 1995) and sorting effects between workers with high and low pension promises (Ippolito, 1998).

Apart from this economic wage incentive, there is also a tax advantage from offering DB pension schemes. By sacrificing some labour earnings as retirement savings in the pension schemes, employees can defer tax payments on these earnings until after retirement. Even though pension benefits earned during retirement are taxed, the tax rate during the retirement period is often lower than during the working period due to a lower tax bracket.

However, these benefits cannot be achieved without costs. It appears that many large multinational firms offered generous final salary schemes as a human resource management tool without a clear understanding of the various risks inherent in this type of pension provision. There are two main significant factors in determining the sustainability of DB occupational pension plans: one is the corporate governance of the plans and the other is the understanding of their underlying risk exposures. It has been widely accepted that efficient corporate governance in the management of occupational plans is difficult to realise, largely because there are often conflicts of interests between the different parties involved in the plans. Even though the law has attempted to alleviate these conflicts by requiring that funded occupational pension schemes must be structured as separate entities and managed by a trustee body separate from other operations of the firms, the reality is that the representation of employees on a trustee board is often minor. The majority of investment decisions are typically made by the firm's chief financial executives. As a consequence, the fund might be used in a way that serves corporate needs which are in conflict to the main objectives of the pension plan. It has also been argued that the asset allocation of occupational pension funds is normally suboptimal, i.e. that it is not managed for the sole benefit of the fund members. Often, an excessive proportion of the funds are invested in the company's own stocks. Such self-investment will result in the funds lacking diversification, and with too great a dependence on the company's earning prospects. Companies may also use their own pension plans to prevent a takeover bid by another company by buying the company shares at an excessive premium. In the years that the funds generate surpluses, most companies normally choose to take contribution holidays or use those surpluses in other company's investment projects instead of preserving them for their employees to hedge against deficits in the years with poor investment performances.

In addition to the corporate governance issue described above, companies seem to underestimate the underlying risks of DB pension arrangements, giving little consideration to the risks of increased life expectancy, which considerably affects the amount of pension payments. The improvement in mortality rates over recent decades has been higher than historical official deterministic projections, meaning that companies will have higher liabilities to their employees over longer periods than they previously expected. Another risk, which between the 1980s and 2000s was regarded as minor, is the investment risk. This is due to the fact that during these periods, investment returns from equity markets increased tremendously, with the majority of occupational pension funds experiencing large surpluses during those periods. Other areas where companies have not paid close attention are interest rate and inflation rate risks. These two parameters are important in determining the present value of pension liabilities. Most companies tend to shadow their large pension liabilities by using high discount rates assumptions, which do not reflect the actual risks and returns trade-off of the fund's assets. Considering all these risks together, many companies are currently faced with large deficits on their pension balance sheets, due to an unexpected increase in the liabilities and poor asset performance returns. These large pension liabilities considerably reduce the flexibility of these firms to use their financial resources on other profitable investment projects.

Warren Buffett used a good example to illustrate the high funding costs of DB pension schemes in US firms. He noted that the cost of pension charges on the GE's balance sheet was US$570 million in 1982 accounting for around 20% of pre-tax earnings. Even though GE realized pension credits of around US$1.74 billion representing 9 per cent of pre-tax earnings in 2000, this gain was not sustainable and it can convert into large losses (with comparable sizes) when financial markets experience a sharp plunge. The costs of reducing pension deficits tend to be remarkably large. For instance, IBM had contributed around US$4 billion to its pension schemes in 2002 and General Motors (GM) had made approximately US$1.2 billion in 2003. Because of these large pension deficits, credit ratings of many multinational firms including GM, Ford, and Boeing had been downgraded by credit rating agencies. According to the Statistics from Watson Wyatt (2005), there tends to be a positive correlation between pension deficits and credit ratings of firms in the Fortune1000 during 2002-2004.

These large DB pension costs are not limited only in US firms. Many UK listed firms are also hit hard by the costs of their DB pension provisions. For example, according to British Telecom's annual report 2012, it had to make extra contributions to its DB schemes at a total of almost £5 billion (between 2008 and 2012) in order to reduce funding deficits. In 2005, ICI stated in its annual report that if mortality assumptions were adjusted to comply with the current improvement in mortality rates, pension deficits of £470 million reported in the financial statement could be further increased by up to £250 million. Based on the finding of The Financial Times (2008), 99 per cent of UK pension schemes use mortality assumptions that were lower than the actual estimate. This statistic indicates that the actual amount of pension deficits incurred by many UK firms will be larger than the reported numbers in the company financial statements. These significantly unexpected costs of pension provision are also considered as one of the main reasons that obstruct some takeover or M&A deals in the UK. O'Brien, Woods and Billings

(2009) note that a takeover deal of £940 million by Permira, the private equity group, on W.H. Smith failed in 2004 because Permira did not agree to pay extra contributions to W.H. Smith's pension schemes to reduce £190 million funding deficits. Examples of some other European companies that have to make substantial contributions to their DB schemes include Rabobank in the Netherlands at €1.2 billion and Siemens in Germany at €2.6 billion during 2001-2003.

In theory, sponsoring firms should not incur large unexpected costs from pension schemes because when a new employee join the schemes, the firms can estimate the expected present value of contributions and choose appropriate contribution rates such that this expected value can be equal to the expected present value of pension benefits (Bulow & Scholes, 1983). However, the key variables for these calculations are the assumptions about expected returns and discount rates. Therefore, recent large unexpected pension costs have mostly resulted from the fact that actual returns and discount rates have largely been deviated from the previous assumptions used in the theoretical models. For example, current expected equity returns and risk-free interest rates have been substantially lower than equity returns and interest rates observed during the 1980s. Because the absolute dollar amount of pension assets and liabilities is relatively large, a slight variation in underlying asset returns can lead to significant changes in the costs of pensions to a company. For example, the European Federation for Retirement Provisions (EFRP) estimates that, for a fully funded pension scheme with a mature liability, a 1 per cent increase in asset returns could potentially lower the costs of pension obligations to a sponsoring company by 2 to 3 per cent (Davis, 2000).

Apart from these unexpected substantial financial burdens from the provisions of DB pension schemes, there are some other factors that encourage companies to replace DB schemes with DC pension plans. Those factors include the changing nature of workforce mobility and the changing framework of pension regulations and accounting. The structural shift in the labour market that moves toward the increasing need for workforce mobility tends to encourage employees to prefer personal DC pension plans because they can easily transfer these plans from one employer to another without incurring large penalty costs. Principally, pension benefits of traditional DB schemes are back loaded and not easily portable to a new employer. This implies that employees who change job during the earlier period of their employment tenure normally receive extremely low vested benefits from DB schemes. For instance, Blake (2003a) shows that a typical UK worker would suffer accrual losses from DB schemes at approximately 25 to 30 per cent of the full pension benefit if he changes jobs around 6 times during his working lifetime. These accrual losses may be lower for employees who are members of multi-employer DB plans. Aaronson and Coronado (2005) also present evidence that the workforce mobility is statistically and economically contributing to the shift from DB to DC plans from observations that cover 40 industries in the US during 1979-1988. Because of the large penalty costs in DB schemes, employees who are expected to change jobs very often may perceive the value of one dollar from DB pensions lower than the value of one dollar from current wages even though there is a tax privilege from pension benefits. This employee perception indicates that DB pension schemes may cost sponsoring firms relatively higher than the ability of firms to reap benefits from an incentive effect of DB pension provisions.

The more transparency of accounting methods and pension regulatory environment has also raised the accounting costs of DB pension schemes. In the case of the UK pension industry, Davis (2004a) noted that the regulatory burden on pension provisions has increased steadily since the introduction of the 1986 Social Security Act. This has led to the gradual closures of occupational DB plans in the UK since then. These regulatory changes include the implementation of the Minimum Funding Rule (MFR)[7] in 2000, the requirement to index pension benefits with inflation, the greater transparency in the calculation of pension funding levels after the establishment of Pension Protection Fund[8], and the removal of tax exemptions on dividends. The use of market-based accounting also increases the volatility of reported pension costs in the company financial statement which is not preferable

[7] The Minimum Funding Requirement (MFR) was legislated in the UK as part of the Pension Act 1995. This legislation defined the minimum value of pension assets that DB pension schemes have to hold so as to guarantee the payments of pension benefits. The MFR was later replaced by the “new statutory funding objective” legislated in the Pension Act 2004.

[8] Pension Protection Fund, established by the Pension Act 2004, is a fund that protects pension benefits of members in insolvent DB pension schemes. When eligible pension schemes are insolvent or have insufficient assets to cover pension benefits, Pension Protection Fund will pay compensations to members of these funds.

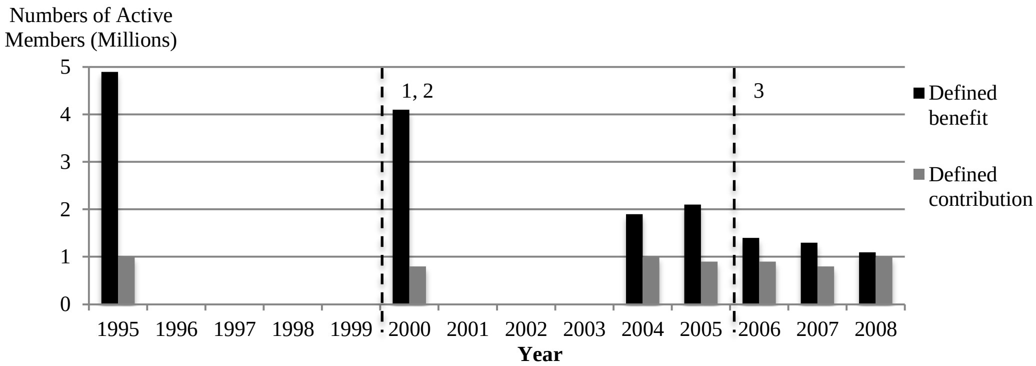
from the perspective of shareholders. Since the implementation of FRS17[9] during 2003, UK firms have begun to recognize larger on-going costs of DB pension provisions. This factor has accelerated the closures of DB plans among UK firms recently. This shift away from DB schemes of UK firms is an attempt to reduce exposures to any accounting risks associated with DB pension obligations. This impact from the fair-value accounting on the provisions of DB occupational plans can also be seen in the US, Japan and some European countries. The proposed changes of pension accounting standards in 2011 that will not allow an amortization of the realization of actuarial gains/losses[10] will amplify the volatility of pension accounting costs in the financial statements. Generally, the greater the earning volatility is, the higher likelihood the rating agency will lower credit ratings of firms with an ageing workforce. This additional pressure from the rating impact on pension funding levels appears to encourage firms to replace their DB schemes with DC or hybrid plans.

Owing to the financial burden of DB occupational schemes and the increasing costs of pension regulations and accounting, many firms have begun to close or freeze[11] their final salary schemes to new employees since the 1990s. Increasingly, firms have been introducing DC pension plans over the last decade in order to reduce the costs of pension provisions. Examples from the occupational pension provisions in the UK will illustrate this point. As Figure 2.1 indicates, the number of active members of open DB occupational plans decreased from nearly 5 million in 1995 to almost 1 million in 2008. This was in contrast to the increase in the proportion of active members in closed DB plans from 500,000 in 2000 to around 1.6 million from 2004 onwards (Figure 2.2). These statistics show that, over time, DB plans have been closing. New employees are often not provided with this type of pension. The increasing shift toward DC plans is not limited to only small employers. Watson Wyatt (2005) shows that 81 per cent of companies in the FTSE100 has already

[9] FRS17 is the UK accounting standard that specifies the accounting treatment of occupational pension schemes.
[10] Actuarial gains/losses are gains or losses that arise from the differences between the actuarial assumptions and the actual realization.
[11] A freeze of DB schemes can be classified into three levels. A hard freeze refers to a full termination of all additional accrued benefits from an increase in future salary or in the length of tenure for all plan members. A soft freeze often involves some limits, but not all, of additional accrued benefits. A partial freeze is the freeze of pension plans only to some groups of employees.

introduced DC plans to their employees. Lane Clark and Peacock (2006) also find that nearly half of the FTSE100 firms have been closing their DB plans to new members. Although there is no upward or downward trend for the numbers of active members in DC plans as seen in Figure 2.1, other recent statistics have shown that the proportion of new employees enrolled in DC plans is higher than in DB plans.

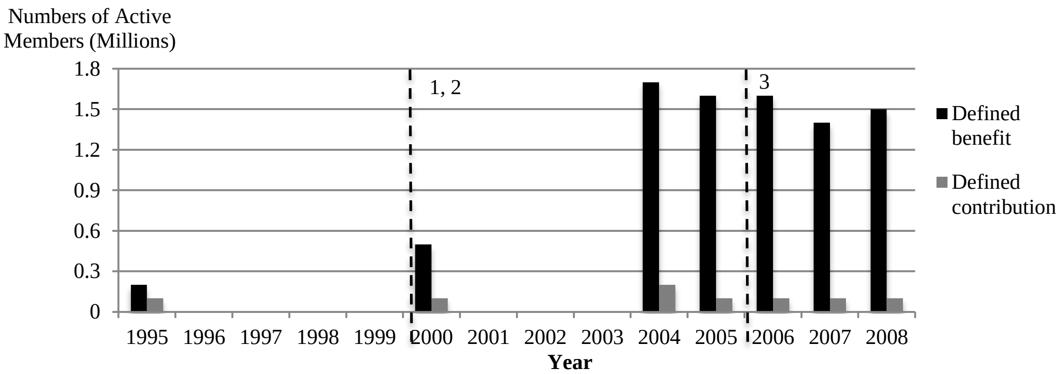
Figure 2.1 Numbers of active members in open occupational pension plans from 1995 to 2008



1 From 2000, some pension plans has been reclassified from public to private sectors because of changes in plan definitions
2 The survey does not include hybrid plans during 1995-2000.
3 The methodological procedure of the survey has some changes from 2005 onwards.

Source: 2008 Occupational Pension Scheme Survey, ONS

Figure 2.2 Numbers of active members in closed occupational pension plans from 1995 to 2008



1 From 2000, some pension plans has been reclassified from public to private sectors because of changes in plan definitions
2 The survey does not include hybrid plans during 1995-2000.
3 The methodological procedure of the survey has some changes from 2005 onwards.

Source: 2008 Occupational Pension Scheme Survey, ONS

Based on the auto-enrolment practice, the proportion of all new employees auto-enrolling in DC occupational plans increased from 8 per cent in 2005 to 18 per cent in 2008, while the proportion of auto-enrolment in DB plans declined from 40 per cent to 34 per cent during the same period (Table 2.1). The statistics from the Occupational Pension Scheme Survey (OPSS) also show that the proportion of new employees entering open DB plans was around 40 per cent while the proportion of new employees entering DC plans was approximately 50 per cent in 2008. A survey by the NAPF (2005a) also documents that common pension provisions in the private sector has now been DC pension plans. It shows that the proportion of employers offering a money purchase plan and a stakeholder plan has been increased to around 62 per cent and 24 per cent respectively.

Table 2.1 Proportions of new members auto-enrolling into occupational pension plans

% Percentage

Year	DB occupational plans			DC occupational plans			Total		
	All	Some	None	All	Some	None	All	Some	None
1995							43	7	50
2000[1]							43	14	43
2004	32	20	16	9	2	21	41	22	37
2005[2]	40	11	23	8	1	17	48	12	40
2006	40	4	19	10	3	25	50	7	44
2007	35	10	18	16	2	19	51	12	37
2008	34	3	18	18	1	25	52	4	43

1 From 2000, some pension plans has been reclassified from public to private sectors because of changes in plan definitions
2 The methodological procedure of the survey has some changes from 2005 onwards.

Source: Author's calculation based on the 2008 Occupational Pension Scheme Survey, ONS

However, the shift from DB occupational plans to DC plans does not imply that the proportion of employees with pension provisions in the labour market is constant over time. In fact, the coverage rate (the ratio of active members in occupational pension plans to the total number of employees in the labour market) indicates that there is a decline in private occupational pension provisions. As demonstrated in Table 2.2, the coverage rate of private pension schemes decreased from 30 per cent in 1995 to 15 per cent in 2008. Although there was a strong gradual increase of the coverage rates in public pension schemes, this increase is less than the absolute decline in private pension coverage rates, meaning that the overall coverage rate has declined over the past 20 years from approximately 40 per cent in 1995 to 30 per cent in 2008.

Table 2.2 Pension coverage rates between public and private sectors

Year	Employment (Millions)			Active members (Millions)		Coverage rate (%)		
	Total	Public sector	Private sector	Public sector	Private sector	Total	Public sector	Private sector
1995	25.8	5.4	20.4	4.1	6.2	39.94	76.43	30.35
2000[1]	27.5	5.3	22.2	4.4	5.7	36.69	82.82	25.66
2004	28.4	5.8	22.6	5.0	4.8	34.48	86.23	21.21
2005[2]	28.8	5.9	22.9	-	4.7	-	-	20.51
2006	29.0	5.8	23.2	5.1	4.0	31.34	87.39	17.24
2007	29.2	5.8	23.4	5.2	3.6	30.13	89.93	15.37
2008	29.5	5.8	23.7	5.4	3.6	30.51	93.38	15.18

1 From 2000, some pension plans has been reclassified from public to private sectors because of changes in plan definitions
2 The methodological procedure of the survey has some changes from 2005 onwards.

Source: Author's calculation based on the 2008 Occupational Pension Scheme Survey and Public Sector Employment statistics

This trend of the shift away from DB schemes is not only limited in the UK. Ippolito (1985) documented that the percentage of US workers which are covered by DB pension schemes declined from more than 75 per cent to only 59 per cent. This statistic was derived from the US Department of Labour. When classifying workers between public and private sectors, the coverage rate of DB plans was only 32 per cent for full-time workers in the private sector compared to 90 per cent of those in the public sectors.

2.4 Consideration of the risk and return trade-off for different pension funding systems

As shown previously, there has been a continuing trend of transformation from DB pension provisions to DC pension arrangements over the past decades. The chief factor that induces this transformation in both public unfunded provisions and private occupational funded pensions is concern over the inherent risks involved in the DB-type system. The sustainability of the DB pension scheme largely depends on a movement of various financial and demographic variables. The main risk exposure for DB pensions are inflation rates, interest rates and investment returns as well as demographic transitional risks such as mortality and fertility rates. Under the DB system, pension incomes for each pensioner are defined by a particular function, to which a sponsor of the DB system will have to be legally obliged. Therefore, the stream of cash outflow of pension incomes can be considered as liability payments, similar to fixed-income securities. Although this liability might appear to be known in advance from the defined function of the plans, in fact its present value cannot be calculated with certainty. Apart from the known amount of pension payment streams, the actuarially fair value of DB liability requires an estimation of future expected inflation rates, interest rates and mortality rates of the beneficiaries. All these related variables cannot be accurately estimated, especially for the distant future. A movement of these parameters in an unfavourable direction implies that the sponsor may not have sufficient assets to fund the pension provisions. For a funded system where there are explicit investment assets to fund the payments, there is an additional risk that a sponsoring party will have to consider, namely the investment risk. The asset allocation of pension funds is, therefore, a crucial decision in determining the solvency status of the funds. The returns from investments not only have to be maximised at the minimum risk, but they must also be sufficiently high to meet the obligation payments. The next section will discuss the underlying risks and benefits of DC accounts and DB pension schemes.

2.4.1 Main advantages of DC pension plans over DB pension schemes

By offering DC-type schemes, a sponsoring entity – governments or companies – can transfer all these risks to plan members. If the investment in the DC scheme is restricted to only the risk-free asset and there is no lifetime wage insurance in the social security DB system, an individual will be equally drawn to both systems. Nevertheless, the DC scheme will be preferred if investment can be made in risky assets which can earn risk premiums that are assumed to be greater than the internal rate of return under the PAYG or DB occupational scheme. Moreover, extra funds raised by a shift to a funded system can be invested internationally for higher investment returns. This international investment provides greater benefits of international diversification (Brennan & Cao, 1997; Kang & Stulz, 1997) and a positive impact on the real economy from international capital flows (Helpman, 1998; Obstfeld, Rogoff and Wren-Lewis. 1996). Aside from the risk transfer consideration, there are other potential advantages to shifting the regime from the DB arrangement pension scheme to the investment-based DC account.

Firstly, it is accepted that the DC plan is inherently self-sustaining with no solvency risk, owing to the fact that promised pension benefits depend on the accumulated value of the account; as such, the benefits cannot exceed the available financial resources. Secondly, the DC plan tends to be exposed to fewer political risks arising from the government intervening in the value of pension benefits. This intervention gives less credibility to future promised pensions under the traditional PAYG system, especially in a period of expected large fiscal deficits. Not only that the PAYG system may be less credible from the viewpoint of plan members, the political risks in the PAYG system also give rise to a slow response to the shift in the solvency status of the unfunded liabilities because the adjustments of the parameters in the PAYG system require a long process of legislation. Valdes-Prieto (2005) calls this political risk as the implicit fiscal liability[12].

Thirdly, saving through individual accounts provides greater transparency and makes individuals more responsible towards their own retirement saving. Compared to the DC plan, fund surpluses under the traditional PAYG (or DB occupational) system may be dissipated to support other non-social security deficits (or other corporate activities), which can lead to a low level of real saving for the intended uses as retirement resources. More awareness of personal retirement savings would also increase labour force participation rates. It has often been argued that generous public pension systems in some European countries provide an incentive for working people to leave the labour market (Gruber & Wise, 1999; Schnabel, 1998). Fourthly, corporate governance problems in the management of DB occupational plans can be alleviated by the implementation of the DC scheme. Under the DC principle, employees have more discretion to manage their pension plans in terms of asset allocation. Investment options of DC plans can be typically tailored to suit different risk appetites of the plan members, thereby allowing highly risk-tolerant individuals the opportunity to invest a large proportion of their account in a volatile equity market.

[12] In order to reduce this political risk, Valdes-Prieto (2005) suggests that the PAYG system should hold a Covered Wage Bill, a new financial instrument written by the government. The notional value and coupon payments of this bond are identified from expected implicit tax on future generations to finance pension benefits of current retirees.

Finally, Wilcox (2009) argues that the increasing trend of DC plan provisions in both the public social security and private occupational sector may reduce the price of risk and increase the efficiency of capital formation. Financial costs of equity and debt financing of companies will be reduced. This consequence stems from the fact that DC plans will generate higher participation rates of households in the financial market. Since a low aggregate price of risk implies that risky investment projects are more likely to be undertaken by entrepreneurs and companies, the DC regime may create beneficial repercussions on the national economic growth rate. Growth rates in outputs as a result of the productive capital formation will also have a positive feedback on saving rates. Although there may be a substitution effect from bank deposits to savings in a funded pension system leaving the aggregate size of savings unchanged, Boersch-Supan and Winer (2001) argue that this displacement in saving may provide greater benefits by improving the capital market structure, increasing the efficiency of resource allocation and promoting better corporate governance[13]. An increase in liquidity in the financial market as a result of the shift from the PAYG programme into a nation-wide DC plan may also reduce the volatility of asset prices[14].

2.4.2 Main disadvantages of DC plans compared to DB schemes

Even though such consideration of the investment aspect may serve to promote the benefits of DC type pensions, it is not possible to assert that pensioners will all be better-off if the national pension system is structured with DC type funding at every level of the pillar system. Other issues, which need to be considered, include the fact that the considerable investment risk exposure of individuals may not be optimal, especially for those investment funds that are designed to support incomes in retirement. In addition, pensioners may outlive their accumulated funds from the DC account if there is no mechanism to control how the funds will be withdrawn. The

[13] Boersch-Supan and Winter (2001) support their argument by showing that countries with predominant PAYG systems such as Germany, France and Spain have lower market capitalization and GDP growth rates compared to the countries with predominant funded systems such as the Netherlands, the UK and the US.

[14] Davis and Steil (2001) show evidence that greater investment activities from institutional investors can largely dampen the swing in stock prices.

likelihood of outliving financial resources is high, particularly in the case of high and unexpected improvements in future mortality rates. If DC plan members seek to hedge against this mortality risk, they will face a higher cost of annuity contracts compared to a lower cost of longevity hedging in DB schemes. As shown in Horneff, Maurer, Mitchell and Stamos (2007), annuity contracts offered by life insurance companies will be attractive only to those individuals with a very high degree of risk aversions and those with no bequest motives. Because of the existence of adverse selections and moral hazard problems, insurance companies cannot offer annuity contracts in a cost-efficient way. Additionally, the annuity market does not even exist or is still in the early process of development in a few OECD countries, though with the exception of the US and UK annuity market[15].

Furthermore, there are several corresponding drawbacks from the implementation of the DC scheme, especially as first-pillar social security provisions. Under the DC plan, the progressivity of pension benefits as an insurance against lifetime earning shocks is diminished, a problem specifically for low-income earners who receive a higher replacement ratio than high-income workers under the current PAYG system. Additionally, the inter-generational risk sharing to smooth wealth and consumption among different generations is eliminated because pension benefits for each individual depend on their own lifetime contributions. Owing to the fact that low-income workers appear to experience greater risks of unemployment, the accumulated funds of these individuals will be both more uncertain and lower than those of high-income workers. This situation is not optimal for the overall social welfare enhancement. In discussing these issues, Geanakoplos and Zeldes (2008) propose “Progressive Personal Accounts” which can promote both inter- and intra-generational risk sharing of lifetime incomes. Based on their system, accounts will be invested in an innovative derivative security, known as a personal annuitized average wage security (PAAW), which provides an individual with inflation-protected cash flows, as a life annuity, proportional to the national average labour wage in the retirement year of the individual.

[15] The UK annuity market has been being developed rapidly because of the regulation on compulsory annuitization of personal pension plans when individuals reach 75 years old.

2.5 Investment risks and the shift in demographic patterns

The main shortcoming of the investment-based DC account is the substantial risk exposures that pension plan members have to bear individually. As noted above, risk transfer is the main motivation for the developing trend towards DC pension provisions. While this risk transfer is beneficial for the solvency of a sponsoring entity in providing pension benefits, it may not be optimal for individuals to take such high-risk exposures with a plan whose purpose is to provide adequate financial resources in retirement. Ideally, the purpose of retirement planning is to secure a standard of living by smoothing consumption and to insure against the risk of outliving financial resources. These two crucial requirements cannot be achieved via a 'pure' DC plan because of two main risk exposures, namely, the investment risk and the longevity risk. In the case of a DB pension system, investment risks are absorbed by the sponsoring entity, who have obligations towards their pension promises no matter how poor the performance of pension assets. The longevity risk is insured under the normal term of pension payments in the DB system, that is, periodical pension payments are guaranteed to be paid until the death of pensioners. These two prevailing risks exposed by the plan members of DC schemes may significantly have an impact on their welfare after retirement.

This chapter will mainly focus on the investment risk that DC plan members may have to face in the midst of changing demographic patterns over the next decades. As discussed in the previous sections, the main underlying cause of the motivation to transfer most of the pension risks from sponsoring entities to individuals is the sharp rise in old-age dependency ratios over the next twenty years, which creates substantial financial burdens on both funded and unfunded traditional DB pension arrangements. The shift away from unsustainable DB pension schemes into personal DC plans may appear to solve the insolvency problem posted by demographic transitions at the first glance. However, if the shift in demographic patterns actually has some impacts on the financial market, i.e. by changing price levels and expected returns of financial assets in the next ten years or so, DC plan members may not earn sufficient investment returns from their investment-based pension accounts. This suggests that the transition from the DB system into the funded DC plan may still not guarantee adequate retirement incomes for the next generations. Even though actuarial mathematics have long attempted to incorporate the dynamic of demographic structures in the calculation of demographically-related liabilities, the understanding of how demographic transitions will have a direct effect on asset prices is less clear. The following section will explain how the investment risk may negatively affect the adequacy of DC pension benefits. It will also attempt to outline the critical aspects of the impacts, and propose a potential underlying causality that links the dynamic of demographic transitions with the movement of financial markets.

2.5.1 Investment risk exposures of DC pension plans

Instead of specifying promised pension benefits (as with DB schemes) the value of accumulated retirement resources under DC schemes is unknown in advance. Pension benefits can be of any value, based on the investment performance over time of the DC account. The uncertainty of investment returns can be detrimental to the value of pension wealth, thereby threatening pensioner welfare. Even though the DC scheme is self-sustaining and free from solvency risk, pensioners may end up with an inadequate retirement income, which may harm their consumption in retirement. If, in the year of retirement, the financial market is in a deep downtrend due to an unexpected economic crisis, the value of an individual's pension pot may be extremely low. Moreover, during a financial crisis, the likelihood of one's employment being terminated is high, meaning that the risk of pensioners not having sufficient funds to finance their retirement living will increase. Population aging is also argued to have a profound impact on inflation rates. An increase in expected inflation is a result of greater demands for goods and services by the retirement of baby-boomers. If central banks accommodate these demands, inflation rates will be pushed even higher. This implies that investment returns from pension schemes is a crucial element in determining the purchasing power of the next generation (Barr, 2002). Although Samwick and Skinner (2004) conclude that retirement benefits from 401(k) accounts are superior to DB occupational plans, based on the understanding that DB occupational plans suffer from a considerable earning risk which may be more severe than uncorrelated market returns, their results may be invalid because of an underestimation of the fat-tail riskiness of market returns. Moreover, their analysis is based on market movements between 1983 and 2001 which is the period, claimed by many scholars, of too high-unwarranted equity returns[16].

Several pieces of research have tried to propose solutions which might reduce the investment risks of the DC pension system. Feldstein and Ranguelova (2001) suggest the investment of a zero-cost collar strategy incorporated in the DC account. This investment strategy includes the use of derivative option instruments, meaning that individuals can hedge the value of their DC pension benefits by purchasing a ‘put’ option which guarantees a minimum level of pension. The cost of this put option is financed by selling a ‘call’ option which caps the maximum value of pension benefits from the traditional DB social security system. The consequence of this investment strategy is that the combined benefits of the additional DC personal account and the reduced-benefit traditional PAYG schemes can be guaranteed to be at least equal to the promised benefits of the full PAYG system.

Additionally, Feldstein (2005) shows that investment risks can be reduced by the incorporation of Treasury Inflation Protected Securities (TIPS) into the asset allocation. The risk-return of this financial instrument can reduce the overall risk of the funds, although with a higher proportion invested in the equity market. Samwick (2009) recommends an alternative approach to reduce the investment risk of the DC scheme, namely to increase the progressivity of basic social security provisions. The high progressivity of the PAYG benefits implies that there will be higher wealth transfer from the wealthy to the poor. In other words, part of the investment risk of low-income members of the society in the DC account is absorbed by the government and wealthier members of the society. Therefore, the optimal investment allocation of DC accounts can consist of a higher allocation on the equity investment, and the expected average returns from the DC account can be increased.

[16] Mehra and Presscott (1985) suggest that the equity returns in excess of the risk-free rate should be no more than half a percentage point compared to the actual value of six. Therefore, the actual risk premium and the price of systematic risk are much larger than the value suggested by the rational optimization assumptions of individual investors and the efficient market hypothesis. The cost of volatility in prices of risky securities or economic fluctuation is substantially high in magnitude, which is not consistent with the standard C-CAPM model (Campbell & Cochrane, 1999). In addition, the equity premium puzzle is further extended into another puzzle known as the risk-free rates puzzle (Weil, 1992).

The other strand of the literature which attempts to understand the investment risks of personal retirement funds uses mathematical derivations based on particular utility functions of risk-averse agents. The purpose of these derivations is to identify the optimal solution for lifetime portfolio asset allocations, such that the terminal value of DC account can reach an appropriate level. Based on the dynamic models of Campbell and Viceira (2002), which presumes a power utility function incorporating specific stochastic labour income shocks, a household's equity exposure would have to be reduced as the individuals age. Their results are consistent with Cocco, Gomes and Maenhout (2005)'s model, which incorporates non-tradable labour income profiles with borrowing constraints. Shiller (2005) simulates portfolio wealth at the retirement date for different lifecycle portfolios, finding that the probability of negative terminal pension wealth is high at around 30 to 70 per cent, depending on the assumptions which inform future expected investment returns. Poterba, Rauh, Venti and Wise (2005; 2006) incorporate utility functions to estimate certainty equivalent wealth for different lifecycle portfolios. They find that the optimal strategy largely depends on the assumptions about expected returns, risk aversion coefficients, other wealth outside the DC accounts and the investment fees pertaining to different strategies.

2.5.2 A proposed hypothesis explaining the linkage between demographic transitions and the financial market

Rather than focussing on the various strategies which attempt to mitigate the investment risks in the DC scheme as discussed above, this paper concentrates on another aspect of investment risk which can threaten the sustainability of the DC scheme. Volatility, or the uncertainties in market returns, is not the only determinant of terminal portfolio wealth. Since the DC plan's investment strategy has a long horizon (around 40 years), even a small variation in the average levels of future expected returns among different financial asset classes could lead to a significant variation in the dollar value of the terminal pension wealth. For example, a decline of just 50 basis points annually in the rate of returns on investment portfolio could lead to a decline of around 17 per cent of the terminal wealth over a 40-year investment horizon. Although the relative percentage effect will be lower if the benchmark equilibrium return is high, the absolute effect in term of money value will still be large. This example indicates that a tiny change in expected investment returns can substantially affect the welfare of DC plan members after retirement.

The main concern is that if there are any structural transformations in the society which affect economic activities, the future risk-return characteristics of financial assets may behave quite differently than in the past. Periods of high equity returns during the 1990s and 2000s might not be the norm in the 21st century. It is dangerous for any model or analysis to assume a historical perspective for risks and return distributions in simulating projected outcomes in the future, especially if they are used to inform policy implications. One such potential factor that may have an impact on the future risk-return characteristics of financial assets is the dynamic of demographic structures.

Demographic transitions are widely accepted to have an effect on aggregate economic activities throughout the nation as a whole. Modigliani and Brumberg (1954) propose the lifecycle hypothesis, a hypothesis which determines an individual's consumptions and saving decisions based on their age and lifetime income. According to this hypothesis, the economic growth rates and national saving rates depend considerably on the dynamic of demographic patterns. This hypothesis suggests that the investment and consumption behaviour of economic agents at each age group will be different. It is argued that one's individual lifetime can be divided into three stages: childhood, working-age and retired. At the childhood stage, young people are assumed to have no earnings, financing their consumption by borrowing from their parents and developing skills and knowledge through education. Once they reach the working-age stage, they have to use their human capital to earn labour income. Based on the uncertainty of future labour income, working-age people have to make optimal decisions regarding their current consumption and savings. Their savings will earn expected market returns, which will be used to finance future consumptions. At the retired stage, retirees are assumed to have no labour income. They finance their consumption through the accumulated financial resources from their savings in the working-age stage. Upon death, the amount of retirees' wealth inherited by their heirs depends on their bequest motives or precautionary savings. As such, demographic dynamics that change the proportion of the elderly relative to the young may significantly affect aggregate levels of consumptions and savings.

This hypothesis also implies that the cyclical fertility rates over time may translate into the cyclical variation in financial asset prices and risk premiums in the financial market. The high saving demands of households that we have observed over the past decades are a result of baby-boomers' desire to save for retirement at the time of peak in their labour incomes. A sharp rise in equity prices during the 1990s has been argued by many researchers that it may arise from the high saving demands of baby-boomers when they reached their prime earning years (Dent, 1994; Sterling & Waite, 1999; Shiller, 2000). In a similar vein, the expected sharp rise in the dependency ratio over the next twenty years may lead to a situation where there is high consumption and dissaving by the elderly. The decumulation of their accumulated financial resources would generate a downward pressure on the price of assets. This downward pressure will be significant if there is insufficient demand to purchase the assets of retirees. As a consequence, the size of the working-age population of the next generation will be a significant factor that determines the extent to which the capital supply of retirees can be absorbed in the financial market.

In addition, with the assumption that total financial capital is fixed, the price pressure effect from the supply of capital by retired populations will be amplified. This will lead to a significant decline in asset prices and returns. If the assumption of fixed capital is relaxed, the variation in the total amount of capital to balance the rise and fall in demands still cannot be done costlessly (Neuberger, 1999). This implies that asset prices may still be significantly affected by the shifts in saving demands of households. Based on this line of reasoning, Siegel (2006) noted a concern that baby boom cohorts may experience a sharp drop of their asset values by as much as 50 per cent when they start dissaving. In contrast, if there are high demands from other sectors of the economy such as foreign investments, hedge funds, or other financial institutions, the downward pressure on the price of assets may not be significant. Prices of financial assets can be maintained at a certain level even though there may be massive sell-off by the elderly. Nevertheless, the risk-return profiles of financial assets will still be changed. Equity prices may respond differently from what has been seen in the past despite the similarities of expected average earnings of the companies involved.

From this causality, the demographic transition to the expected high dependency ratio may be detrimental to the potential returns of the next generation's savings under investment-based DC schemes. The shift of pension provision from a DB to a DC arrangement to tackle the current pension crisis caused by population aging may not prove to be a sustainable policy to generate adequate pension income. Some of the literature has investigated the causal relationship between financial asset prices and demographic variables. However, no consensus regarding this causality has been reached. This is because some economists argue that actual household behaviour may not be consistent with the lifecycle hypothesis. The dissaving rate of pensioners may not be as high as the hypothesis suggests. Generally, the bequest motive is often argued to be at high levels, which reduces the tendency of the elderly to dissipate all their accumulated wealth during retirement. Kotlikoff and Summers (1981) find that nearly 80 per cent of the elderly's wealth is inherited. According to the theoretical model of Hurd (1989) and Bernheim (1992), the bequest motive appears to be the main factor causing accumulated wealth of the elderly to remain flat over their retirement period rather than declining. Munnell and Sunden (2003) also note that around 50 per cent of household wealth in America is from gifts and bequests. In addition, Carroll (2001) argues that households with liquidity constraints are more likely to have high precautionary savings at older ages. All of these findings tend to indicate that the large dissaving rates of households over the next twenty years may not be excessively high.

Instead of investigating the direct investment and saving behaviour of households in the financial market, this thesis attempts to disentangle the mechanism underlying the strong relationship between demographic structures and asset prices by proposing that a shift in the institutional structure of the financial market during the 1960s was a key factor which may increase the correlation between the financial market and demographic patterns. The emergence of financial institutions has changed, in a number of different ways, the way that the financial market operates. Instead of directly holding financial assets themselves, households have been using financial services provided by these institutions to manage their investments and savings. In the UK, the government has long been promoting household savings through the provision of occupational pension schemes and personal pension plans. This has led to a dramatic increase in the quantity of money being managed by autonomous pension funds and life insurance funds over the last 50 years. The liability of these financial institutions is apparently sensitive to the demographic structure of the plan beneficiaries. Therefore, the shift in the demographic pattern may have an impact on the financial market through the investment behaviour of these demographically-sensitive financial institutions.

The advent of these financial institutions may ensure a greater correlation between demographic structures and asset prices or returns. This is because the asset allocation of each financial institution represents a large pool of money from many households, in contrast to the direct holding of financial assets by disparate households, each making their own decisions. Therefore, if the majority of fund managers have the same investment beliefs as to how assets should be allocated based on the changes in demographic patterns, a significant impact on financial asset prices and returns could be the result. Moreover, the dissaving motives of the elderly and the retirement of the baby boom generation suggest large net cash outflows from funds invested within the financial institutions. This large supply of capital can create significantly negative pressure on the upside movement of asset prices. This proposed hypothesis will be modelled and analysed in more detail in chapter 5, 6, and 7.

2.6 Concluding Remarks

Both public and private sectors are currently facing a pension crisis due to an unexpected increase in the pension liabilities of DB pension plans. Even though the extent of the impact on risk sharing and wealth distribution may be different between funded and unfunded systems, the current method of dealing with the crisis seems to be the transformation of the pension system towards personal retirement accounts. DC pension funding systems have been implemented in many countries so as to reduce government financial deficits. Likewise, private firms are offering DC pension plans to their new employees and closing or freezing their existing DB plans. However, the coverage rates of private occupational pension provisions are not expected to increase in the near future since companies tend to reduce pension provisions to new employees over time. This situation therefore raises a concern about the retirement savings of younger generations.

Policy makers appear to believe that DC pension accounts are a sustainable solution for the current pension crisis which is mainly caused by the sharp increase in dependency ratios. One of the main reasons for this is that there is no apparent direct linkage between demographic patterns and pension benefits in such accounts. Nevertheless, DC pension plans may not be sustainable if a strong relationship between the financial markets and demographic transitions exists. A shift in demographic patterns may have an influence on the rates of return to capital or on the demand and supply of capital in the market. Therefore, no matter how the pension system is structured, if an underlying relationship between demographic structure and the capital market exists, DC pension plans may not be sustainable since the rate of returns from investments may not be sufficient to maintain a good standard of living during retirement.

This paper proposes that a structural shift in the financial institutions of the financial market during the 1960s may be the key factor which increases the correlation between demographic structures and the financial market. The emergence of financial institutions, especially occupational defined-benefit pension schemes, has substantially increased household participations in the financial market. Because of the significant amount of fund flow from a large pool of many households and pension liabilities that are directly related to the shift in demographic patterns, asset allocations of these pension schemes may be the main underlying factor that links the dynamic of demographic patterns with the movement of asset prices in the financial market. The next chapter will demonstrate how demographic patterns have been changing over time in most developed and developing countries. A detailed analysis of the UK demographic structure will also be presented. This is to show that the problem caused by population ageing is severe and urgent.

Chapter 3: Demographic transition in the UK and other developed and developing countries

3.1 Introduction

Population aging is a worldwide phenomenon having a widespread impact on the stability of current social and economic structures in many countries across the world. Demographic projections by the UN illustrate that the World population's median age will increase from only 26.4 in 2000 to 36.8 by 2050. The old-age dependency ratio of the world population is estimated to increase from 11 per cent in 2000 to 25 per cent by 2050. However, the timing and rates of the aging may vary between different countries. Industrialized countries appear to experience greater improvements in healthcare and lower rates of fertility than emerging countries. Over the next 10 years, most developed countries in Europe and North America will experience a sharp increase in the dependency ratio, while other developing countries in Asia and South America may not encounter this similar phenomenon in the near future. Additionally, the fraction of the working-age population in most developing countries is not estimated to experience a dramatic decline in the near future as in many developed nations. The contraction of the labour force and the expansion of the proportion of the elderly, which occur particularly in industrialised countries, have created significant challenges to the economic growth rates and the sustainability of the existing national pension system.

This chapter will illustrate the general trend of the evolution of demographic patterns. The improvement in mortality rates in developed and developing countries will also be shown. The OECD demographic statistics are the main database for this analysis. Comparisons of demographic structures amongst different countries will provide clear evidence indicating the main concern regarding the demographic impact on the national pension system, predominantly in developed countries. A detailed analysis concerning fertility rates and mortality rates will be presented for the United Kingdom only, the reason being that the research project which follows is based solely on empirical evidence from the United Kingdom. Predictions of UK demographic patterns are presented by comparing projections from the United Nations, the OECD and the UK Office for National Statistics (ONS).

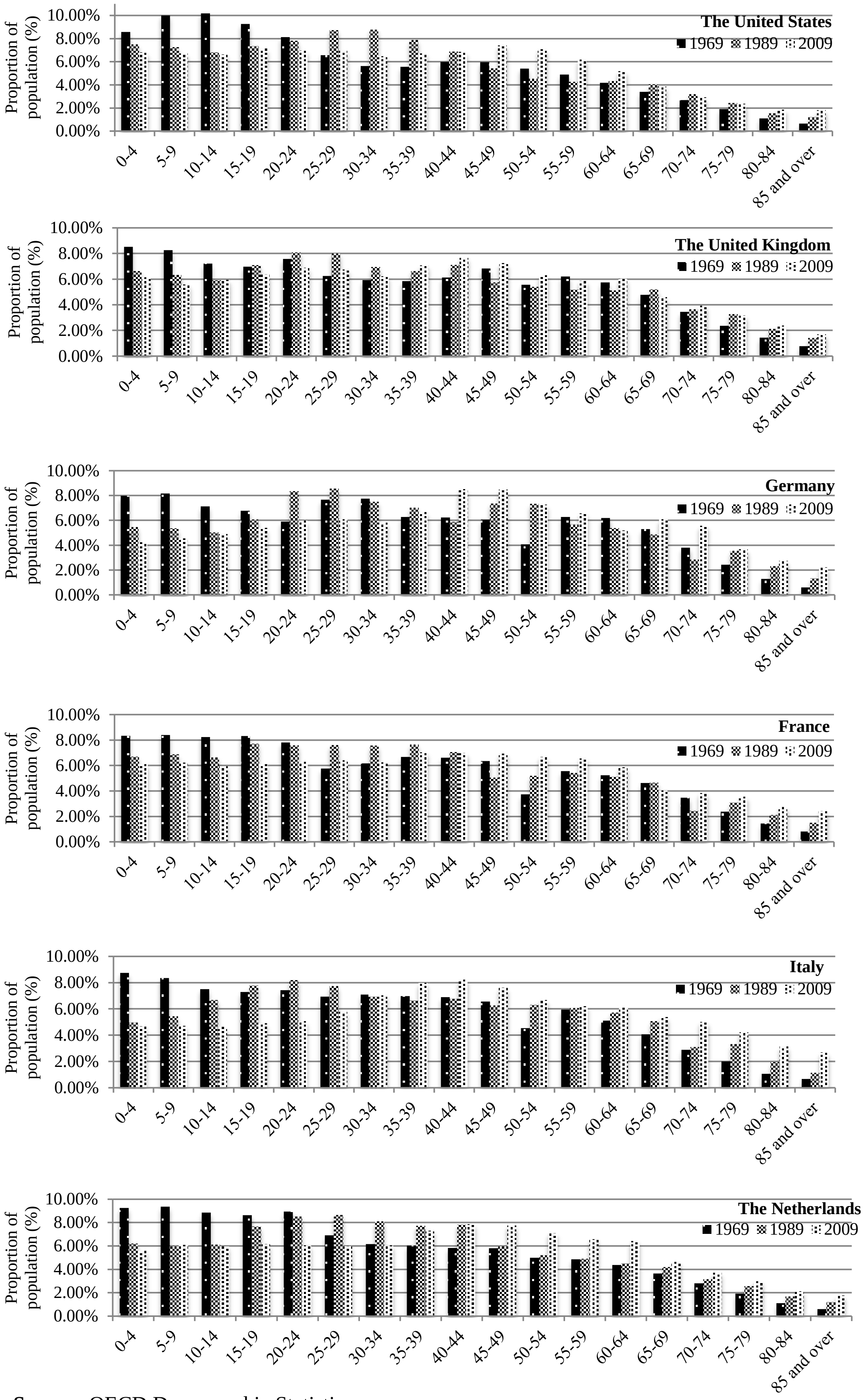
3.2 General trend of the evolution of demographic patterns in developed and developing countries

Generally speaking, dynamic transition of demographic patterns is driven by three main factors: fertility rates, mortality rates and migration rates. Changes in these three factors determine the age, sex, size, and geographic distribution of the population within a country. Unexpected events, such as natural disasters, large wars or medical breakthroughs may lead to a sudden and dramatic shift in these factors. These unexpected events also create the comovement of the drop and rise in fertility rates among developed countries. One such example which clearly illustrates how certain events can lead to a prolonged and substantial shift in demographic patterns is World War II. During this war, there were low fertility rates and also high adult mortality rates for those countries involved. In the peacetime which followed, fertility rates saw a rapid increase and mortality rates returned to their normal level, resulting in a high number of post-war births. One of the main reasons for these high fertility rates during the 1950s among many developed countries is the expectation on the prosperity and high economic growth rates after the war which makes people confident about their well-being. This cohort is often known as the baby boom generation. Since fertility rates declined dramatically after the birth of the baby boom cohort, a seemingly imbalanced age structure is present in most EU and North American countries. Many scholars posit that the ageing of baby-boomers over time may pose a significant challenge on the social and economic structures of those countries. This demographic transition can also negatively affect the sustainability of the national pension system.

Demographic structures of six developed countries are illustrated in Figure 3.1, namely the US, the UK, Germany, France, Italy and the Netherlands. Figure 3.1 shows the evolution of demographic structures between 1969 and 2009, from the population data that are classified into 5-year age bands. It can be seen that the baby boom cohort, which refers to individuals born in the years between 1946 and 1964, accounted for around 26 per cent of the whole US population in 2009, compared to around 27 per cent of individuals born between 1965 and 1984, and 13 per cent for individuals born before 1945. Although the proportion of the generation which succeeded the baby boom cohort (aged 25 to 44 in 2009) appears to be comparable to the proportion of the baby boom generation itself (aged 45 to 65 in 2009), this number does not control for the mortality effect, that is, the proportion of the population of the same cohort will decrease over time because some of the population will have died. Therefore, if we assume that the mortality rate over the next 20 years (from 2009 to 2029) is the same as in the past 20 years (from 1989 to 2009) and that the net migration rate is zero over this period, the proportion of the cohort born between 1965 and 1984 would be around 22 per cent in 2029, when these cohorts reach the age between 45-65 years old. This number is less than the proportion of the baby boom cohort (aged 45-65 years old) in 2009.

When looking at the demographic transition of European nations, Figure 3.1 shows that the imbalanced age structure of these nations, with the exception of France, is more acute than in the US. Populations in European countries appear to be relatively older than in the US. There were peaks in the population born between 1960 and 1969, accounting for approximately 15 per cent of the population in the UK and the Netherlands, and approximately 16-17 per cent in Italy and Germany in 2009. These populations will move toward the 40-64 age group around 2000-2020. The proportion of the population immediately following these cohorts is significantly

Figure 3.1 Demographic distributions of the US, UK, Germany, France, Italy, and the Netherlands



Source: OECD Demographic Statistics

lower in Germany, Italy and the Netherlands. Evidence has shown that fertility rates in these countries have been ranging below 2 children per woman since 1980. This rate is lower than the replacement rate that can maintain a stable population assuming no migration (around 2.1 children per women). These low fertility rates have created a disruption in the demographic patterns as seen in Figure 3.1. Some scholars point out that the interaction between economic and social factors is the main cause of this sharp drop in fertility rates (Heckman & Willis, 1975; Poot & Siegers, 2001). Becker and Barro (1988) explain the movement of fertility rates by showing that it tends to be positively related with long-term real interest rates and negatively related with an improvement in the social security and technological progress.

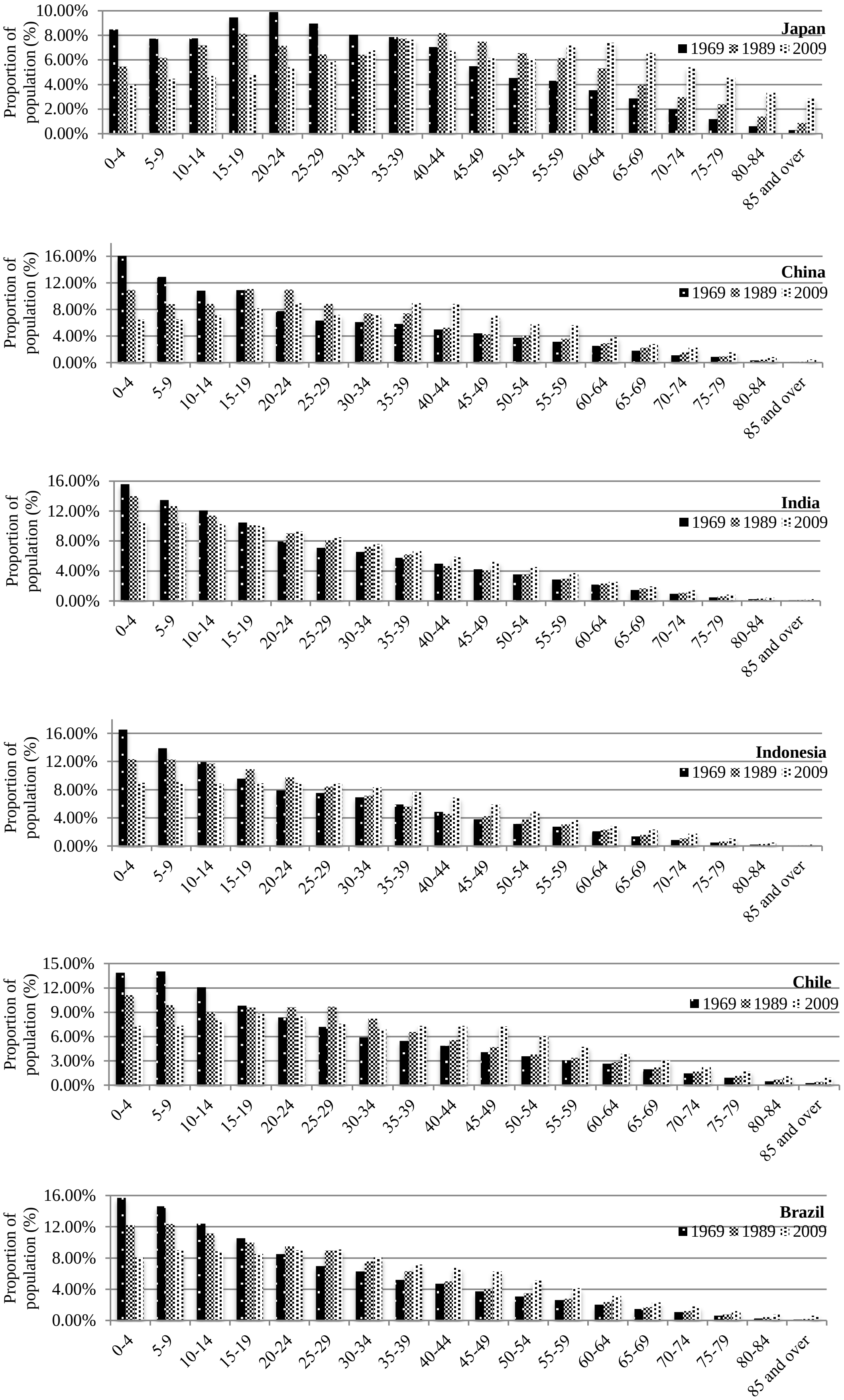
Figure 3.1 also indicates how mortality rates can affect demographic patterns. Over the second half of the 20th century, the proportion of population aged over 65 was, on average, around 12 per cent in the US, 14 per cent in the UK and Germany and 16 per cent in France. There is a clear decline in mortality rates over time, as shown by the increasing proportion of the population aged over 70. Italy and Germany in particular have shown a significant increase in this particular area. This was partly resulted from an increase in life expectancy at birth among the EU countries at around 8 per cent during 1960-2000, which was equivalent to 3 months annually. Forecasts by Oeppen and Vaupel (2002) indicate that life expectancy at birth among developed nations may increase to 100 years by 2060. It has also been projected that life expectancy at birth in the US may reach 85 years by 2050 (Li & Lee, 2005).

These imbalanced demographic patterns raise a concern that there may be a significant contraction of the labour force in these countries after the cohorts born between 1960 and 1969 have retired around the 2020s. For example, in the US, the growth rate of labour force was around 1.5 per cent per annum over the past 25 years but it is expected to approach zero in the next 20 years. The growth rates of labour force in European countries tend to post more concerns because they are expected to be in a negative territory in the near future. With the assumption that capital-output ratios are in the range of 2 to 3, a 1 per cent negative growth rate in labour forces will be accompanied by a decline of investment rates by around 4 per cent annually. This is one of the main troubles caused by population ageing.

In contrast to the demographic patterns of most developed nations in Europe, demographic distributions in other regions of the world are much different. Figure 3.2 demonstrates demographic structures of Japan, China, India, Indonesia, Chile, and Brazil. In the case of the industrialised country, Japan, the proportion of the population aged above 60 has significantly increased over the past 40 years. The average age of population in Japan has been stable only until 1970, but it had started to increase rapidly since then. The improvement in mortality rates appears to be much higher than in the European nations. There was also a sharp reduction in the population aged below 20. This demographic pattern in Japan may partly be one key factor that creates the prolonged economic recession of the country (Faruqee & Muhleisen, 2003).

Demographic structures of other developing countries, shown in Figure 3.2, appear to be similar among each other. A large fraction of the population is in the young age ranges, even though fertility rates have consistently declined over the past 40 years. Approximately 35 per cent of the population in India, Indonesia, Chile, and Brazil was below 20 in 2009. However, one child policy in China has led to a sharp decline in new-borns recently. One main distinction of the demographic distributions between developed and developing countries is the level of mortality rates. Figure 3.2 illustrates that the fraction of the population aged above 60 in those developing countries is at a low level. Mortality rates in developing countries tend to be significantly higher than in developed nations. The substantial drop of fertility rates in developing countries does not create immediate worry that the countries may not have sufficient resources to support the living of the old-age population because life expectancy of this population still remains at low levels.

Figure 3.2 Demographic distributions of Japan, China, India, Indonesia, Chile, and Brazil



Source: OECD Demographic Statistics

In order to understand more clearly how society has aged over the past 40 years, the trend of old-age dependency ratios is illustrated in Table 3.1. In the US, the old-age dependency ratio was at the lowest level compared to other EU industrialised countries. The growth rate of old-age dependency ratios from 1959 to 2009 (a 5 per cent growth rate) was lower than the EU countries presented in the sample. One of the main reasons for this low growth rate in the dependency ratios is that the fertility rates following the births of the baby boom generation in the US did not experience substantial declines as in the EU countries. Dependency ratios in the EU countries dramatically increased from around 20-25 per cent in 1959 to approximately 35-40 per cent in 2009. Italy experienced the highest growth rate of old-age dependency ratios over the past 40 years from 20.6 per cent in 1959 to nearly 41 per cent in 2009. The ageing pattern in the UK tends to be similar to the US although the UK demographic structure is a bit older. According to the UN population projection, the dependency ratio in European countries will be approximately 50 per cent by 2050, which is much more severe than in the US where the dependency ratio is expected to reach a benign level at 36 per cent. Spain is expected to experience the highest dependency ratio among other European countries at around 72 per cent by 2050, followed by Italy at 64 per cent. In other words, this number implies that less than two working-age people will have to support one pensioner.

Emerging countries in Asia and South America have not experienced high old-age dependency ratios at comparable levels as in other developed countries. The dependency ratios of these countries were at low levels of only 10-15 per cent over the past decades. However, the growth rate of the dependency ratios in Japan was significantly high from only 14 per cent in 1959 to around 48 per cent in 2009. According to the UN population projection, Japan would experience the most severe dependency ratio by 2050 at around 78 per cent. Based on the statistics shown in Table 3.1, it is fairly clear that population ageing in developing countries may not have a greatly effect on the economic and financial system of those countries in the near future.

Table 3.1 Old-age dependency ratios of the US, UK, Germany, France, Italy, the Netherlands, Japan, China, India, Indonesia, Chile, and Brazil

Year	US	UK	Germany	France	Italy	Netherlands
1959	22.13%	26.13%	25.96%	27.05%	20.59%	21.57%
1969	23.83%	29.98%	32.16%	30.44%	24.42%	24.05%
1979	24.99%	32.93%	32.62%	29.22%	27.81%	24.88%
1989	26.19%	33.02%	29.76%	29.77%	30.51%	25.62%
1999	25.48%	32.53%	32.89%	32.79%	35.58%	26.49%
2009	27.21%	33.15%	39.63%	35.00%	41.01%	31.76%
Year	Japan	China	India	Indonesia	Chile	Brazil
1959	13.70%	13.04%	8.77%	9.61%	13.73%	10.02%
1969	15.18%	12.98%	9.69%	9.50%	14.81%	11.07%
1979	18.79%	12.71%	10.17%	10.13%	14.63%	11.43%
1989	24.56%	12.82%	10.45%	10.37%	14.46%	11.44%
1999	33.43%	14.15%	11.07%	11.85%	16.00%	12.79%
2009	47.79%	16.13%	11.67%	13.21%	19.15%	14.70%

Source: Author's calculation based on the OECD Demographic Statistics

As Figure 3.1 and Figure 3.2 have shown, there have been low mortality rates among industrialised countries while mortality rates in developing countries tend to stay at high levels over decades. However, Figure 3.1 and Figure 3.2 only show a rough picture of the mortality improvement. A more precise estimate of the mortality improvement is illustrated in Table 3.2. In this table, the mortality rate improvement of different cohorts is calculated, focusing on the percentage of the population aged between 55 and 74 in a particular year who will survive over the next decade (i.e. when they would be aged between 65 and 84) and assuming net zero migration rates over the same period. In other words, the data in Table 3.2 show the cohort- and time- effect of mortality improvement. It can be seen from Table 3.2 that there was a gradual increase of 10-year survival rates throughout developed countries in the sample from around 60 per cent for the cohorts aged between 55 and 74 in 1954 to approximately 75 per cent for the cohorts aged between 55 and 74 in 1999. France and Italy experienced the highest mortality rate improvement, followed by the UK and Germany.

Table 3.2 Proportions of population aged 55 to 74 years old who survived in the next 10 years.

10-Year period	UK	US	Germany	France	Italy	Netherlands
1954 → 1964	62.73%	60.69%	63.99%	62.79%	63.61%	63.66%
1959 → 1969	64.00%	61.48%	63.43%	64.60%	65.09%	64.02%
1964 → 1974	65.85%	64.05%	64.97%	66.03%	67.02%	64.97%
1969 → 1979	68.12%	67.30%	68.52%	68.39%	67.46%	67.31%
1974 → 1984	69.11%	68.88%	69.25%	69.41%	68.92%	69.78%
1979 → 1989	70.13%	68.70%	70.80%	72.25%	73.53%	71.38%
1984 → 1994	70.98%	68.80%	72.13%	75.71%	77.09%	71.66%
1989 → 1999	72.70%	69.31%	75.21%	78.45%	79.85%	72.44%
1994 → 2004	74.08%	70.65%	78.36%	78.24%	79.58%	73.59%
1999 → 2009	75.41%	72.92%	80.41%	78.28%	80.13%	77.09%
10-Year period	Japan	China	India	Indonesia	Chile	Brazil
1954 → 1964	59.45%	44.29%	42.33%	41.45%	50.26%	48.33%
1959 → 1969	61.42%	44.03%	43.55%	42.95%	51.42%	50.12%
1964 → 1974	62.74%	46.49%	45.11%	45.10%	54.08%	52.48%
1969 → 1979	66.65%	52.25%	46.33%	47.10%	57.34%	54.06%
1974 → 1984	71.08%	56.12%	47.08%	48.62%	59.84%	53.94%
1979 → 1989	75.53%	56.25%	47.59%	50.88%	61.05%	54.76%
1984 → 1994	79.32%	57.23%	48.45%	53.98%	62.46%	58.68%
1989 → 1999	81.71%	61.17%	50.31%	56.92%	65.19%	62.03%
1994 → 2004	83.74%	64.72%	52.85%	59.01%	69.11%	63.99%
1999 → 2009	86.22%	66.93%	55.22%	60.55%	72.05%	66.47%

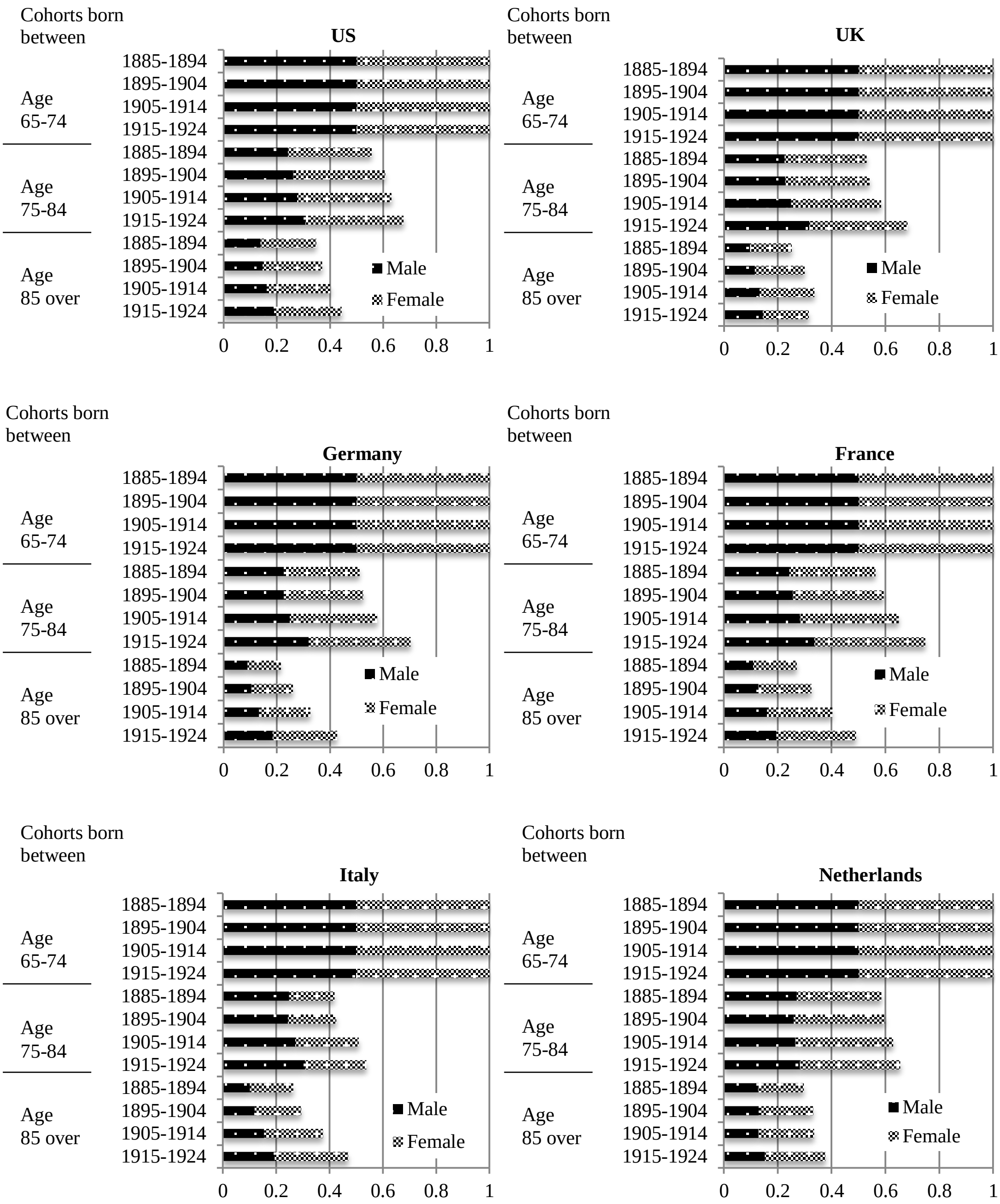
Source: Author's calculation based on the OECD Demographic Statistics

In Japan, the survival rate of the population aged between 55 and 74 was highest at around 86 per cent in 1999. The improvement of mortality rates in Japan over the past 50 years was marginally higher than other EU industrialised countries. In the case of developing counties, even though the survival rates remained at low levels, the improvements in mortality rates were higher than other developed countries. The survival rates of the population aged 55 and 74 in those developing countries significantly increased from around 40 per cent in 1954 to approximately 65 per cent in 1999. At this rate of improvements, it can be projected that the old-age dependency ratio in China may be above 30 per cent by 2050.

While Table 3.2 shows the survival rates of a particular age group, Figure 3.3 and Figure 3.4 attempt to compare the mortality rate improvements between males and females by specifically looking at how mortality rates evolved over different cohorts and age groups of the old-age population. Female mortality improvements were greater than male improvements in both of the developing and developed countries. As shown in Figure 3.3, there was a significant reduction in mortality rates for both men and women born between 1915 and 1924 in the UK, the US, Germany and France. Mortality rates of the elderly aged 75-84 years old in the Netherlands did not experience a large improvement over time but they tend to remain at the same level among different cohorts. Italy experienced the lowest mortality rate for the oldest females (those aged 85 and over), which may be the reason why Italy had the highest dependency ratio among these countries.

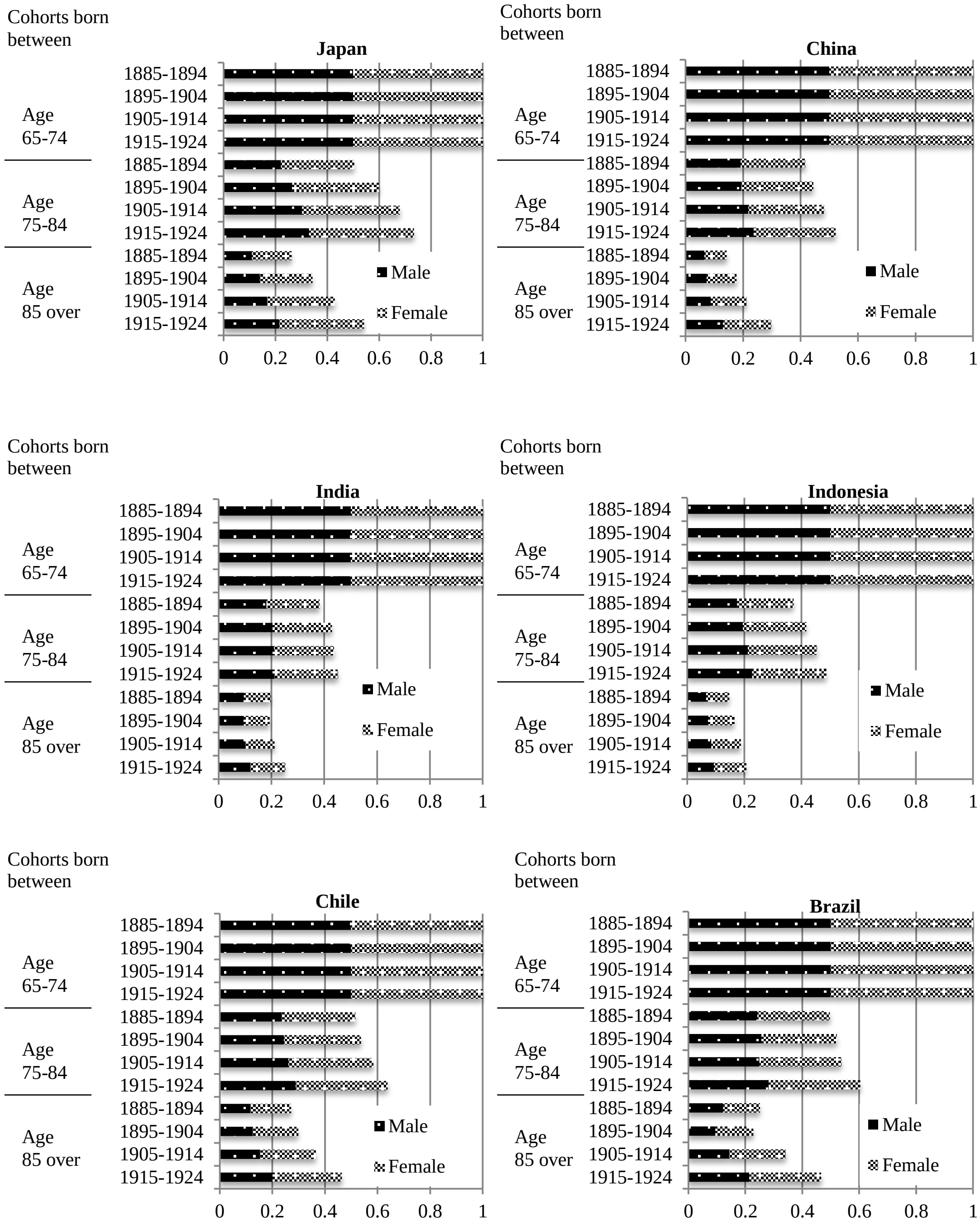
From Figure 3.4, mortality rates in Japan have improved significantly. Larger proportions of younger cohorts could survive to the higher age ranges. Among the industrialised countries in the sample, Japan has experienced the greatest reduction in mortality rates of the elderly. Even though there were slight improvements in mortality rates in China and Indonesia, the mortality rates of the elderly still remains at high levels. Only 40 per cent of the population in the 65-74 age group could survive to the 75-84 age group. In Chile and Brazil, the survival rates of the elderly aged 75-84 have improved noticeably. Approximately 60 per cent of female aged between 75 and 84 could survive to the higher age ranges. In contrast to the improvements in Chile and Brazil, the elderly in India experienced no improvement in the survival rates over the past decades. More than half of the old-age population could not survive to the higher age ranges. If the rate of mortality improvements seen in Figure 3.4 continues to happen over the next 50 years, it can be projected that the fraction of the population aged over 60 in developing countries will increase to 20 per cent by 2050.

Figure 3.3 Proportions of population survived to older ages based on cohorts born in different periods of the US, the UK, Germany, France, Italy and the Netherlands



Source: Author's calculation based on the OECD Demographic Statistics

Figure 3.4 Proportions of population survived to older ages based on cohorts born in different periods of Japan, China, India, Indonesia, Chile, and Brazil



Source: Author's calculation based on the OECD Demographic Statistics

3.3 Detailed analysis of the demographic transition in the UK

Since this paper will examine the impact of demographic transition on the financial market by using empirical evidence from the UK, it is necessary to analyse in more detail the demographic structure and mortality improvements in this country. Statistical descriptions of the UK population are illustrated in Table 3.3. As can be seen, the proportion of the retired population increases by around 60 per cent from 1959 to 2009. When comparing the growth rate of various subgroups, the population aged over 85 increases at the fastest rate. In 1970, around 0.8 per cent of the population was over 85 whereas by 2009, this number has more than doubled to 1.7 per cent. One of the most interesting facts derived from Table 3.3 is that the percentage of people aged 40-64 increased by an average of 60 basis points annually between 1979 and 2009 whereas the proportion of the whole working-age population (aged 25-65 years old) increased by only 0.2 basis points annually. This evidence indicates an ageing of the baby boom cohort from around the 25-40 age group to the 41-64 age range while the proportion of the generation following the baby-boomers was much smaller. As a consequence, the 40-64 age group over the next 40 years may account for a significantly lower proportion of the population than today. According to the projection from the ONS, this age group is expected to decline from 30 per cent of all the adult population in 2009 to 27 per cent in 2051 and to only 25 per cent in 2081. The shrinkage of the labour force and the rising average age of the workforce seem to be inescapable.

Table 3.3 UK demographic statistics

Year	Proportion of each age group (%)					Old-age dependency ratio
	0-19	20-39	40-60/65	60/65 - 84	85 and over	
1954	29.19%	27.47%	29.32%	13.50%	0.52%	24.69%
1959	29.92%	26.79%	28.77%	13.91%	0.60%	26.13%
1964	31.06%	25.18%	28.77%	14.29%	0.70%	27.78%
1969	31.01%	25.64%	27.43%	15.13%	0.78%	29.98%
1974	30.83%	26.25%	26.05%	15.94%	0.93%	32.24%
1979	29.62%	27.45%	25.49%	16.42%	1.02%	32.93%
1984	27.67%	29.20%	25.18%	16.78%	1.17%	33.01%
1989	26.00%	29.69%	25.94%	16.94%	1.43%	33.02%
1994	25.37%	29.67%	26.64%	16.64%	1.68%	32.54%
1999	25.41%	28.56%	27.72%	16.44%	1.87%	32.53%
2004	24.71%	27.51%	29.21%	16.72%	1.86%	32.75%
2009	24.04%	26.97%	30.05%	17.20%	1.70%	33.15%

Source: ONS

In terms of the percentage growth rate of the whole population, it has started to slow since the 1970s, even though the growth of the absolute amount of population appears to be high. According to the ONS 2004-based principle projection, the UK population is estimated to reach approximately 67 million by 2029. Around 44 per cent of the population growth is projected to result from natural increases and the remaining 56 per cent as a result of net immigration.

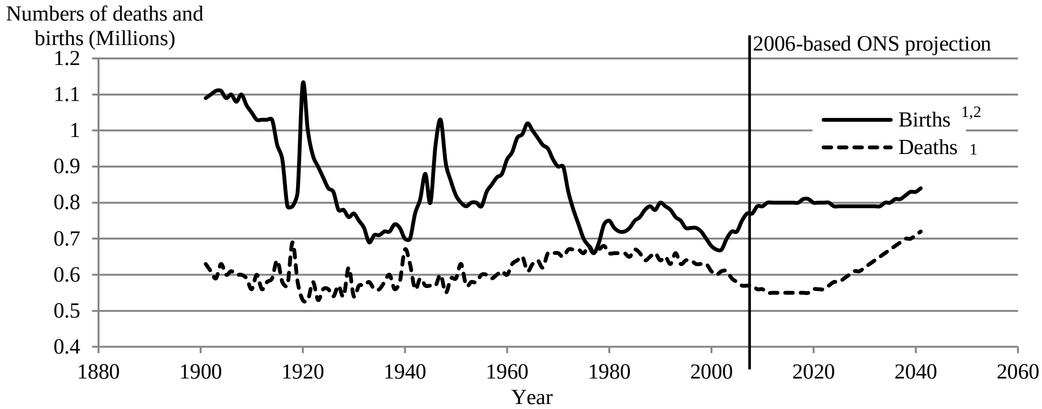
Net migrations to the UK have been fluctuating around an upward trend since the 1970s, though there was a net outflow in 1981. These net migrations often affect the estimate of the working-age population. Even though the net inflow of immigrants surpassed the growth of population from natural increases in 1998 and it accounted for nearly two-thirds of the annual growth of the UK population by the end of 2001, absolute numbers of net migrations are not high when compared to the total population. They have been ranging around 100,000 to 200,000 during the first decade of the 21st century. The average numbers of net immigrants during 1970 to 1990 were quite low at around 50,000 (ONS, 2006).

In order to estimate how demographic structures will be altered over the coming decades, a thorough understanding of the changes in fertility rates, mortality rates and migration rates is required. Although demographic projections are regarded as one of the most reliable economic forecasts because projecting the future proportion of individuals in a certain age range depends on the known current proportion of younger individuals, long-term projections over a 20-30 year period may not be as accurate. Considerable uncertainties between the estimated value and the actual value may arise from the potential bias of the assumptions underlying the projection of future fertility rates, mortality rates and migration rates. Most official projections from governmental departments often do not contain an estimate of the distribution of uncertainties of those projected variables. In other words, projection methodologies are normally based on a deterministic approach rather than a stochastic one. Official may produce certain projected values that are based on certain assumptions without probability estimates adhering to those projected values.

Typically, the inaccuracy in birth rate forecasts is not as extreme as mortality rate projections. It has been widely accepted that mortality improvements have increased more rapidly than the projected estimates. Most governmental statistical agencies normally assume a constant rate of mortality improvement in a deterministic manner. The estimates of life expectancy for very old individuals are also inaccurate owing to the statistical issue of small historical samples. Due to the high uncertainty of mortality projections, there has been considerable debate regarding deterministic and stochastic mortality modelling (Cairns, 2000; Renshaw & Haberman, 2006; Cairns, Blake & Dowd, 2006a). In the UK, the Continuous Mortality Investigation Board (CMIB) attempts to implement various stochastic methodologies so as to accurately project future life expectancy.

As Figure 3.5 shows, fertility rates in the UK rose dramatically in 1920 and in 1947 following the end, respectively, of World Wars I and II. From 1964, birth rates declined substantially from around one million new-borns to around 0.7 million in 1976. The main reason for low birth rates after the 1960s was mainly due to the use of new contraceptive techniques and other social factors such as the legislation of abortion in 1967 and the improvement in the levels of education. The increasing labour force participations by women also give rise to higher opportunity costs of having one more child. Moreover, the 1970 recession caused by oil price shocks also helped to reduce the fertility rate. It is projected that fertility rates will fluctuate around this level for the next 50 years. Even though mortality numbers tend to fluctuate around 0.6 million (as illustrated in Figure 3.5), mortality improvements have increased dramatically over the last two decades, especially for older women, as previously illustrated in Figure 3.3. This noticeably decline in death rates mostly results from better medical treatments. The increase in the projected numbers of deaths from 2020 onwards is mainly a result of the predicted demise of the baby boom generation.

Figure 3.5 Numbers of births and deaths in the UK

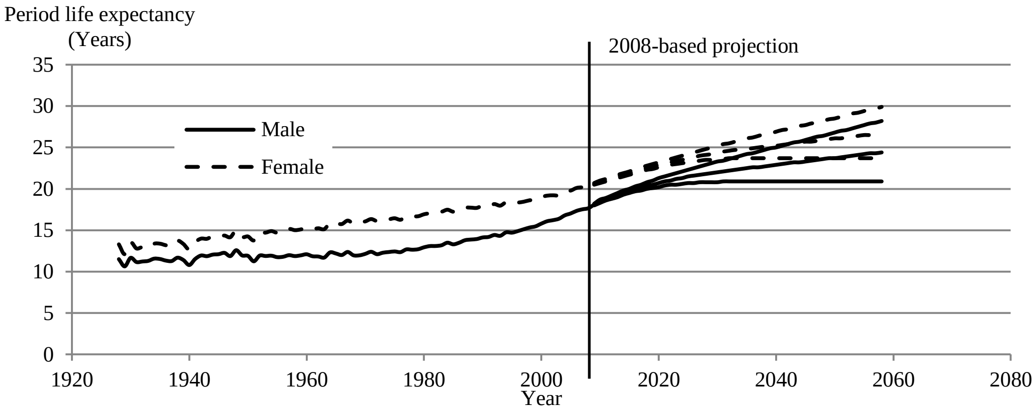


1 From 1901 to 1921, data excludes Ireland
2 From 1981 onwards, data excludes the non-residents of Northern Ireland.

Source: ONS

From Figure 3.6, period life expectancy for British males aged 65 has improved from 12 years in 1970 to 18.1 years in 2009, while the increase for women has been slightly smaller, namely from 16 years to 20.6 years. The higher rates of mortality improvement for males since the 1970s may be due to the reduction in smoking habits amongst the male population (Doll, Peto, Boreham & Sutherland 2004). The 2008-based projection from the ONS appears to assume similar rates of mortality improvements for both British males and females. The three graph lines for males and females represent the range of future forecasts according to three separate assumptions, namely: the old-age structure assumptions, the principle assumptions and the young-age structure assumptions. More details of these assumptions can be found in the ONS 2008-based projection statistical bulletin.

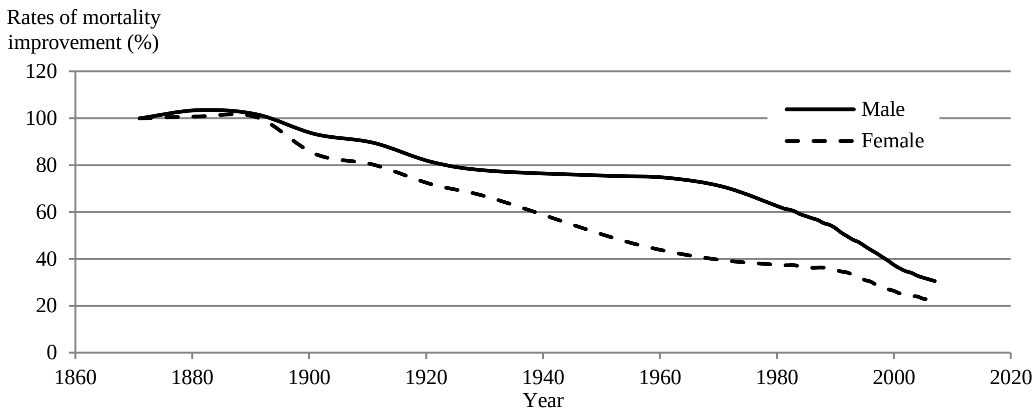
Figure 3.6 Period Life expectancy of British males and females aged 65 years old



Source: ONS

Figure 3.7 shows initial mortality rate reductions for males and females aged 65 as a percentage of the reference value in 1881. Women have been experiencing a significant reduction in mortality rates since 1940, long before their male counterparts, who experienced almost no reduction from 1940 to 1960. However, the mortality reduction rates of males accelerated from the 1970s, and by 2000 had come close to parity.

Figure 3.7 Mortality rate improvements of British males and females aged 65 years old as a percentage of the base year (1881)



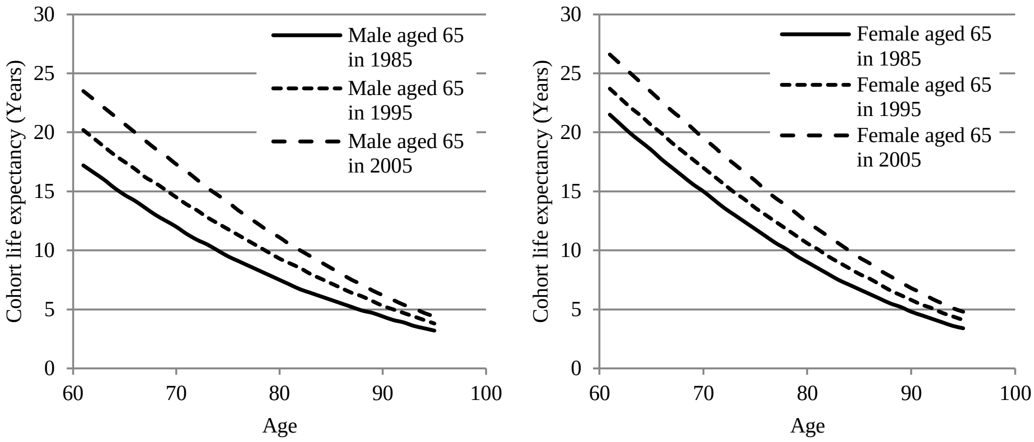
Source: ONS

Cohort life expectancy is another estimate for life expectancy that may provide more accurate data than the period life expectancy. The reason for this is that cohort life expectancy uses the assumptions of mortality rates on a cohort basis, that is, persons born in different years will have different age-specific mortality rates over their life. This assumption is in contrast to the period life expectancy, which uses the age-specific mortality at a certain time to estimate the life expectancy. Figure 3.8 shows the increase in cohort life expectancy of both males and females aged 65 in three different time periods. Younger generations of males experienced a higher rate of mortality improvement than females. Moreover, the reduction of mortality rates was higher at younger ages than older ones. There were little mortality improvements for people aged 90 or over.

This significant decline in old-age mortality rates results in an increase in life expectancy at birth over the past 30 years. For example, an increase in life expectancy at birth of both British men and women of 1.87 years during 2001 to

2007 was accompanied by an improvement in life expectancy at age 65 of 1.54 years. However, this marked decline in the mortality does not always imply that morbidity rates will be lower. For example, Crimmins and Saito (2001) find that although overall life expectancy increased by 1.7 years from 1970 to 1980, an increase in the period life expectancy that was free from all disability was only 0.2 years in the US.

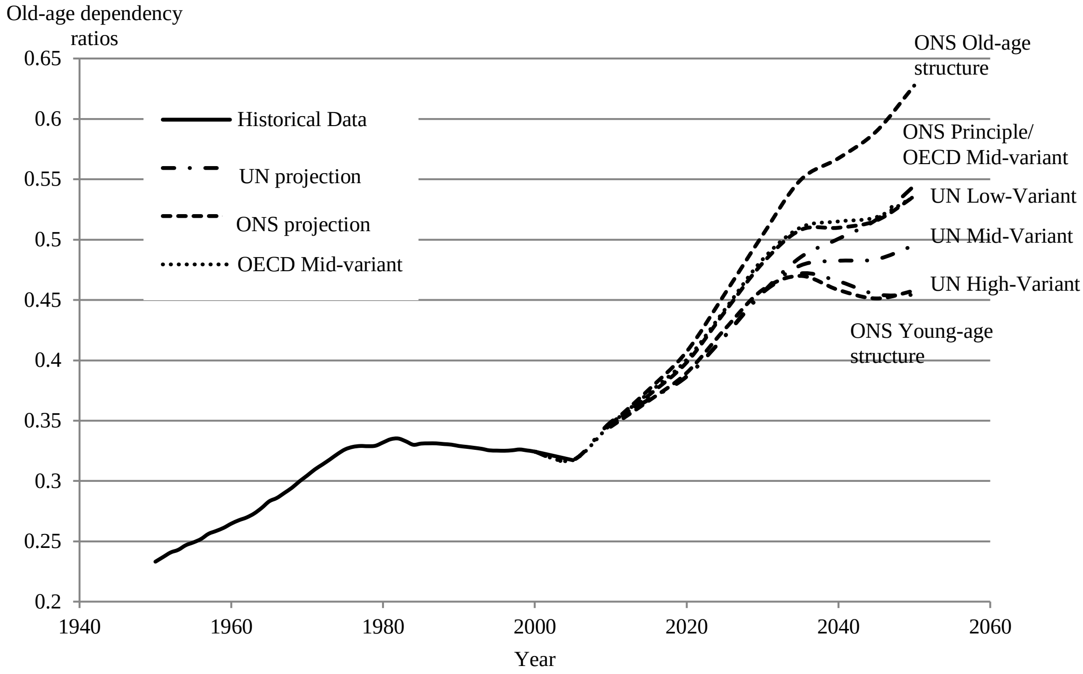
Figure 3.8 Cohort life expectancy of British males and females aged 65 in 3 different periods



Source: ONS

These projections of future fertility rates, mortality rates, and life expectancy combined with the ageing of baby-boomers, would sharply increase the old-age dependency ratio over the next 50 years. Historical experiences and projections of old-age dependency ratios in the UK are illustrated in Figure 3.9. It illustrates three main different assumptions of the UN and the ONS projections. This variance in the projections represents a range of plausible scenarios that may occur in the future. It is a projection, not a forecast; therefore, it does not actually represent the upper or lower limit. According to the ONS principle and mid-variant projections by the OECD, it is expected that the dependency ratios will sharply increase from around 30 per cent in 2009 to 40 per cent in 2025. The ONS old-age structure assumption appears to provide the most extreme case at the upper end, while the UN projections tend to be at the lower end. The projected sharp growth rates in old-age dependency ratios occur as a result of fertility rates falling below replacement rates and the retirement of the baby boom generation. In terms of the accuracy, a study by Shaw (2007) shows that the accuracy of the ONS dependency ratio projections tends to be satisfactory. Although the projection of the elderly population is generally underestimated due to unexpected improvements in realised mortality rates, it is normally offset by an underestimate of the working-age population (from low net migration assumptions). On average, Shaw (2007) estimates that the ONS principle projection for the old-age dependency ratio is underprojected by just 8 per cent.

Figure 3.9 Historical and projected old age dependency ratios of the United Kingdom



Source OECD demographic statistics; UN demographic yearbook; and Office of National Statistics

Generally speaking, a high dependency ratio implies that outcomes from economic activities contributed by the working-age population will have to support the substantial costs of pension provisions and health care for pensioners. Typically, the transition from the high youth dependency ratio in 1960 to the high old-age dependency ratio in 2020 creates different costs on working-age people. Cutler and Meara (1998) measure the different costs of education, health care, and other consumptions needed by children and adults. They find that the estimated cost of bearing children under 20 is 72 per cent of the total consumption of working people, while the estimated cost of caring the elderly over 65 is at 127 per cent. This implies that economic growth rates may decrease during the periods of high old-age dependency ratios because there will be fewer financial resources available for investment with which to expand the national economy. However, it is necessary to note that the impact on the economy will be different according to whether the high old-age dependency ratios arise from an increase in old-age longevity or from a decline in birth rates. Principally, the rising old-age dependency ratio resulting from the improvement in life expectancy is much more problematic than the rising old-age dependency ratio resulting from the fall in fertility rates. This is because a rise in the life expectancy at old ages will create immediate pressure on the national pension systems whereas a decline in fertility rates will result in a greater time lag before its impact is felt on the economy.

3.4 Concluding remarks

This chapter describes the evolution of demographic structures in developed and developing countries over the past 50 years. Large proportions of the population in developing countries are still in the working-age range. Although there were some improvements in the survival rates of the elderly in Indonesia, China, Brazil and Chile, the mortality rates still remain at high levels. The proportion of the old-age population is not projected to increase significantly in the near future. As a consequence, even though fertility rates in developing countries have significantly declined over the past 20 years, this situation does not tend to pose a great challenge on the sustainability of the national economic and pension system.

On the contrary, a significant increase in the population aged over 60 in the US, EU industrialised countries and Japan has clearly been observed. Italy, Germany and the UK are among the countries that have experienced a significantly continued improvement in the old-age mortality rates. This improvement of the old-age life expectancy coupled with the retirement of baby-boomers will dramatically accelerate the growth rates of the old-age dependency ratios. It is projected that the old-age dependency ratio in the UK will have been rising from around 32 per cent in 2009 to 40 per cent by 2020 and 50 per cent by 2040. This demographic transition has created a great impact on the sustainability of the existing pension systems in most developed countries as previously shown in chapter 2.

However, it is still a question as to whether the proposal of transforming the traditional DB pension schemes in both public and private sectors into funded DC pension schemes would be the right solution to encounter the impact of the demographic transition. In the following chapters, research projects that attempt to answer this question will be presented.

Chapter 4: Graphical illustrations showing the potential relationship between demographic structures and the financial market

4.1 Introduction

The aim of this chapter is to present evidence leading to an interesting question of whether there may be a significant relationship between demographic structures and the capital market. To do so, a time series of financial indicators is compared with a time series of demographic variables. The key demographic factors which are considered to have a significant relationship with the financial market variables are the proportion of adults under retirement age and the proportion of the population aged over 40 but under retirement age. Based on the lifecycle hypothesis (Modigliani & Brumberg, 1954), the proportion of the working-age population is important in determining the aggregate consumption and savings of the country. It is also widely accepted that the population aged between 40 and the retirement age is highly motivated by saving for retirement. Labour incomes also generally reach a peak level in this age group. Therefore, the aggregate amount of money belonging to this age group, during the period of high proportions of this age group relative to others, may account for the majority of financial transactions in the markets. The main indicators of the financial market are the FTSE-All Share index, the price-to-earning ratios, the dividend yields, and the GILT yields. A strong relationship between demographic variables and the movement of the financial market variables may indicate that the demand and supply of financial assets determined by the movement of demographic patterns is an important factor in determining the prices of financial assets.

However, the following illustrations only provide a rough picture of these potential relationships, which need to be explored further. These illustrations do not provide robust results which either support or reject any underlying mechanisms; instead, they merely show a few trends between different variables. Any apparent relationship between the financial market and the demographic variables may just be coincidental. Therefore, care should be taken in asserting any strong conclusions from the graphical illustrations below unless a further detailed analysis is done to test any proposed hypothesis. The chapter will end with research plans that attempt to investigate potential underlying mechanisms of the relationship between demographic structures and the financial market.

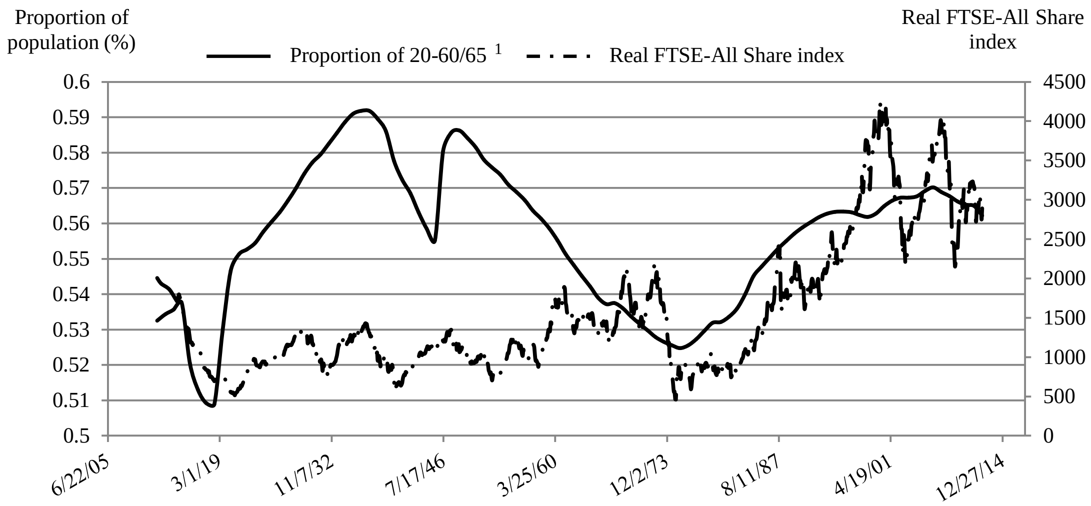
4.2 Graphical illustrations of the relationship between the evolution of demographic structures and financial market indicators

Whether demographic patterns significantly affect financial asset prices is a topic of debate amongst economists. In this section, the relationship between demographic variables and financial market indicators, such as equity indices and GILTs yields, is explored. A high fraction of working-age population implies a high demand for savings. Therefore, the price of financial assets, which are used as saving tools to store the value of money, may be influenced by demographic transitions. Siegel's (1998) controversial work illustrates how demographic transitions can impact on the equity market in the long-term, thus increasing concern for the 'market meltdown hypothesis' whereby the stock market might collapse following the retirement of baby-boomers.

Figure 4.1 depicts the relationship between the 'real' FTSE-All share index and the proportion of the adult population. This index is deflated by the consumer price index so as to obtain the real growth of the FTSE index. Retirement ages for males and females are assumed to be 65 and 60 respectively because these are the official retirement ages in the UK. However, the actual proportions of retired people may slightly be different from these cut points because the employment status is influenced by many social and economic factors. For example, as shown in IMF

(2005a), labour force participations of populations aged between 55 and 64 vary widely within the range of 20-70 per cent across G10 countries.

Figure 4.1 The historical real FTSE-All share index as of 31 December and the proportion of population aged 20-60/65



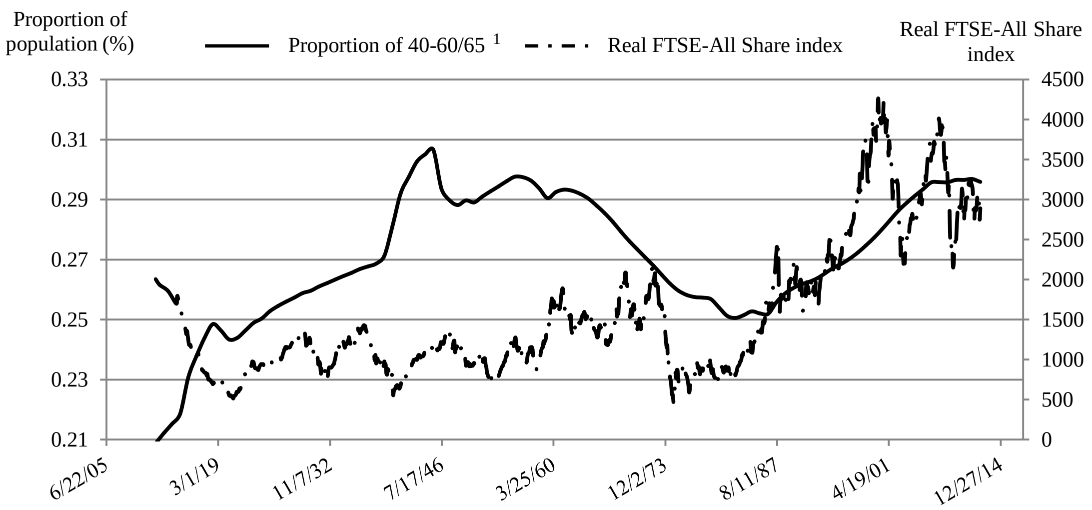
1 Retirement age is 65 for males and 60 for females

Source Global Financial Data (GFD); Office of National Statistics (ONS)

It can be seen that there seems to be no discernible direction of the correlation between the real FTSE index and the demographic variable during the period before 1960. Even though the fall in the real FTSE index during 1910s appears to be mirrored by the fall in the working-age population, this evidence does not indicate any potential causal relationship between these two variables because the real FTSE index did not rise dramatically during 1930s and 1940s in parallel with the increase in the proportion of the working-age population. However, from 1960s onwards, there appeared to be a strong positive correlation between the demographic variable and the real FTSE index. The fall of the real FTSE index in 1970s and the rise of the index after 1980s corresponded with the movement of the proportion of the working-age population. Interestingly, even though there were intermittent disruptions in the economic growth rates during the beginning of the 1980s, 1990s, 2000s, and 2008, the real equity index has been steadily increasing for more than 40 years, which was accompanied by the movement of the proportion of working-age people. This evidence suggests that the development and liberalization of the financial market after 1960s, which dramatically changed the structure of the capital market, may be the main mechanism that leads to a strong correlation between the demographic variable and the financial market.

Figure 4.2 illustrates the relationship between the FTSE index and the proportion of prime savers. It can be seen that the long-term trend of the FTSE index can partly be explained by the movement of this demographic variable. The peak in the market value in the 2000s corresponds with the period when baby-boomers were aged between 40 and 64. Although the real FTSE index did not rise dramatically to mirror the movement of the demographic variable prior to 1960, the index did not experience any continued upward or downward trend but rather fluctuated around a certain level. This evidence may indicate that pre-1960 there was a lower level of market participation by households; therefore, demands for and supplies of financial assets from households did not particularly influence asset prices.

Figure 4.2 The historical real FTSE-All share index as of 31 December and the proportion of population aged 40-60/65



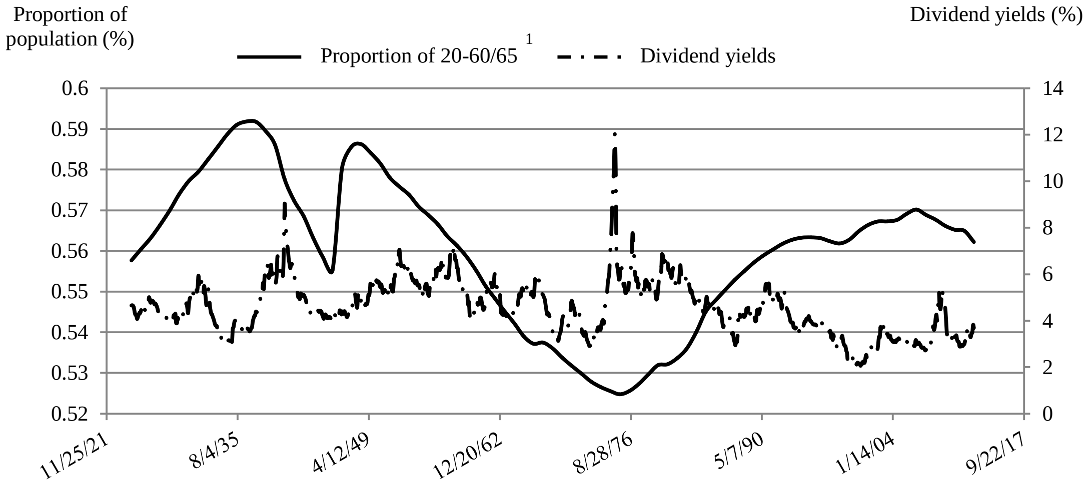
1 Retirement age is 65 for males and 60 for females

Source GFD; ONS

Nevertheless, some economists may argue that the stronger correlation between the real FTSE index and the demographic variables observed after the 1960s may result from a coincident event. This is because the economic conditions during the 1950s and 1960s were plenty of growth prospects after the end of the war leading to a long-term upward movement. The trough in the proportion of working-age people during the early 1970s may be coincident with the trough in real equity prices caused by the oil crisis. In addition, over the period of the long-term increase in equity prices since the late 1960s, the economy had only experienced some temporary interruptions such as a burst of inflation and quantitative controls on banks' balance sheets during the late 1970s and the Gulf War crisis during the late 1980s. The steady growth of the economy since the early 1990s had also been driven by an increase in lending to housing loans, industrial companies and unsecured consumer credits. There was apparently no significant crisis that could turn the economy into a long-term downward trend. Although this argument seems convincing, equity prices after the 1960s appear to be more expensive, relative to the earnings they can generate, than the average historical level in the prior period. The increasing expensiveness of equities after 1965, which is subsequently shown in Figure 4.3 and 4.4, may partly result from substantial demands for investment from working-age people.

Generally speaking, the expensiveness of equities can be measured by the price-to-earning ratios or dividend yields. In theory, these measures should stay roughly constant over a certain level. Equity prices can only be increased if they can be supported by rising dividends in the next period. However, during the periods of imbalanced demands and supplies, prices of financial assets may diverge from the average historical level of the ratio between prices and dividends, or between prices and earnings. This behaviour is illustrated in Figure 4.3, which depicts the historical movement of dividend yields and the proportion of the adult population. It can be seen that the period of peak dividend yield (the 1970s) coincided with a period where a low proportion of the adult population was of working-age. This implies that prices of financial assets during the 1970s plummeted dramatically, leading to excessively high dividend yields. This sharp decline in financial asset prices could be argued to be the result of both the market wide economic crisis during that time and of the imbalance between demand and supply which was created by demographic shift. The clear evidence that may support the latter hypothesis was during the period from 1980 onwards. It can be seen that dividend yields experienced a steady downward trend rather than moving around a long-term constant level, which could be seen during the period before 1970. The declining dividend yields shown in Figure 4.3 is also consistent with the findings by Campbell and Shiller (2001) who discovers that dividend yields for companies in the S&P500 decreased from 4.7 per cent in 1872 to 1.4 per cent in 2001.

Figure 4.3 Historical dividend yields and the proportion of population aged 20-60/65

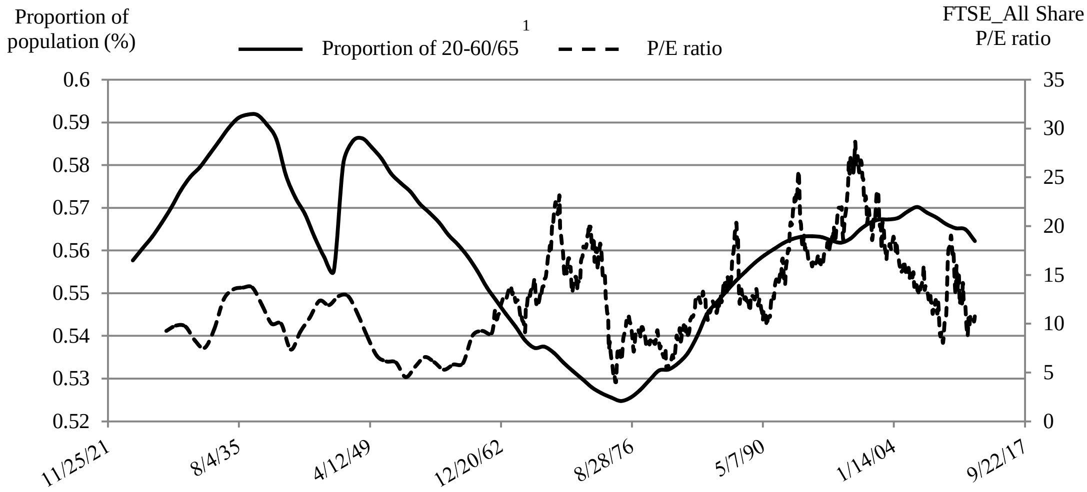


1 Retirement age is 65 for males and 60 for females

Source GFD; ONS

The relationship between the proportion of the adult population and the P/E ratio, shown in Figure 4.4, also provides evidence in supporting the hypothesis that a rise in the saving demands from the increasing proportions of the working-age population may partially have caused an upward pressure on asset prices. Prices of stocks in the FTSE index had been pushed higher than the historical average level over the past 30 years. This evidence in the UK stock market is also consistent with Shiller's analysis of the US equity market which shows that stock prices are significantly overvalued over the past 20 years.

Figure 4.4 Historical price-to-earning ratios (P/E) and the proportion of population aged 20-60/65

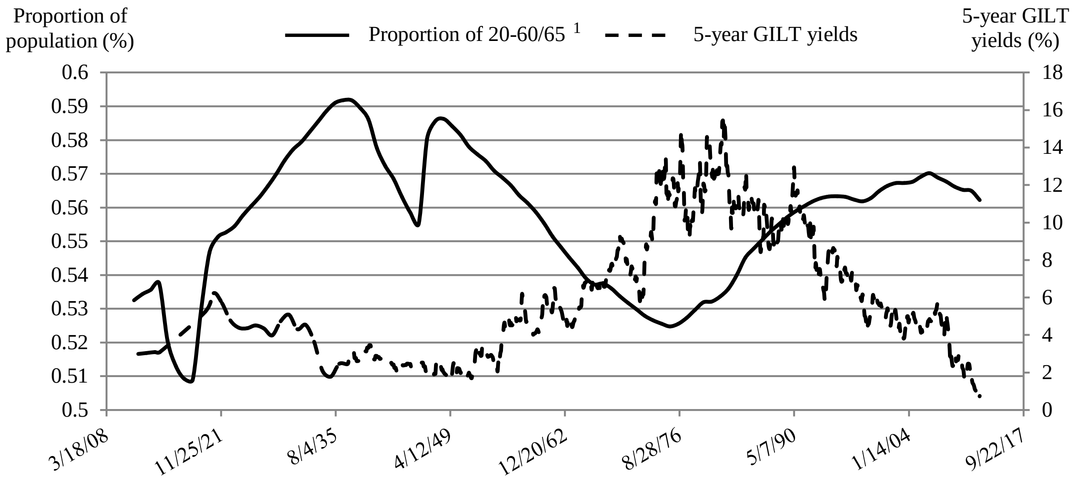


1 Retirement age is 65 for males and 60 for females

Source GFD; ONS

Equity is not the only financial asset that tends to have some correlation with demographic variables. Price movements of fixed-income securities, such as government bonds and corporate bonds, also show a relationship with demographic variables. Figure 4.5 shows the movement of 5-year government yields and the proportion of the adult population. It appears that these two parameters move in an opposite direction. During periods of a high proportion of the labour workforce, demand for savings is high, meaning that interest rates tend to be low. Before 1960, there appeared to be no significant correlation between the demographic variable and the GILT yields, which is similar to the relationship between the demographic variable and the real FTSE index. Therefore, the emergence of the financial institutions after 1960s may potentially be one of the factors that could lead to a high correlation between demographic variables and the financial market.

Figure 4.5 Historical 5-year Gilt yields and the proportion of population aged 20-60/65



1 Retirement age is 65 for males and 60 for females

Source GFD; ONS

4.3 Discussion of the above graphical illustrations

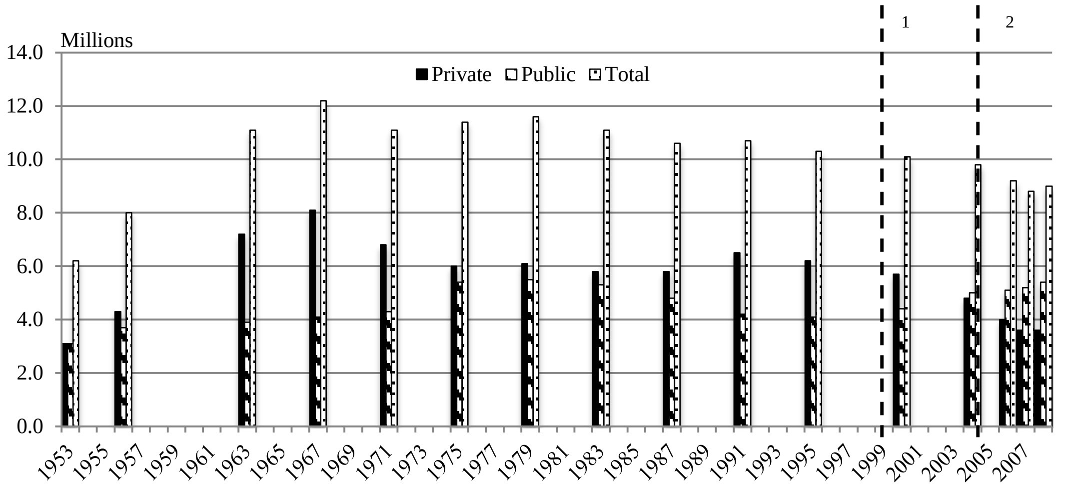
The strong correlation between the price of financial assets and demographic variables appears to hold for long time periods, even though in the short-term there appears to be low correlation between these two variables. This short-term low correlation may result from the high-frequency movement of stock prices which tend to be influenced by many factors. Demographic variables appear to exhibit a strong correlation with financial asset prices only after the 1960s. Prior to this period, the relationship was insignificant with no clear direction. This evidence may support the hypothesis that the emergence of pension schemes since the 1960s may amplify the impacts of the imbalance in supply and demand caused by demographic shifts upon the prices and returns of financial assets in the financial market. Because previous researchers have only attempted to test the existence of the direct statistical relationship between financial asset prices and demographic variables without explicitly considering the institutional differences in the structure of the financial market as this thesis suggests, the question of whether the correlation between asset prices and demographic variables represents a causal relationship still remains.

With an increase in the range of instruments and services provided by financial institutions since the 1960s, the high saving demands from households to purchase financial assets have flowed to these institutions as a means for savings and investments. Participation rates of households in the financial market have been increasing because the presence of financial institutions has led to a reduction in fixed costs (i.e. transaction costs and information costs) of an investment in the financial market. A number of previous literatures have shown that the institutionalization from the presence of pension funds in the financial market has some positive impacts on personal savings (Davis, 1988) and on the improvement of the capital market (Boersch-Supan & Winter, 2001). For example, Davis (2006) discovers that the proportions of the 40-64 age group have a negative impact on the ratio of bank loans to equity during 1960-2002 from a panel data consisting of 72 OECD and emerging countries. This suggests that an increase in households' savings through pension schemes is accompanied by a higher amount of equity relative to bank loans. Allen and Gale (1999, 2001) also show that fund inflows into pension funds boost credit finances in the property market, while Boersch-Supan and Winter (2001) show that the growth rate of the pension fund industry in European countries is positively correlated with the size of the stock market with a correlation coefficient of around 0.6. Because, during certain periods, fund flows across these institutions may be influenced by demographic patterns according to households' savings and consumption motives, demographic structures may have an impact on the capital market if fund flows of these institutional investors significantly affect the prices and returns of financial assets. The next section will show statistical data related to the growth of pension schemes in the UK over the past 60 years.

4.3.1 Empirical evidence showing the growth of pension funds since the 1960s

In the UK, the presence of occupational DB pension plans throughout the 1950s and the increased provisions of DC pension schemes in the 1990s may encourage the savings of households in the financial market. Figure 4.6 shows an increase in occupational pension provisions in both public and private sectors over the past 60 years. As can be seen, the number of active members in private sector pension schemes significantly increased during the 1950s and 1960s. The peak in the number of active members in both public and private pension schemes occurred around the late 1960s. Nearly 40 per cent of the UK workforce had been covered by occupational pension schemes by the end of the 1990s (previously shown in Table 2.2).

Figure 4.6 Numbers of active members of occupational pension schemes



1 From 2000, some pension plans has been reclassified from public to private sectors because of changes in plan definitions
2 The methodological procedure of the survey has some changes from 2005 onwards.

Source: Occupational Pension Scheme Survey

The particularly sharp growth rate in the number of active members in pension schemes may partly result from the generosity of pension benefits during that period. Ninety per cent of pension benefits in the private sector are indexed to inflation. Low replacement ratios in the government earning-related pension schemes and the double taxations[17] of direct equity ownerships have also helped to encourage the growth of pension schemes in the private sectors.

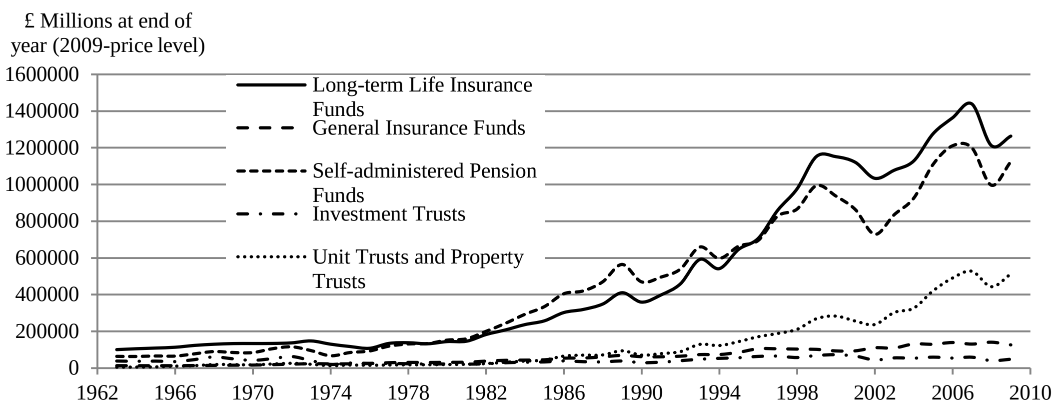
This data also implies that individuals who previously had not directly owned financial assets could otherwise have exposures to the financial market through these pension provisions. The proportion of household financial wealth indirectly held through pension funds and insurance companies rose from only 20 per cent of the total household wealth in the late 1970s to nearly 40 per cent in the late 1990s. The shares of life insurance and pension funds in both the public and private sectors grew

[17] The double taxation of direct equity ownerships is due to the tax on labour earnings and the tax on capital gains from investment.

from around 14 per cent in 1970 to approximately 38 per cent in 1985 (Davis, 1988). Banks and Smith (2000), who analyse changes in the UK household portfolios, also find that housing assets are less important over time because of a rising proportion of wealth in financial assets held through life insurance and pension schemes.

The growth of assets under management of each type of institutional investors is illustrated in Figure 4.7 and Figure 4.8. Figure 4.7 shows the 2009-price level of the aggregate market asset values managed by each financial institution, while Figure 4.8 sets out asset values as a percentage of the GDP. The market values of pension funds and long-term life insurance funds have increased sharply since 1980. In 2009, the aggregate asset value of all self-administered pension funds reached around £1.1 trillion or 80 per cent of the GDP. This significant growth rate in long-term life insurance funds and pension funds results from both dramatic fund inflows into these institutions and high compounded returns from their investments.

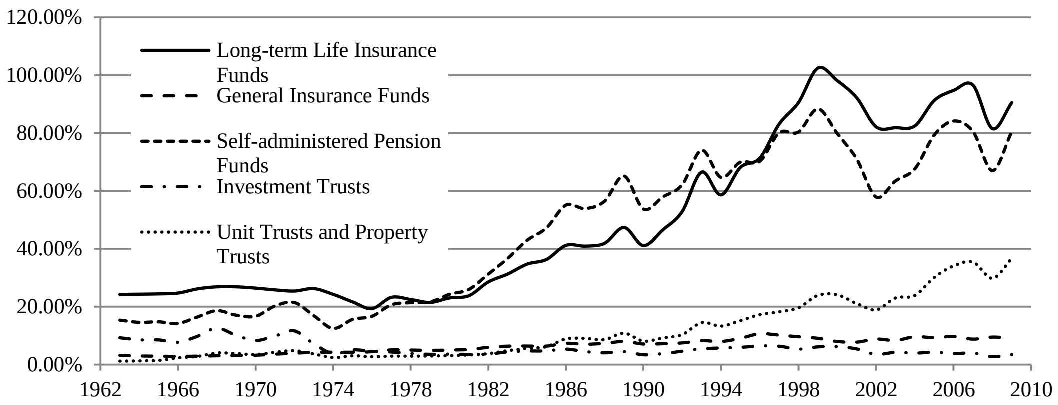
Figure 4.7 Aggregate market asset values under the management of UK financial institutions (2009-price level)



Source: Author's calculation based on the MQ5 survey[18]

[18] The MQ5 survey data comprises the UK official pension statistics, acquired from a sample covering around 340 pension schemes in the UK.

Figure 4.8 Aggregate market asset values as a percentage of GDP

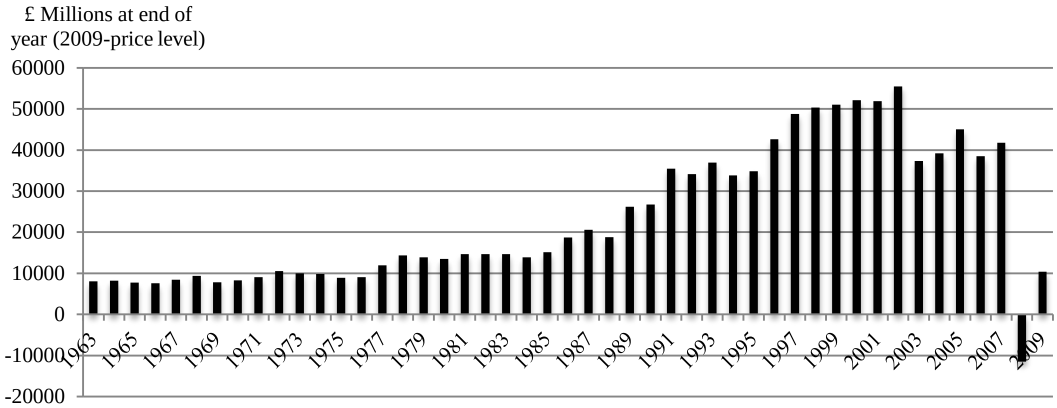


Source: Author's calculation based on the MQ5 survey and ONS Blue Book

UK is not the only country that has seen a sharp growth rate in the market value of the total pension fund size. In relation to the OECD (2007), the total size of funded pension systems, including all work-related pension schemes, across the world has reached US$24.6 trillion. According to the survey by Watson Wyatt (2008), the proportion of pension assets invested in the equity markets was estimated to be approximately 56 per cent in 2007. This figure implies that the total absolute value of equity investments was more than US$8 trillion.

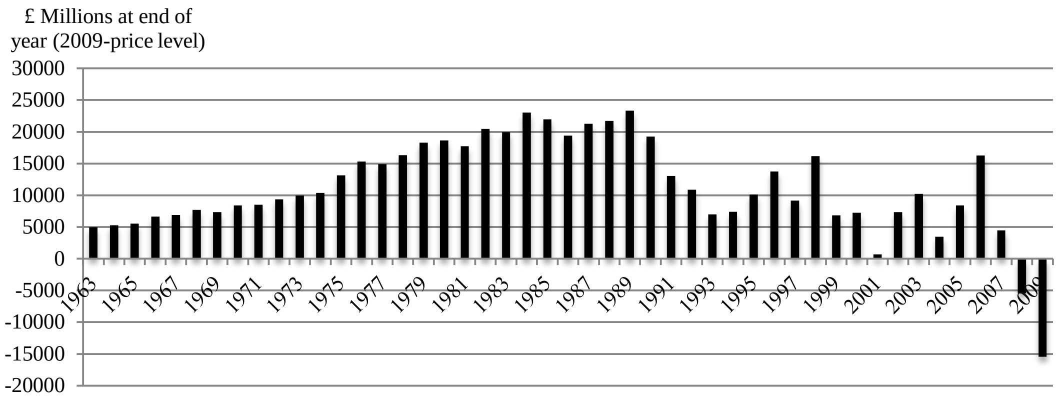
Figure 4.9 and Figure 4.10 demonstrate the real price level of net investments in the financial market of life insurance funds and pension funds. The value of money is presented at the 2009-price level. There was a significant increase in the amount of fund inflows into pension funds since the late 1960s. The peak (in real term) of the net investments in the financial market of self-administered pension funds occurred during the 1980s before sharply declining from 1990 onwards. In the case of long-term life insurance funds, positive net investments rose dramatically during the 1990s. The negative value of net investments in 2008 means that both pension funds and life insurance funds realised their assets during the financial crisis. Pension funds continued to sell their investments in 2009, while life insurance funds started to buy back.

Figure 4.9 Net investments in the financial market of long-term life insurance funds



Source: Author's calculation based on the MQ5 survey

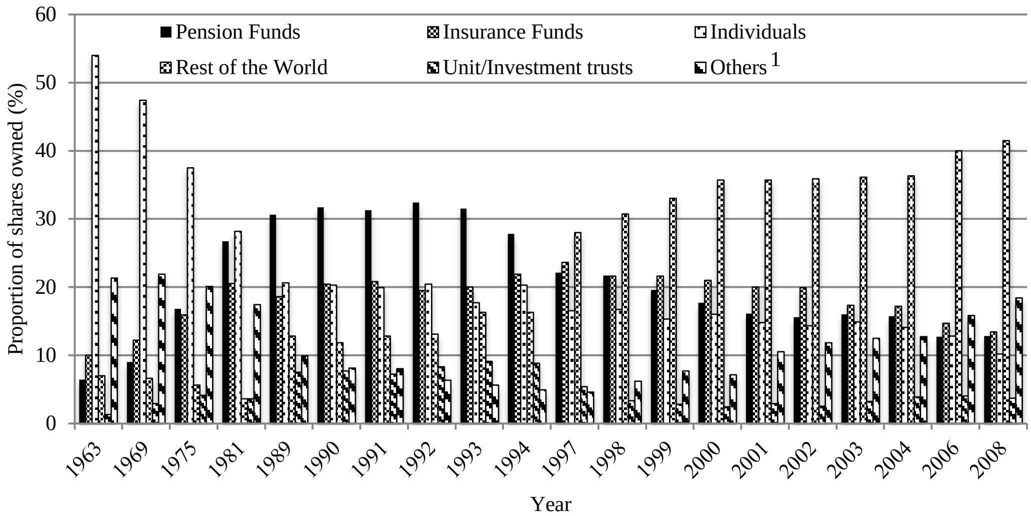
Figure 4.10 Net investments in the financial market of self-administered pension funds



Source: Author's calculation based on the MQ5 survey

Figure 4.11 shows the proportion of UK shares owned by each sector of the market. As can be seen, the proportion owned by pension funds increased dramatically from approximately 6 per cent in 1963 to approximately 32 per cent in 1990. During 1993, the UK pension funds had the highest equity allocation in the world at around 78 per cent of the total asset value. This level was even higher than the level at 70 per cent observed in 1986. The proportion of UK shares owned by insurance funds, covering pooled pension funds managed by insurance companies, also rose gradually from 10 per cent to approximately 20 per cent.

Figure 4.11 Proportion of UK shares directly owned by different market participants



1 "Others" sector includes other financial institutions, banks, charities, public sectors and private non-financial companies

Source UK Share Ownership Data, Office for National Statistics

In contrast, the proportion of individuals who directly owned equity sharply decreased from approximately 50 per cent in 1963 to only 10 per cent in 2008. Unit and investment trusts only owned a small amount percentage of shares in the market. The decline in the proportion of shares owned by pension funds and insurance funds since 1998 stemmed from an increase in money flows from abroad. However, this decline in the proportion of shares owned by pension funds and insurance funds does not imply that these financial institutions significantly reduced their investment in the equity market. The reason for this is that an increase in ownership by overseas sectors may be the result, partly, of the acquisition of additional capital issued by UK listed companies. There was evidence that UK firms tended to issue more shares at high prices to reap the benefits of the high demands from foreign investors. Regarding the ownership structure of UK government bonds, the MQ5 survey by the ONS shows that pension funds and insurance companies actively increased their holdings in GILTs which can partly offset overseas investors over the past twenty years.

4.3.2 Theoretical discussion involving the proposed hypothesis

As shown in the figures above, pension funds and life insurance funds manage a sizable value of assets relative to other institutional investors. Fund flows and asset allocations of these financial institutions may have some impact on the prices and returns of financial assets. The dramatic increase in equity prices over the past 20 years may partly be explained by the large net investments of pension funds and life insurance funds. Although some economists argue that the large trading volume of institutional investors may only influence asset prices and returns in the short-term, but in the long-term prices tend to move towards their fundamental value, a long-term impact from the trading of demographically-sensitive financial institutions on the financial market may be possible because cash inflows and outflows from these funds are substantial in absolute money value, and these fund flows tend to depend on a slow-moving demographic pattern. Some economists may also contend that a larger proportion of securities being held by well-informed large institutional investors should help to keep asset prices at an efficient level. Asset allocation decisions should be made more efficiently compared to direct investment of households because pension funds have more knowledge and skills to shift the portfolio at will. However, the institutionalization in the financial market also implies that demands for and supplies of each particular asset are likely to be more homogenous over time. Rather than making investment decisions separately, heterogeneous individuals who put their money in the same fund will always make the same decisions on buying and selling certain financial securities. This could potentially lead to a scenario where the demand curves of asset prices are not perfectly horizontal as suggested by the efficient market hypothesis.

In addition, consistently large trading orders over a long period of time by pension schemes could potentially move asset prices higher or lower than their fundamental values in the long term because the valuation of financial assets tends to be more subjective rather than objective. It is difficult to reach a consensus on the appropriate level for a company’s capitalization value. The market price valuation of financial assets can be at any level, depending on the assumptions and valuation methodologies that each investor uses to discount the expected future cash flows of the firms. Therefore, it is possible that other market participants may perceive the new level of asset prices, which has been gradually caused by the trading activities of pension schemes, as a new fundamental value even though this new fundamental level may be inconsistent with the historical valuation.

To illustrate this point, the expensiveness of securities is not measured by only its own price levels, but by the ratio between its price and its capability to generate future cash flows. The price-to-earning ratio (P/E) is often considered as one of the main measure that investors use to gauge the expensiveness of stocks. In theory, the P/E ratio should fluctuate fairly closely around its constant long-term level, that is, an increase in prices can only be maintained if earnings can rise to support those prices. However, this relative expensiveness of the prices might be different during different periods, even though the average expectations about the future prospects of the firms are similar. During periods of high demand for financial assets, the prices of the assets may be traded at high P/E, or high price-to-dividends (P/D) ratios for a long duration. The presence of a price 'bubble' is an example of irrational demand and supply in the financial market, which are inconsistent with the valuations based on the efficient market hypothesis. It has often been noted that when equity prices are traded at too high P/E ratios, it has often been followed by a period of abnormal negative returns, and vice versa (Shiller, 1980; Cochrane, 2011). The presence of trend followers and speculators, who often trade without considering much fundamental information about the assets, could also make asset prices to diverge significantly from their fundamental values.

All of those empirical examples tend to suggest that financial asset prices are not actually traded according to what the efficient market hypothesis suggests. Previous research explains the anomaly in the expensiveness level of stock prices after the late 1950s as being caused by a reduction in risk aversion coefficients of baby-boomers (Malkiel, 1999; Shiller, 2000). Blanchard, Shiller and Siegel (1993) argue that this reduction in the degree of risk aversions may result from the benefit of diversification that institutional investors offer to households. Because pension funds take the pooled risk from diverse households, the aggregate degree of risk aversions should be lower than the individual level of each heterogeneous investor (Davis, 1988). Nonetheless, some pieces of research have found that a sharp increase in equity prices over the past 40 years was relatively larger than the level that can be explained by the reduction in risk aversion coefficients of households. For example, Mehra and Presscott (1985) suggest that equity returns in excess of the risk-free rate should be no more than half a percentage point compared to the actual value of six. Campbell and Cochrane (1999) also argue that the cost of volatility in prices of risky securities or economic fluctuation is too high in magnitude, which is not consistent with the standard C-CAPM model. Therefore, a dramatic increase in equity prices over the past decades may, instead, largely be caused by the institutionalisation in the financial market which has substantially increased the participations of households since the 1960s. Because there are no other markets, apart from the equity and bond markets, that can provide a high level of liquidity at greatly cheap costs, financial asset prices may be supported over time by the constantly net inflows of households' savings into institutional investors.

After the presence of pension schemes since the 1960s, households have been able to participate more freely in the capital market (as opposed to directly purchasing equity themselves). There has been an increase in positive cash inflow into these pension schemes as previously shown in Figure 4.10. Since there are more baby-boomers than the population of the preceding and succeeding generation, the demand for and supply of certain financial assets, indirectly through pension schemes, may be imbalanced. This imbalance could cause asset prices to be adjusted to a new level. As a consequence, demands for and supplies of a particular asset class by pension funds would have an influence on financial market prices and returns to extent certain degree.

A number of factors could also intensify the impact of large trading orders of these pension schemes. Firstly, pension schemes across the market may have the same investment principle when they allocate their assets, leading to a scenario where large trading orders of many pension schemes are coincidentally occurred nearly at the same period. One main distinction of pension funds from other institutional investors is their liabilities which depend on the age structure of their plans' beneficiaries. Because DB pension funds have legal obligations to provide pension incomes for their retired members, asset allocations of these financial institutions, which determine demands for and supplies of a particular financial asset class, may be sensitive to the movement of demographic patterns. They will supposedly move their asset allocations towards instruments that can provide safe, periodic cash flows or they may have to sell part of their assets in order to finance payments when large proportions of their plan members are retired. Because the shift in the national demographic structure is the primary factor that affect the ageing of plan members across all pension schemes in the industry, asset allocations of each pension scheme may response to this common demographic shift similarly at the same time. The “herding” movement of pension investments from one asset class to another would, therefore, have a significant impact on financial asset prices and returns.

Secondly, the effect of large trading on the level of asset prices tends to be dependent on the robustness and deepness of market makers in such markets. The liquidity risk of large trading volumes in one side when most institutional investors decide to change their investment allocations would potentially cause short-term price volatility, especially in the markets that are not deep enough. This acute price swing, initially triggered by the large trading of pension schemes, could also be intensified if other market participants do not prepare to encounter this sharp volatility. For example, if some other institutional investors have previously had leveraged positions of financial assets at high prices during the period when pension funds accumulate assets, the decumulation of financial assets by pension funds, which causes a downward pressure on asset prices, can have a severe impact on those leveraged positions leading to a shortage of capital in the market. The market price will decline substantially greater than the pure effect of pension fund trading. The stock market crashes in 1987 and 2008 are good examples of this liquidity factor that causes a widespread impact on many financial markets around the world.

Thirdly, large supplies of financial assets in certain asset classes, which occur when pension schemes start decumulation, could create a negative sentiment to the wide market, even though this supply and demand of demographically-linked financial institutions may not indicate any changes in the fundamental information about the future prospects of the underlying assets. This feedback amplification mechanism is possible particularly in the low-efficient financial market. When investors see stock prices plunge, they may start to have less confidence and make inferences from the price drops by forming too pessimistic outlooks. Then, asset prices will drop even further, enticing other investors to sell. This vicious cycle can only be broken when there is new information that changes overall market perception. Therefore, the aggregate investors' perception on the valuation of financial assets could be systematically misled by these supplies and demands that are driven by demographic shifts rather than by fundamental changes in future expected returns to capital of the assets.

If this causality between demographic structures and the financial market is verified, one may expect to see a decline in certain asset prices. At the same time, prices of other financial asset classes may increase as a result of the shift in pension schemes' investment strategy in response to the demographic transition. Because financial assets are instruments which store the value of money over time, there may be less incentive to invest when baby-boomers moves toward retirement. The retirement of baby-boomers may lead to a situation where the demand for capital, indirectly through pension schemes, will be relatively less than the supply. In contrast, prices of some financial asset classes such as fixed-income securities or other safe assets may be push upward as pension schemes increase their investment positions. In the other possible scenario, market prices of risky assets may not drop significantly if future earning outlook remains intact, but the downward pressure on prices from the supplies of demographically-link financial institutions may reduce the premium included in the asset prices; therefore, the risk-return characteristics of financial assets may still change from the historical experience.

The following section will explain research plans that attempts to investigate whether the presence of demographically-link financial institutions, such as pension funds, over the past 50 years would be the main underlying mechanism that lead to a strong correlation between demographic variables and the financial market.

4.4 Research plans and contributions

This paper attempts to explore underlying causal mechanisms between demographic transitions and financial markets by proposing that the presence of financial institutions is the key-interconnecting element linking the movement of demographic structures with the movement of financial asset prices. Pension funds are examples of financial institutions whose liabilities are dependent on the dynamics of demographic shift. The age structure of the funds' beneficiaries is a crucial element influencing the asset allocation decisions of these financial institutions. If the majority of these demographically-linked institutional investors possess the same investment beliefs as to how assets should be allocated in response to the age profile of fund members, the retirement of baby boom cohorts and the increase in life expectancy of the population could have a significant impact on prices and returns in the financial market.

There are three main topics which need to be investigated in order to test the main hypothesis. The first issue is to test which age variables have a statistical significant relationship with financial asset prices. The graphical illustrations in this chapter do not provide robust statistical results proving that the correlation of demographic variables and financial asset prices is stronger during the period after the 1960s than the prior period. The analysis in chapter 5 will involve the use of some statistical techniques to specify a structural break in the time-series data. After the structural break has been determined, the time-series regression analysis will be applied so as to estimate the age group that has the most significant relationship with prices of equities, P/E ratios, dividend yields and prices of GILTs at different maturities. The finding from this analysis is crucially one of the main elements that help identify whether the households' lifecycle saving decision through pension schemes is the main mechanism that significantly affects asset prices.

The second topic of the research is related to the lifecycle saving decisions of households through different investment opportunities. This research is presented in chapter 6. It is necessary to estimate whether the actual lifecycle saving decisions by households demonstrate hump-shaped age patterns, as the lifecycle hypothesis suggests it will. If the elderly do not have high rates of dissaving, the relative supply of capital from the direct investments of retirees will not be sufficiently large to create significant pressure on financial asset prices and returns. In analysing household saving decisions, all available existing investment opportunities that households can choose should be considered, namely direct ownership in financial markets, investment in mutual funds, savings in occupational pension plans and private saving in personal retirement plans. It is important to analyse the behaviour of household participations in pension schemes because the presence of pension funds may be the main reason explaining why many previous literature tended not to find evidence in supporting the lifecycle hypothesis from the direct investment behaviour of households. The research, which includes all those investment opportunities, will explain the complete picture regarding household investment behaviour. After the hump-shaped age pattern of household participations in each investment opportunity has been specified, it will then be compared with the age group that exhibits the highest significant relationship with financial asset prices found previously in chapter 5 in order to prove the main hypothesis about the importance of pension schemes in the financial market.

The next topic to be investigated concerns the relationship between demographic structures and asset allocation decisions of DB pension schemes. The investment decisions of these financial institutions represent the decisions of many households. This homogenising effect implies that households frequently take the same actions regarding the asset allocation of their investment indirectly through their investment in pension schemes. This is in contrast to the diverse decisions made by households in terms of their direct ownership of financial assets. The investment decisions of DB schemes are expected to have a direct association with the age structure of their plan members because they need to manage their assets in the way that can generate sufficient returns to support their pension obligations. Therefore, greater understanding of the investment principles of demographically-sensitive financial institutions such as pension funds is necessary in order to prove that the asset allocation of these funds are the interconnecting mechanism linking the impact of demographic patterns on the financial market. Findings from this analysis also provide a good insight in estimating how pension asset allocation will change in the next decades. A detailed study on this issue will be presented in chapter 7.

4.5 Concluding remarks

This chapter presents graphical illustrations regarding the relationship between demographic variables and the capital market. Demographic variables appear to have some relationship with the prices of financial assets. Although the evolution of the FTSE did not mirror the movement of the demographic variables before 1960, the index did not experience any strong upward or downward trend but rather fluctuated over a certain level. The reason for this insignificant relationship at this period may be that the participation rate of households in the financial market was low. Therefore, a rise in the fraction of the working-age population during 1930s did not significantly increase demands for capital in the market.

After 1960, households can participate in the capital market more effortlessly through financial services provided by financial institutions. The presence of occupational pension plans also leads to a dramatic increase in the amount of fund inflows into the financial market during 1970s and 1980s. Aggregate households' savings and dissaving motives, which largely depend on demographic patterns, will determine the amount of fund flows across financial institutions, particularly pension funds, whose liabilities have a direct association with the age structures of their plan's beneficiaries. Since the size of assets under management of these funds is large, asset allocations of these funds may have a significant effect on the prices and returns of financial assets. This may be the reason for a high correlation between demographic variables and the financial market after 1960.

The main research that attempts to investigate this relationship will be presented in chapter 5, 6 and 7. Chapter 5 will presents a research that investigates the statistical relationship between age variables and financial asset prices. Chapter 6 will test a lifecycle saving pattern of households in a variety of available investment options. The analysis about the asset allocation decisions of pension funds in order to examine as to whether their investment decisions are based on the age structure of their plan's members will be illustrated in chapter 7.

Chapter 5: Research investigating the relationship between demographic structures and the financial market

5.1 Introduction

A statistical analysis of the relationship between demographic variables and the financial market will be presented in this chapter. Since the graphical illustrations in chapter 4 do not provide robust evidence of the causal relationship between age structures and financial markets, a time-series regression analysis will be conducted in this chapter. The impact of demographic structures on the financial market is identified by analysing the movement of separated age groups with the movement of real equity returns and the movement of GILT yields. The real level of the FTSE-All Share index, price-to-earning ratios, and dividend yields are the main financial variables used to represent the movement of the UK equity market. Because the movement of stock prices is expected to depend on the future outlook of underlying companies, the price-to-earning ratios and dividend yields used in this analysis will be constructed by using forward earnings of the companies. Regarding the bond market, yields of GILTs with different maturities, i.e. 3-year, 5-year, and 10-year GILTs, are used.

Because the proposed hypothesis argues that the presence of pension schemes since the 1960s may be the main cause of stronger correlations between the financial market and demographic variables, the first part of the research in this chapter will conduct a statistical technique, namely the Chow test statistic, to test the existence of structural breaks in the time-series data. According to the proposed hypothesis, the period of the structural break, which will be tested, is between 1960 and 1970. Results from the Chow test confirm that the structural break in the relationship between demographic variables and the financial market is around 1965 at the 95 per cent confidence level. Following this statistical test, the second part of the research will analyse the impact of each age group on the financial market during the period after 1965. The age groups in this analysis are 5-year age groups starting from the age of 35 to 64. This construction will provide a complete picture of the impact from the dynamic transition of the working-age population on the financial market while the degree of freedom of the regression can still maintain at high levels. Results from the time-series regressions that estimate which age groups have the most significant impact on the financial market will indicate that the saving and investment behaviour of such age groups, either directly or indirectly, may significantly influence the movement of asset prices. The findings from this chapter also provide useful evidence for the test of the proposed hypothesis when they are compared with the results from chapter 6 which studies the lifecycle saving behaviour of British households through the participations in different investment opportunities.

The following section will discuss a number of previous literatures related to the empirical studies of demographic structures and financial asset prices. It will be followed by a detailed explanation about the contributions that this research will provide to the existing literature. Subsequently, explanation about the data and methodologies used in this analysis will be presented. Results from the Chow test and time-series regressions will be discussed thereafter. The chapter will end with a discussion and conclusion of the main findings from this analysis.

5.2 Literature Review

As posited by the lifecycle hypothesis, populations in different age groups will have different investment and saving behaviour in the financial market. Therefore, changes in the relative size among different age groups will determine aggregate net demands for or supplies of a certain financial asset. A number of literatures have found that the level of saving demands tend to be related to the movement of demographic patterns. For instance, Disney (1996), who studies the lifecycle saving patterns of households across many countries, finds evidence consistent with the lifecycle hypothesis that saving rates appear to be relatively low in the countries with a high proportion of retired people. Attfield and Cannon (2003), who use a vector-error-correction model to study the saving patterns in the UK, also discover that the lifecycle dynamic of savings significantly determines changes in the demand for financial assets. This evidence implies that if the price pressure hypothesis for the movement of financial asset prices is warranted, the dynamic of demographic structures, which determines relative demands for and supplies of financial assets, can eventually influence financial asset prices and returns.

Observed strong correlations between the prime age group (40-60/65) and the equity index have motivated many scholars to examine the causal relationship between these two variables. In order to statistically test the null hypothesis of no significant relationship between asset prices/returns and demographic variables, an econometric analysis is often undertaken on certain measures of time-series financial and demographic data. A direct econometric approach between demographic variables and asset returns has been conducted by many researchers. Empirical studies in this area include an analysis within a single country as well as an international comparison among different countries. Yoo (1994a) regresses rates of return from different financial asset classes in the US market with demographic variables. He finds a negative significant relationship between real returns of Treasury bills and proportions of the working-age population, while there is no significant relationship for stock and bond returns because the standard errors are high. He estimates that the dynamic of demographic variables explains nearly 50 per cent of the variation of the real annual returns of Treasury bills. Results from Poterba (2001) are similar to Yoo (1994a), although Poterba also points out that a relationship between the price to dividend ratio and demographic variables appears to be significant. However, Poterba’s (2001) model gives an implausible out-of-sample impact of demographic variables on financial asset prices when the model is used to extrapolate over the next 30 years. The insignificant relationship between equity returns and demographic variables may mainly result from the high volatility of returns data relative to demographic variables. According to the study by the Government Accountability

Office (GAO) in 2006, the variation in the US equity returns can be explained by demographic movements at only around 1 to 8 per cent during 1948 to 2004.

Geanakoplos, Magill and Quinzii (2004) analyse the relationship between the S&P500 index and demographic variables, showing that the ratio of the population aged 40-49 to those 20-29 has a significant relationship with equity prices. Based on their estimates, it can be projected that equity returns will decline by 60 basis points over the next 40 years. Instead of directly finding the relationship between demographic variables and asset prices, Goyal (2004) uses a regression technique to analyse the impact of demographic variables on fund flows of the US stock market. He finds that the fraction of the population aged over 65 is positively associated with fund outflows from the stock market, while the fraction of working-age people is negatively related. After adding demographic variables into the regression models, he finds that the r-squared of the regressions increases by more than 18 per cent. This suggests that demographic variables are significant explanatory variables that explain the movement of fund flows in the market. By using a vector autoregression technique, he predicts that a large selling pressure will occur during 2005-2025 and then decline during 2040.

Typically, research within a single country is difficult to estimate the impact of aging on the financial market because the length and the variation of data may not be sufficient for the econometric technique to find any significant relationships. Misspecification problems normally occur. Therefore, some researchers attempt to apply an econometric analysis in an international context in order to mitigate the misspecification problems. Erb, Harvey and Viskanta (1997) examine changes in non-overlapping stock returns and demographic patterns in 18 developed and 45 developing nations between 1970 and 1995. They find that expected stock returns increase for the countries with a high average age of population but they find no relationship between the world average age and expected returns. However, their results may be confounded by the fact that an increase in the average age of population in developing countries may stem from an improvement in economic conditions, which greatly reduces the rates of mortality and morbidity, rather than directly influencing the market movement. Moreover, Poterba (1998) argues that using only the average age measure cannot capture the whole pattern of lifecycle asset accumulations. The analysis by Brooks (1998) shows a positive relationship between the 40-64 age group and real equity prices for 11 countries from the cross-country data of 14 OECD countries. Davis and Li (2003) perform a regression analysis across seven OECD countries and find the same significant relationship as Brooks (1998). The regression results of Davis and Li (2003) tend to be relatively robust because they control for some non-demographic variables such as economic growth rates and inflation rates. They find that after including the 40-64 age group, the coefficients on other age groups are diminished and the significant coefficient of the 40-64 age group dominates the relationship with real equity prices. Ang and Maddaloni (2003) argue that econometric models that explain the relationship between demographic variables and asset returns in samples from the US could not explain the experiences of other nations. Their regression analysis on the pooled sample from data across various developed countries finds that equity returns will significantly fall only for countries that experience a sharp increase in retirees after controlling for the effect of consumption growths. However, one important caveat of their study is that the equity markets of some countries, such as Denmark, the Netherlands, and Belgium, have a large proportion of foreign ownership. Investment activities of these foreign investors may confound the effect of the shift in domestic demographic structures. Geanakoplos et al. (2004) also conduct regression analysis on other countries, examining the significant effect of the mid-age to young-age ratio. They find weak evidence in Japan and France but no evidence in other developed countries.

Although an international study that uses more datasets may reduce the misspecification problems, findings from this study may be confounded by international capital and labour flows across different countries. For example, investors may move capital from aging economies into relatively younger economies in order to reap higher expected returns. These flows of capital are principally caused by the growth differentials between the relatively high expected returns in the emerging markets and the low expected returns in developed countries. For example, Higgins (1998) shows that relatively young OECD countries, such as the US and Canada, may experience a surplus in the current account relative to other old OECD countries until 2025. Bosworth and Keys (2004) also find similar results to those of Higgins (1998). However, after extending the projection of the demographic impact on the international capital flow from 2025 to 2050, they find that the current account of the young countries will be eventually in large deficits in 2050 as the drop in national saving rates exceeds domestic investment. Other analyses exploring how different growth rates of population in different countries could have an impact on international capital flows are presented in Bryant (2004), Helliwell (2004) and Goyal (2004).

Aside from the significant relationship between the age structure and the financial market, Mankiw and Weil (1989) also find significant evidence of the impact of demographic structures on the housing market. They specify that the proportion of working-age population will determine housing demands and these housing demands have a positive function with rental prices. The peak in housing demands during the period of high fractions of the 35-44 age group found in Mankiw and Weil (1989) is consistent with the findings by Bossons (1973). After incorporating demographic projections, they show that US house prices would eventually decline during 1990 and 2010 from a dramatic increase of 14 per cent per annum during the 1980s. They estimate that the housing value will plunge by 47 per cent in 2007. However, the impact of the demographic transition on house prices is more complicated than the direct impact from the demand and supply mismatch. This is because population ageing is also expected to cause a decline in the rates of return. Low returns to capital are normally associated with low interest rates. Therefore, this causality should stimulate housing demands which lead to a positive impact on house prices. Moreover, some researchers contend that the findings from Mankiw and Weil (1989) may be unreliable. Hendershott (1991) proves that the estimated equations of Mankiw and Weil (1989), while fitting very well with prices data in the 1950s and 1960s, cannot accurately forecast house prices during the 1970s and 1980s. Poterba (1992) also argues that the relationship between demographic structures and the housing market, found in Mankiw and Weil (1989), does not represent a generic causality that can apply in countries other than the US. When he applies the Mankiw and Weil's (1989) model with the Canadian data, he finds that the coefficient estimates are mostly insignificant and in some cases have the opposite directions to the original findings. Additionally, Holland (1991) shows that the estimations in Mankiw and Weil's (1989) equation may be biased from a spurious regression[19] because housing demands are non-stationary. He argues that the real factor that drives housing prices is the switching demand from renting to owning a house, rather than the demographic transition. Bergantino (1998) modifies the methodology of Mankiw and Weil (1989) in examining age-specific demands for equity and housing assets. Based on cross-sectional data from the Survey of Consumer Finance (SCF), he shows that demographic demands on assets can explain the movement in equity values during the post-war period.

Apart from the regression analysis that directly investigates the relationship between demographic transitions and asset prices, some researchers attempt to test this relationship by analysing how the degree of risk aversions varies with ages. A rationale behind this study is that the degree of risk aversion can be considered as the main underlying factor that determines lifecycle investment patterns of households. Middle-aged investors are expected to receive regular labour incomes over a long period; therefore they can accept high risks from equity investment. In contrast, incomes of investors aged more than 50 tend to rely more on the returns of their savings. This situation limits the degree of risk they can tolerate. By using an evolutionary model, Rubin and Paul (1979) show that the old are less likely to take risks compared to the young. As shown in Suarez and Morin (1983), the lifecycle degree of risk aversion appears to significantly affect household portfolio allocations at different ages. With this in mind, the fluctuation of age structures in the economy could partly attribute to the fluctuation in aggregate risk premiums. For example, an analysis by Campbell and Shiller (2001) illustrates that high returns in the US stock market over the past two decades stem from the decreasing level of risk aversions of baby-boomers who purchased stocks at relatively high prices when they are at the working-age period. According to the assumption that the risk tolerance of an individual may decline as he or she ages, aggregate demands for risky assets in an ageing society, will decline, thus leading to a reduction in asset prices. In other words, the price of risk will increase over time as the average age of population rises.

[19] A spurious regression is referred to a statistical relationship between variables that do not actually have causal connections. The high correlations may result from the coincidence or the presence of other confounding factors.

Many researchers conduct econometric analyses to estimate lifecycle risk-aversion coefficients from a particular utility function. Even though a study by Bergantino (1998) shows no significant relationship between risk aversion coefficients and ages for the sample during 1946 and 1997, a study by Bakshi and Chen (1994) illustrates a strong evidence of an increase in the degree of risk aversion as household ages. They test this hypothesis by fitting the Euler equation of intertemporal variation of aggregate consumption with risk aversion coefficients that vary as individual ages. Modelled on the US population during 1946 and 1990, they discover that the goodness-of-fit of the equation when including varied risk aversion coefficients could be enhanced. As a result, they argue that if a strong linkage between ages and the degree of risk aversion exists, the market equilibrium risk premium should be correlated with changes in demographic patterns. Riley and Chow (1992) investigate asset allocations of individuals at different ages in order to derive risk aversion measures. They find that risk tolerance declines significantly after the age of 65, which is consistent with the finding by Harlow and Brown (1990). The risk aversion coefficient is also expected to affect the elasticity of investment. From a two-period overlapping generational model, Cai (2004) shows that a highly risk-averse individual will have relatively low investment elasticity. This low elasticity implies that the market prices of financial assets are unlikely to be absorbed by variations in the supply of capital when demands have changed. Asset prices can be appreciated faster than the growth rates of the returns on capital. Therefore, combining the research between Bakshi and Chen (1994) and Cai (2004) would suggest that the demographic transition over the next decade following the retirement of baby-boomers may lead to a significant decline in asset prices, mainly due to a liquidity trap. Lashgari (2008) argues that the need for liquidity of baby boom retirees can lead to a marginal decline of around 1 per cent annually for the rates of return on common stocks.

However, Poterba (2001) argues that those studies on the varied risk aversion coefficients only provide limited support regarding the effect of demographics on the financial market. Because the results of Bakshi and Chen (1994) are inconsistent with the finding from Barsky, Kimball, Juster and Shapiro (1997) who discover that the degree of risk tolerance is highest at both the young and old age group, Poterba (2001) suggests that the use of the average age measure, which cannot capture the whole age profiles, in the analysis of Bakshi and Chen (1994) may be the main source of the inconsistency. Moreover, the research in this area is conditional on the assumptions used to construct a utility function that represent household consumption behaviour. Therefore, results from those studies may be suffered by the misspecification or identification of the equations used to calculate the risk aversion coefficients.

An alternative econometric analysis concerning the demographic transition's effects on the capital market is that corporate policy will change in response to an ageing society. Goyal (2004) shows that cash payout policies are positively related to the proportion of retirees. Higher cash payouts from dividend and share repurchases will further reduce expected equity returns. Even though he finds a strong relationship between financial asset returns and demographic variables, the economic effects are not large enough to drastically influence asset prices.

5.3 Contributions of this research to the existing literature

Overall, previous studies appear to find evidence of a strong relationship between financial asset prices and demographic patterns. By using a time-series regression analysis, a significant relationship is often found between the proportion of the working-age population and annual real returns of government bonds. However, a number of literature shows that the movement of demographic variables is insignificantly related with real returns of equity. One main reason for this finding is that standard errors from the regressions are normally quite high. The power of the regression will greatly be diminished when regressing a high-frequency dependent variable with slow-moving explanatory variables. This stems from the fact that the volatility in equity prices is much higher than the slow-moving process of demographic variables. It is difficult for econometric techniques to extract the effect of demographic transitions from the movement of equity prices and returns which generally include substantial noises. The volatility of equity returns also depends on the length of the measured period of returns. For example, annual returns of stock prices contain larger noises than the estimate of 3-year returns. Since most previous studies normally investigate the relationship between demographic variables and annual returns of equity prices, it is unsurprising that the time-series regression could not find a significant relationship between these two variables. For instance, Yoo (1994a) and Poterba (2001) find that the coefficient between the proportion of the prime age group and annual equity returns is insignificantly different from zero.

Because the dynamic of demographic patterns is slow, demands for and supplies of financial assets should be slowly adjusted over the long period of time. In order to test this potential relationship, the research in this chapter will regress the long-term real equity returns, i.e. 3-year and 5-year arithmetic real returns, with the dynamic of demographic variables. However, measuring the returns over the period of 3 years or 5 years will greatly reduce the number of observations if the return variables are non-overlapping. Therefore, this study will use the 3-year and 5-year overlapping returns of equity prices as the dependent variables for the regression analysis such that the degree of freedom of the regression still maintain at high levels. The detailed discussion on the methodology used to compute these returns variables and the explanation about the statistical technique used to eliminate the autocorrelation problem resulting from the use of overlapping returns will be presented in section 5.4.

Moreover, most existing literature normally investigates the relationship between demographic variables and the returns data of equity or bond prices. Erb et al. (1996) link the average age population with equity returns. Poterba (2001) links the proportion of the prime age group and the old-age dependency ratio with annual real equity returns. Davis and Li (2003) regress log returns of real equity prices with the proportion of certain demographic variables. Those studies appear to relate the movement of the "level" variables, i.e. the proportion of the population at a certain age group, with the movement of the "differenced" variables, i.e. the returns of stock prices or bond prices. A regression between the returns data and the level of demographic variables appears to provide a statistical test for the hypothesis that argues the shift in demographic variables may influence expected returns of financial assets. However, this hypothesis is different from the hypothesis about the impact of the demand and supply mismatch caused by demographic shifts on the level of real equity prices. In order to test whether the variations in the proportion of certain age groups will positively be related with the movement of real equity prices, the research in this chapter will use the n-year percentage changes in the fraction of population in certain age groups as explanatory variables rather than the direct "level" estimate of the proportions of population.

The use of the n-year percentage changes in the population estimates also appears to reduce a potential bias from a spurious regression. The time-series movement of the "level" variables, such as the proportions of population in certain age groups, typically contain a unit-root. Unit-roots in a time-series variable will make such variable non-stationary. If one of the variables in a regression model is non-stationary, regression results will be severely biased. By differencing a "level" variable, a unit-root in the variable will be eliminated. As a result, using the n-year percentage changes in the population estimates as explanatory variables should provide a more robust statistical inference than using the level of the population estimates. A detailed illustration of the unit-root tests will be shown in section 5.4. In addition, standard errors from a regression model with "differenced" variables are normally larger than those from a model with "level" variables. Therefore, any statistically significant coefficients found from the regression between n-year equity returns and n-year percentage changes in the demographic variables should provide strong evidence in supporting the relationship between these two variables.

Unlike previous literatures that investigate only a few demographic variables, the research in this paper attempts to examine the impact of changes in the proportion of population over the lifecycle on financial asset prices. The main demographic variables that are often used in previous studies are the proportion of the prime working-age people (Poterba, 2001), the old-age dependency ratio (Poterba, 2001), the middle-aged to young ratio (Geanakoplos et al., 2004) and the average age of population (Bakshi & Chen, 1994; Erb et al., 1996; Davis & Li, 2003). All these variables only indicate a rough picture of the impact of population ageing on certain financial assets. They do not provide detailed evidence about the impact of the full lifecycle age profile on financial asset prices. As argued in Poterba (1998), the average age measure cannot accurately represent the complete profile of lifetime asset accumulation. In certain circumstances, there is a possibility that the average age may stay constant while a relatively large proportion of a certain cohort is moving from young to old age groups.

The main concerns in a time series regression analysis are the variability and size of the sample used in the estimation. Since demographic structures are normally estimated annually, it is difficult to increase the degrees of freedom of the regression estimates. One possible solution would be to expand the time horizon as long as possible so as to increase the number of observations. However, this may not be adequate to maintain a high degree of freedom if the number of independent variables is still large. In order to reduce the number of explanatory variables on the right hand side of the equation, 5-year age groups over the full lifecycle of households during the working-age period are used in this research. These 5-year age groups also provide more information than some previous literature that normally groups the demographic patterns into a 10-year and 20-year age band. For example, Geanakoplos et al. (2004) break the age pattern into three 20-year age groups representing the young, the middle-aged, and the old. These rough classifications cannot capture the detailed impact of the age distribution on the financial market. Even though Macunovich (1997) uses 12 demographic variables to represent the complete profile of the lifecycle and finds that these variables have an explanatory power on the variation of the US equity real returns after the war period, her results are likely to be biased by the overfitting problem.

Furthermore, the main financial variables that are used in the existing literature normally include the real returns of equity prices and bond prices. This research attempts to investigate further by analysing the impact of demographic variables on the price-to-earning ratios, dividend yields and bond yields. In general, dividend yields and P/E ratios are calculated from the 12-month trailing average earnings of a company. However, the number from this calculation may not actually represent the actual expensiveness of stock prices. Typically, investors are assumed to make investment decisions based on the expectation about future outcomes not the past results. They will make a forecast about future cash flows of a company and discount these cash flows into current market prices. This implies that a high price-to-earning ratio calculated from 12-month trailing earnings may not actually indicate that stock prices are expensive than other companies. In contrast, it may suggest that investors expect to see a sharp growth rate in future earnings of the company. Therefore, research findings from Poterba (2001) and Geanakoplos et al. (2004) who estimate the impact of demographic variables on the P/E ratios and dividend yields that are calculated from 12-month trailing earnings may not provide a precise picture about the impact of demographic structures on the expensiveness of stock prices. A more appropriate approach to calculate the price-to-earning ratios and dividend yields is to incorporate future expectations of earnings. Dividend yields and P/E ratios that use future earnings in the calculation are often called “forward” dividend yields or “forward” P/E ratios respectively. The detailed calculation of these forward measures will be illustrated in section 5.4.

The research in this chapter also introduces an analysis that attempts to estimate the existence of a structural break in time-series data. To my knowledge, this is the first research that uses a statistical test to estimate a breaking point in the time-series relationship between demographic variables and the financial market. Most literature in the past often used the end of World War II as a potential breaking point. This may be because this period was related to the emergence of baby-boomers and the beginning of the economic prosperity. For example, Geanakoplos et al. (2004), Poterba (2001) and Bakshi and Chen (1994) arbitrarily use the breaking point in the time series data to be in 1945 or 1947. However, these locations may not be a statistically significant breaking point in the time-series relationship. Moreover, the insignificant relationship between asset prices and demographic variables found in Poterba (2001) and Geanakoplos et al. (2004) may result from the fact that these studies do not consider a possibility of the existence of a structural break in the time-series data. The statistical technique used to specify a breaking point is the Chow test statistic. The detailed calculation and the regression process to obtain this statistic will be presented in the next section.

5.4 Data and methodologies

This section explains the main dataset and statistical techniques used in the research of this chapter. Financial variables for the analysis include the FTSE-All Share index, P/E ratios and dividend yields of all companies in the FTSE-All Share index, and yields of GILTs at different maturities. All these financial variables are obtained from the Global Financial Data (GFD). The length of the time-series of each financial variable is different, depending on the availability of data collected by the GFD. The longest period of the financial variables is the level of FTSE-All Share index, which starts from 1911. This long time-series greatly increases the effective number of observations, which helps explain the relationship between the financial market and demographic structures. All the financial variables used in the analysis are on an annual basis. Even though quarterly data of financial variables is available and the use of this quarterly data can greatly increase the degrees of freedom of the regression, this quarterly data cannot be used because the UK population estimates are measured on an annual basis. The main data for demographic structures is obtained from the mid-year ONS population statistics, which are dated back to 1911.

The FTSE-All Share index is used to represent the movement of the UK equity market. The index level is deflated by the Consumer Price Index (CPI) in order to factor out the inflation effect over time. The real returns of the FTSE-All Share index, used in the regression model, are calculated in the form of arithmetic returns as shown in Equation 5.1. These arithmetic returns will comply with the calculation of the n-year percentage changes in the demographic variables. This analysis uses 3-year and 5-year overlapping returns. Even though, the volatility in asset returns appears to include the effect of changes in the return to capital while the movements of asset prices tend to largely be corresponded to the variation in the supply and demand mismatch, returns calculated only from the changes in observed prices rather than using the total returns, which include dividends and returns from reinvestments, could be used to test the hypothesis about the demand and supply mismatch caused by demographic shifts on financial asset prices.

$$n - year\ arithmetic\ return = \frac{P_t - P_{t-n}}{P_{t-n}} \qquad \_\_\_\_\_\_(5.1)$$

The price-to-earning ratios and dividend yields obtained from the GFD are calculated from 12-month trailing earnings. As discussed in the previous section, a more appropriate measure for the expensiveness of stock prices needs to involve a forward-looking forecast of future earnings. However, the GFD does not explicitly provide information about earnings and dividends of all firms listed in the FTSE-All Share index. In order to estimate earnings and dividends for each year, the index level and the P/E ratio of all underlying firms at the end of the first quarter in a certain year are used to estimate the full earnings of the companies in a previous year (Equation 5.2). The main reason to use the index level at the end of the first quarter is that the full-year earning results of underlying companies are generally announced in February. In other words, earnings of companies for each quarter are normally announced during the 15-45 days after the end of the quarter. Therefore, the 12-month trailing P/E ratios at the end of the first quarter, obtained from the GFD, are calculated by using the earnings of the previous four quarters (Quarter 1 to 4 of the previous year). This calculation process also applies to the 12-month trailing dividend yields in order to obtain the last 12-month dividends of underlying companies (Equation 5.3).

$$[Earnings]_{(Q1-Q4\ during\ year\ t-1)} = \frac{P_{(at\ the\ end\ of\ Q1, year\ t)}}{[12-month\ trailing\ PE]_{(at\ the\ end\ of\ Q1, year\ t)}} \qquad (5.2)$$

$$[Dividends]_{(Q1-Q4\ during\ year\ t-1)} = \frac{(12-month\ trailing\ DY)_{(at\ the\ end\ of\ Q1, year\ t)}}{P_{(at\ the\ end\ of\ Q1, year\ t)}} \qquad (5.3)$$

After obtaining the full-year earnings and dividends of all underlying companies in each financial year, the forward P/E ratios and dividend yields at the end of each year are calculated by using the full-year earnings and dividends of the next 12 months. For example, the P/E ratio in 1960 is calculated from the price of the FTSE-All Share index at the end of 1960 divided by the earnings of all firms in the index during 1961 (Equation 5.4). This calculation method is also applied to the computation of the forward dividend yields (Equation 5.5). This calculation of the forward measures assumes that market participants have a perfect foresight about future earnings of the companies in the next 12 months before making investment decisions.

$$(FW\ PE)_t = \frac{P_t}{E_{t+1}} \qquad (5.4)$$

$$(FW\ DY)_t = \frac{DY_{t+1}}{P_t} \qquad (5.5)$$

The main demographic variables that are used for the analysis include the proportion of 5-year age groups from the age of 35 to 64 and the proportion of adult populations (20-60/65). As discussed in section 5.3, the n-year percentage changes in the fraction of these demographic variables will be used in the regression models. These differenced variables can be considered as the overlapping growth rates of the proportions of population in each age band. The range of the age profile in this analysis can only include the ages between 35 and 64 otherwise a severe multicolinearity problem will occur. This multicollinearity problem results from the fact that the cohort aged 35-39 in 1965 will be 65-69 years old in 1995. This implies that the growth rates of the 35-39 age group will be significantly correlated with the growth rates of the 65-69 age group if the length of the time-series is greater than 30 years. The correlation matrix in Table 5.1 and Table 5.2 will illustrate this point.

As can be seen, the 3-year overlapping growth rates of the proportion of 35-39, 40-44, and 45-49 are significantly correlated with the 3-year overlapping growth rates of the proportion of 65-69, 70-74, and 75-79 respectively. These significant correlations also exist for the 5-year overlapping growth rates shown in Table 5.2. The main reason for the negative significant correlations between those pairs of demographic variables is that these age groups cover a large fraction of baby-boomers. Since the numbers of baby-boomers are relatively larger than the preceding and successive cohorts, the growth rates of the population aged 35-44 were relatively larger than those of other age groups during the 1960s and 1970s. The ageing of the baby-boomers to 65-74 years old during the 1990s and 2000s also causes the growth rates of these age groups to be relatively larger than those of other age ranges. This dynamic of the ageing of the baby-boomers is the main cause of the negative significant correlations seen in Table 5.1 and Table 5.2.

Table 5.1 Correlation matrix of 3-year percentage changes in the fraction of each age group

	3-year changes in the proportion of each age group							
	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74
35-39	1							
40-44	0.0127	1						
45-49	-0.3379	-0.2206	1					
50-54	0.1914	-0.0489	-0.3528	1				
55-59	0.1406	0.2008	-0.0748	-0.31	1			
60-64	0.1093	-0.116	0.129	-0.0113	-0.3774	1		
65-69	-0.7549*	0.1576	-0.1168	-0.1501	-0.1016	-0.3042	1	
70-74	0.0459	-0.7390*	0.2067	-0.1015	-0.13	-0.0423	-0.3138	1
75-79	0.3663	0.1037	-0.6962*	0.248	-0.0764	-0.0929	-0.0195	-0.2636

Note: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05

Table 5.2 Correlation matrix of 5-year percentage changes in the fraction of each age group

	5-year changes in the proportion of each age group							
	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74
35-39	1							
40-44	0.0653	1						
45-49	-0.3231	-0.0986	1					
50-54	0.2387	-0.0861	-0.2116	1				
55-59	0.1964	0.2002	-0.1155	-0.1714	1			
60-64	0.1069	-0.0355	0.0806	-0.0647	-0.1753	1		
65-69	-0.7812*	0.0555	-0.1217	-0.2518	-0.1612	-0.2209	1	
70-74	-0.0164	-0.7776*	0.0923	-0.0846	-0.2038	-0.132	-0.1863	1
75-79	0.4512	0.0118	-0.7234*	0.1847	-0.0675	-0.1658	-0.0306	-0.1080

Note: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05

The main statistical technique used in this research involves a time-series regression analysis. One of the main concerns about the time-series regression is the presence of a unit-root in dependent and explanatory variables. The time-series movements of the “level” variables, i.e. asset prices and proportions of population, normally contain a unit-root. It is important to test for the existence of the unit-root because the unit-root will lead to incorrect statistical inferences, often known as spurious results (Granger & Newbold, 1974). The augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test are used in this research to test the null hypothesis of having unit roots for all variables in the model. The PP test can be viewed as a modified Dickey-Fuller test which provides greater robustness to the biases stemming from autocorrelation and heteroskedasticity. Because financial and demographic variables used in the regression model of this research are the returns data and n-year growth rates of the population estimates, these differenced variables normally have eliminated the unit-root in time-series variables. A series of the ADF and PP tests for the variables used in the regression models are shown in Table 5.3. The table presents for each regression, the t-statistics of the ADF and PP tests, the number of lags used in the regression of the ADF tests and the Mackinon approximate P-Value. As can be seen across the board, t-statistics for all differenced variables can clearly reject the null hypothesis at the 5 per cent significant level, with the only exception of the 5-year overlapping changes in 3-year and 10-year GILTs yields.

Table 5.3 Results from the augmented Dickey-Fuller test and Phillips-Perron test

	Augmented Dickey-Fuller Test			Phillips-Perron Test	
Variables	Test Statistics	lags(#)	p-Value	Test Statistics	p-Value
FTSE-All Share Index					
3-year overlapping real returns	-4.904	4	0	-5.039	0
5-year overlapping real returns	-4.86	3	0	-4.21	0.0006
FW PE of FTSE-All Share Index					
3-year overlapping changes	-3.366	4	0.0122	-4.887	0
5-year overlapping changes	-3.322	1	0.0139	-3.762	0.0033
FW DY of FTSE-All Share Index					
3-year overlapping changes	-4.302	4	0.0004	-5.585	0
5-year overlapping changes	-3.984	1	0.0015	-4.85	0
3-Year GILT Yields					
3-year overlapping changes	-3.743	2	0.0036	-3.529	0.0073
5-year overlapping changes	-2.7	1	0.074	-3.769	0.0032
5-Year GILT Yields					
3-year overlapping changes	-2.926	4	0.0424	-5.034	0
5-year overlapping changes	-3.239	2	0.0179	-3.799	0.0029
10-Year GILT Yields					
3-year overlapping changes	-3.842	2	0.0025	-3.749	0.0035
5-year overlapping changes	-2.002	2	0.2855	-2.374	0.1493

Table 5.3 (continued) Results from the augmented Dickey-Fuller test and Phillips-Perron Test

Variables	Augmented Dickey-Fuller Test			Phillips-Perron Test	
	Test Statistics	lags(#)	p-Value	Test Statistics	p-Value
Proportions of 20-65					
3-year overlapping changes	-3.589	4	0.006	-3.873	0.0022
5-year overlapping changes	-4.375	2	0.0003	-3.252	0.0172
Proportions of 35-39					
3-year overlapping changes	-4.034	4	0.0012	-3.434	0.0098
5-year overlapping changes	-3.346	4	0.0129	-3.074	0.0285
Proportions of 40-44					
3-year overlapping changes	-3.656	4	0.0048	-3.498	0.008
5-year overlapping changes	-4.496	2	0.0002	-3.18	0.0212
Proportions of 45-49					
3-year overlapping changes	-3.737	4	0.0036	-3.521	0.0075
5-year overlapping changes	-5.01	2	0	-3.303	0.0147
Proportions of 50-54					
3-year overlapping changes	-4.336	4	0.0004	-3.71	0.004
5-year overlapping changes	-5.129	2	0	-3.404	0.0108
Proportions of 55-59					
3-year overlapping changes	-3.872	4	0.0023	-3.459	0.0091
5-year overlapping changes	-5.134	2	0	-3.208	0.0195
Proportions of 60-64					
3-year overlapping changes	-3.291	4	0.0153	-3.553	0.0067
5-year overlapping changes	-3.212	3	0.0193	-2.91	0.0442

Note: ADF Critical values are -3.514 for 1% significant level, -2.892 for 5% significant level, and -2.581 for 10% significant level; Number of lags depends on the lowest value of Akaike's Information Criteria (AIC).

The statistical test used to significantly specify the existence of a structural break in the time-series relationship between dependent and explanatory variables is the Chow test statistic. This test involves three regression models; namely a regression model for the whole sample size, a regression model for the sample before a specified breaking point, and a regression model for the sample after a specified breaking point. Each regression model has different numbers of observations based on the location of the specified breaking point. The formula of the Chow test statistic is shown in Equation 5.6, where RSS_{total}, RSS_1, and RSS_2 are the residual sum of squares from the regression models that cover the whole sample size, the first group and the second group respectively. N represents the total number of observations for each group while K represents the number of coefficient estimates. Results from the Chow test analysis will be presented in section 5.5.

$$Chow\ test\ statistic = \frac{\left[\frac{\left(RSS_{total}-(RSS_1+RSS_2)\right)}{K}\right]}{\left[\frac{S_1+S_2}{(N_1+N_2-2K)}\right]} \qquad \text{\_\_\_\_\_(5.6)}$$

Because all the variables in the regression models are overlapping returns, standard errors from the time-series regressions normally exhibit a high degree of serial correlations. In order to correct for serial correlations in the error terms, Newey-West t-statistics are used instead of the traditional OLS t-statistics. The conventional OLS standard errors will have severe size biases. If these traditional t-statistics are used, there is a possibility that the rejection of the null hypothesis will be overestimated. The number of lag values for the calculation of the Newey-West standard errors is determined by Schwarz's (1978) information criteria.

5.5 Research Results

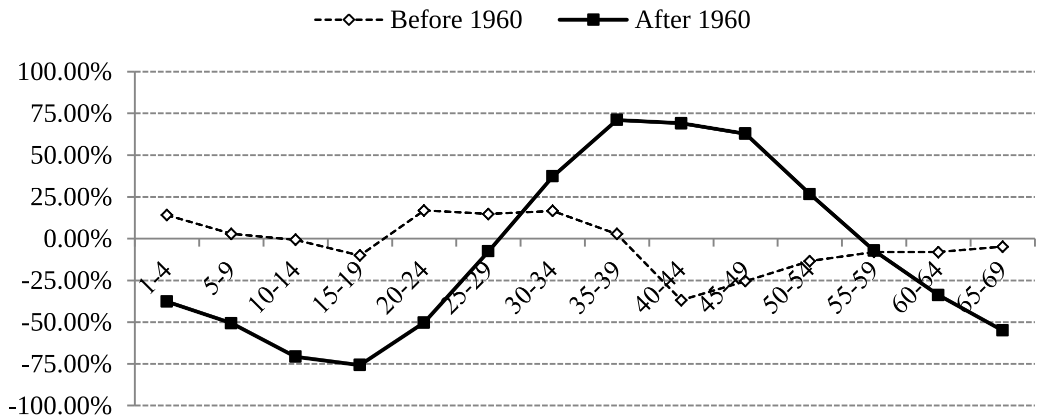
As shown in chapter 4, the relationship between the variation in asset prices and the proportion of adult populations appear to be stronger after the 1960s than prior to this period. However, chapter 4 only presents graphical illustrations without statistical estimates to prove the claim. In this section, correlation coefficients between the fraction of adult populations and a range of financial indicators are illustrated in Table 5.4. As can be seen, the correlation coefficients are not significantly different from zero for the period before 1960. These low correlations during the first half of the 20^{th} century may result from a low variation in fertility rates and a low level of institutionalisation in the financial market. These coefficients have increased significantly after 1960 across all financial variables. The correlation coefficient between the proportion of adult populations and the real level of FTSE-All Share index is significantly positive at 0.82. The correlation estimates for the 12-month trailing and 12-month forward P/E ratios appear to be insignificantly different from each other. This characteristic also occurs for the relationship with the 12-month trailing and 12-month forward dividend yields. The negative coefficient between the proportion of adult populations and dividend yields is as expected. An increase in asset prices was much greater than an increase in dividends. This has led to a steadily decline in dividend yields over the past decades.

Table 5.4 Correlation coefficients between the proportion of adult population and financial market variables

The financial market variables	Proportion of 20-60/65	
	Before 1960	After 1960
FTSE-All Share Index	-0.04	0.82
FTSE-All Share 12m trailing PE ratio	0.13	0.51
FTSE-All Share 12m Forward PE ratio	0.14	0.55
FTSE-All Share 12m trailing Dividend Yield	-0.01	-0.62
FTSE-All Share 12m Forward Dividend Yield	-0.08	-0.63

Figure 5.1 depicts the correlation coefficients between the proportions of population in each age group and the real level of the FTSE-All Share index. Interestingly, the correlation coefficients during the period before 1960 for all age groups are insignificantly different from zero. After 1960, the correlation coefficients for the relationship between the proportions of population aged 35-49 and the real FTSE-All Share index have increased significantly to around 60-70 per cent. The high correlation among people aged between 30 and 44 shown in Figure 5.1 is also consistent with the findings from Erb et al. (1996). This age range is normally considered to be the prime working age with the highest productivity. The preliminary results shown in this section suggest that demographic variables have some explanatory power in predicting changes in asset prices. It implies that the saving demands from these age groups may significantly have an influence on the level of asset prices. The pronounced impact after the 1960s may result from the emergence of pension schemes, which has greatly increased household participations in the financial market.

Figure 5.1 Correlation coefficients between the proportion of population in each age group and the real FTSE-All Share index



Nevertheless, the coefficient estimates illustrated in Table 5.4 and Figure 5.1 may be severely biased. As discussed previously, the time-series movement of the "level" variable such as the FTSE-All Share index and the proportions of population may contain a unit-root. The significant coefficient estimates may result from spurious relationships, which imply that the observed significant relationship may be a result of coincident events. In order to test the hypothesis whether the relationship between demographic variables and the financial market during the period after the 1960s is significantly different from the period before the 1960s, the Chow test statistic is conducted. All the variables in the time-series regressions are in the first difference form, i.e. asset returns as a dependent variable and n-year percentage changes in the fraction of population as explanatory variables. This "first difference" adjustment is used to eliminate the unit-root contained in the time-series data. The unit-root tests for all the variables in the regression models have been previously shown in Table 5.3.

A review of the results of the Chow test statistic from the relationship between 5-year percentage changes in the proportion of adult population and 5-year real equity returns, shown in Table 5.5, indicates that there appears to be a structural breaking point in the relationship in 1965. The Chow test statistic is significant at the 95 per cent confident level for the relationship with the FTSE-All share index and forward P/E ratios. In the case of the relationship with the forward dividend yields, the Chow test statistic is significant at the 10 per cent significant level. Unlike Geanakoplos et al. (2004), Poterba (2001) and Bakshi and Chen (1994) that arbitrarily use the breaking point in the time series data to be in 1945 or 1947, Table 5.5 illustrates that the structural breaking point in the relationship should be in 1965. This breaking point is nearly 20 years after the point where most previous studies arbitrarily assumed. This may be the main reason why Geanakoplos et al. (2004) find no significant relationship between the ratio of the middle-aged to the young and the real FTSE index from the observations during 1950 to 2001. A more significant relationship between demographic structures and the financial market during the post-1965 may be associated with the ageing of baby-boomers and the increasing predominance of institutional investors such as pension funds in the financial market.

Table 5.5 Results of the Chow test statistic for the relationship between the proportion of adult population and equity market indicators

Explanatory Variable
5-year changes in the proportion of adult population (20-65) and a constant term

		Dependent variables		
		5-year real returns of FTSE-All Share Index	5-year changes of FTSE-All Share FW PE	5-year changes of FTSE-All Share FW DY
The sum of squared residuals from a regression	Before 1965	7.18	4.55	1.95
	After 1965	6.21	7.61	9.65
	All Period	14.85	13.87	12.30
Chow Test Statistic		4.98	5.27	2.38
Critical value at 95% confidence level		3.1	3.12	3.11
Critical value at 90% confidence level		2.36	2.37	2.37
Degrees of freedom		91	75	78
Number of observations before 1965		50	35	38
Number of observations after 1965		45	44	44

Table 5.6 shows the results of the Chow test statistic from regression models that include the 5-year age groups from the age of 35 to 64. Results are nearly similar to Table 5.5. The only main difference is that the Chow test statistic is no longer significant at the 10 per cent significant level for the relationship with the forward dividend yields. Regarding the relationship with the bond market, Table 5.7 shows the Chow test statistic for the relationship between 3-year percentage changes in the 5-year age groups and 3-year percentage changes in the yields of 5-year GILTs. Results indicate that the relationship after 1965 is significantly different from the

relationship before 1965 at the 90 per cent confidence level. The significant relationship between GILT yields and demographic structures during the period after 1965, found in this paper, is also consistent with the results from Geanakoplos et al. (2004) who find that when analysing the period during 1965-2002, the variation of interest rates was more significantly associated with the movement of the ratio of the middle-aged to the young than using the sample period during 1945-2002. The existence of this structural break in the time-series relationship in 1965 may be the main cause of the inconsistent results shown in Poterba (2001), who find that the fraction of the population aged 40-64 is negatively related to the US Treasury bill returns (observations are from 1926-1999) while it has a positive correlation with the Canadian Treasury bill returns (observations are from 1950-1997).

Table 5.6 Results of the Chow test statistic for the relationship between the proportion of 5-year age groups and equity market indicators

Explanatory Variables:
5-year changes in the proportions of 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and a constant term

		Dependent variables		
		5-year real returns of FTSE-All Share Index	5-year changes of FTSE-All Share FW PE	5-year changes of FTSE-All Share FW DY
The sum of squared residuals from a regression	Before 1965	5.84	1.42	1.27
	After 1965	5.45	6.41	8.15
	All Period	14.30	13.06	11.07
Chow Test Statistic		3.09	6.19	1.69
Critical value at 95% confidence level		2.12	2.15	2.15
Critical value at 90% confidence level		1.79	1.81	1.81
Degrees of freedom		81	65	68
Number of observations before 1965		50	35	38
Number of observations after 1965		45	44	44

Table 5.7 Results of the Chow test statistic for the relationship between the proportion of 5-year age groups and 5-year GILT yields

Explanatory variables: 3-year changes in the proportion of 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and a constant term		
		Dependent Variable: 3-year changes in the 5-year GILT Yields
The sum of squared residuals from a regression	Before 1965	4.45
	After 1965	2.89
	All Period	8.66
Chow Test Statistic		1.92
Critical value at 95% confidence level		2.13
Critical value at 90% confidence level		1.8
Degrees of freedom		75
Number of observations before 1965		44
Number of observations after 1965		45

Time-series regressions between demographic variables and financial variables are demonstrated in Table 5.8 to Table 5.12. These regressions will be conducted only for the observations after 1965 because the previous analyses suggest that structural changes in the financial market by the emergence of institutional investors may be the main cause of the significant relationship between demographic patterns and the financial market. The standard errors shown in parentheses are computed using the Newey and West (1987)'s methodology to reduce estimation biases resulting from the autocorrelations in error terms. The regression models shown in this section have passed a range of model specification tests such as the heteroskedasity test, serial correlation test, Ramsey's RESET test and the Jarque-Bera normality test.

Table 5.8 shows regression results that illustrate the impact of changes in the demographic structures on the real returns of the FTSE-All Share index. The left column shows coefficient estimates from the model with three-year percentage changes while the right column illustrates coefficient estimates from the model with five-year percentage changes. The most intriguing empirical result is that the changes in demographic variables over the 3-year period do not have any significant influence on the 3-year change in the FTSE-All share index. Using short-term differencing yields limited explanatory power of demographic variables on equity returns. This result indicates that equity returns over the 3-year horizon still exhibit a high degree of volatility and noises influenced by many other factors apart from the movement of demographic patterns. It is unsurprising that the slow-moving characteristic of demographic variables is unable to explain the high frequency movements of 3-year equity returns.

Table 5.8 Regression results of the models between demographic variables and the real FTSE-All Share index

Independent variables	Dependent variable	Independent variables	Dependent variable
3-year changes in the proportion of	3-year real returns of FTSE All-Share Index	5-year changes in the proportion of	5-year real returns of FTSE All-Share Index
35-39	1.4753 (0.6561)	35-39	1.8823** (0.6135)
40-44	1.0769 (0.8136)	40-44	1.2927* (0.6731)
45-49	1.4766 (0.8637)	45-49	1.7600** (0.6799)
50-54	-0.0680 (0.9444)	50-54	0.0144 (0.8090)
55-59	0.2122 (1.3803)	55-59	-0.7598 (0.8652)
60-64	-0.0244 (0.8594)	60-64	-0.2339 (0.5939)
Constant	0.0739 (0.0688)	Constant	0.1062 (0.0804)
R-squared	0.1319	R-squared	0.3134
Lags	1	Lags	1
Observation	45	Observation	45

Note: ** and * indicate the statistically significant different from zero (2-tailed p-value) at alpha=0.05 and 0.10, respectively; Newey-West standard errors are shown in parentheses; numbers of lags for Newey-West standard errors are based on the Schwarz's (1978) information criteria.

When looking at the relationship over a longer period, coefficients of the 5-year changes in the proportions of 35-39, 40-44, and 45-49 are significantly different from zero. All these demographic variables appear to have a significantly positive influence on real equity prices over the 5-year horizon. Even though the high volatility of equity returns are affected by many other shocks, the 5-year real returns can partly be explained by the variation in the changes in demographic variables by nearly 32 per cent. The more significant effect on longer horizon returns is plausible because demographic patterns are moving slowly in the long term. The “differenced” form of demographic variables used in this research largely improves the explanatory power of the shift in demographic patterns on the dynamic of asset returns. This result is in contrast to the insignificant result found by Poterba (2001), who runs a regression between annual asset returns and the level of demographic variables.

The coefficient estimates found in this research appear to be in contrast to other previous studies, which normally argue that the age group of 45-54 will have the largest incremental effect on asset prices. Generally speaking, most existing researchers argue that individuals in the 45-54 age group tend to have paid back most of their mortgages and other loans, and tend to receive labour income at a peak level of their lifetime. These circumstances have led to the highest real net wealth of the individuals in this age group relative to other age ranges. For example, Yoo (1994a) shows that the 45-54 age group has the largest wealth compared to other age groups. As a result, he concludes that trading activities of this age group should significantly affect asset prices and returns. However, the significant impact of the 35-44 age group on equity prices found in this chapter tends to indicate that the direct trading behaviour of individuals aged 45-54, who has the largest increment of wealth, does not actually cause a significantly positive influence on asset prices, specifically during the period after the 1960s. In other words, the relative supply of and demand for financial assets determined by the direct investment behaviour of households may not significantly affect asset prices and returns.

Table 5.9 shows regression results from the models that analyse the impact of changes in demographic variables on changes in the forward P/E ratio of the FTSE-All Share index. The only demographic variable that has a significantly positive coefficient with the P/E ratio is the 35-39 age group. Principally, changes in earning yields are often interpreted as changes in the risk premiums or changes in the degree of risk aversions of investors at a certain period. Based on this line of reasoning, the significantly positive impact of the 35-39 age group on the P/E ratio may indicate that the saving of this age group has consistently reduced the price of risks of equities over the past decades.

Table 5.9 Regression results of the models between demographic variables and the forward P/E ratios of the FTSE-All Share index

Independent variables	Dependent variable	Independent variables	Dependent variable
3-year changes in the proportion of	3-year changes of FTSE All-Share FW PE	5-year changes in the proportion of	5-year changes of FTSE All-Share FW PE
35-39	1.6511** (0.7947)	35-39	1.9134** (0.5856)
40-44	0.3953 (0.7705)	40-44	0.4144 (0.6150)
45-49	1.2618 (1.1860)	45-49	1.5442 (0.9454)
50-54	0.1633 (1.1284)	50-54	0.1135 (0.9177)
55-59	-0.7748 (1.4548)	55-59	-0.9951 (0.9249)
60-64	0.0190 (0.9099)	60-64	-0.1868 (0.7052)
Constant	0.0413 (0.0729)	Constant	0.0490 (0.0921)
R-squared	0.1061	R-squared	0.2369
Lags	1	Lags	1
Observation	44	Observation	44

Note: ** and * indicate the statistically significant different from zero (2-tailed p-value) at alpha=0.05 and 0.10, respectively; Newey-West standard errors are shown in parentheses; numbers of lags for Newey-West standard errors are based on the Schwarz's (1978) information criteria.

As can be seen in Table 5.10, the significantly negative relationship between dividend yields and the proportion of the 35-39 age group represents evidence that the relative demands for financial assets, provided by the information contained in the movement of this age group, are relatively higher than the supply of capital, provided by the information contained in the changes in dividend yields. The significant relationship between dividend yields and demographic variables found in this study is consistent with the result shown in Poterba (2001) and Geanakoplos et al. (2004).

Current levels of dividend yields have now been below the long-term historical average observed during the first half of the 20th century. A steadily decline in dividend yields over the past decades implies that excessive demands in the financial market push asset prices relatively higher than the level that can be justified by a rise in dividends. The significant relationship between demographic patterns and dividend yields shown in this chapter also suggests that publicly listed companies have not greatly increased the supply of equity to balance the excess demands. In theory, companies can reap the benefits of high stock prices by raising new capital through share issuances. Because excess demands cannot frictionlessly be balanced by a variation in the supply of capital, some extent of asset price movements may be affected by the imbalance between demands and supplies rather than being influenced by its return on capital.

Table 5.10 Regression results of the models between demographic variables and the forward dividend yields of the FTSE-All Share index

Independent variables	Dependent variable	Independent variables	Dependent variable
3-year changes in the proportion of	3-year changes of FTSE All-Share FW DY	5-year changes in the proportion of	5-year changes of FTSE All-Share FW DY
35-39	-1.0455 (0.7244)	35-39	-1.7007** (0.5602)
40-44	-0.4418 (1.1447)	40-44	-0.2687 (0.7074)
45-49	-1.9589 (1.4921)	45-49	-2.1352** (0.9594)
50-54	-0.2598 (1.1300)	50-54	0.0262 (0.9899)
55-59	-1.1491 (2.2501)	55-59	-0.1064 (1.0612)
60-64	-0.8554 (1.1820)	60-64	-0.2235 (0.6472)
Constant	0.0818 (0.1130)	Constant	0.1069 (0.1092)
R-squared	0.0907	R-squared	0.2126
Lags	1	Lags	1
Observation	44	Observation	44

Note: ** and * indicate the statistically significant different from zero (2-tailed p-value) at alpha=0.05 and 0.10, respectively; Newey-West standard errors are shown in parentheses; numbers of lags for Newey-West standard errors are based on the Schwarz's (1978) information criteria.

Table 5.11 and Table 5.12 illustrate the impact of demographic structures on the bond market. Coefficient estimates of all 5-year percentage changes in demographic variables with the 5-year percentage changes in GILT yields, shown in Table 5.12, are all significantly different from zero. This regression result may be biased by the fact that the movement of GILT yields tend to be highly persistent and slowly moving compared to the movement of real equity returns. Therefore, it may be difficult to accurately estimate which age groups have the most significant impact on the movement of bond prices from the analysis of the 5-year percentage changes.

Table 5.11 Regression results of the models between 3-year percentage changes in demographic variables and 3-year percentage changes in GILT yields

Independent variables	Dependent variables		
3-year changes in the proportion of	3-year changes of 3-year GILT yields	3-year changes of 5-year GILT yields	3-year changes of 10-year GILT yields
35-39	-0.0732 (0.9382)	-0.2306 (0.7689)	-0.6219 (0.5668)
40-44	-1.0244 (0.7326)	-1.1194* (0.6429)	-1.1816** (0.5321)
45-49	-2.0678** (0.8672)	-1.8806** (0.7663)	-1.7494** (0.6844)
50-54	-1.1238* (0.6201)	-1.1519** (0.5522)	-1.1021** (0.5004)
55-59	-1.8135* (1.0484)	-1.6902* (0.9675)	-1.7715* (0.9609)
60-64	-2.1339** (1.0325)	-1.7854** (0.8338)	-1.3993** (0.6438)
Constant	0.0199 (0.0571)	0.0212 (0.0496)	0.0296 (0.0435)
R-squared	0.2886	0.3121	0.3739
Lags	3	3	3
Observation	45	45	45

Note: ** and * indicate the statistically significant different from zero (2-tailed p-value) at alpha=0.05 and 0.10, respectively; Newey-West standard errors are shown in parentheses; numbers of lags for Newey-West standard errors are based on the Schwarz's (1978) information criteria.

Table 5.11, which shows the regression results from the models with 3-year percentage changes, tend to provide a clearer picture. Changes in the fraction of the 45-49 and 60-64 age group appear to have a significantly forecasting power for the changes in the yields of 3-year GILT, 5-year GILT and 10-year GILT at the 5 per cent significant level. The coefficient estimates are all significantly negative indicating that a rising proportion of the 60-64 age group are associated with an increase in bond prices. This empirical result appears to be consistent with the finding by Davis and Li (2003), who discover that bond yields will significantly decline when the share of the 40-64 age group increases. Because their regression models use the age variables that are constructed by grouping the 15-year age range together (40-64), the result shown in this paper that investigates the impact of the 5-year age groups should provide clearer results.

Table 5.12 Regression results of the models between 5-year percentage changes in demographic variables and 5-year percentage changes in GILT yields

Independent variables	Dependent variables		
5-year changes in the proportion of	5-year changes of 3-year GILT yields	5-year changes of 5-year GILT yields	5-year changes of 10-year GILT yields
35-39	-0.9176** (0.4416)	-1.0148** (0.3042)	-1.2106** (0.2362)
40-44	-1.2525** (0.4802)	-1.3514** (0.3844)	-1.3042** (0.3003)
45-49	-2.3580** (0.5371)	-2.1465** (0.3895)	-1.9266** (0.3678)
50-54	-1.1364** (0.3749)	-1.1490** (0.3131)	-1.0097** (0.2848)
55-59	-0.9565** (0.3823)	-0.8973** (0.3503)	-1.0737** (0.4045)
60-64	-1.3186** (0.6065)	-1.0152** (0.4590)	-0.7261** (0.3394)
Constant	0.0576 (0.0691)	0.0611 (0.0502)	0.0636 (0.0427)
R-square	0.4752	0.5769	0.6618
Lags	1	1	1
Observation	43	45	45

Note: ** and * indicate the statistically significant different from zero (2-tailed p-value) at alpha=0.05 and 0.10, respectively; Newey-West standard errors are shown in parentheses; numbers of lags for Newey-West standard errors are based on the Schwarz's (1978) information criteria.

Overall, the coefficient estimates from the time-series regression models tend to have anticipated signs consistent with the lifecycle hypothesis. Because the "differenced" model tends to yield weaker statistically significant coefficients than the "level" model, the significant coefficients found in this study appear to show strong evidence in supporting the relationship between demographic variables and the financial markets, specifically during the period after the 1960s. On the one hand, results have shown that the gradual increase in the population aged 35-40 since the 1970s has led to a significantly positive movement in real prices of common stocks. On the other hands, a rise in the fraction of population aged 60-64 appears to be significantly associated with a rise in bond prices. This long-term relationship between the percentage changes in demographic structures and the rates of return on common stocks and fixed-income securities tend to support the hypothesis that the retirement of baby boom cohorts in the next 20 years may have a negative pressure on stock prices and a positive pressure on bond prices as the portfolio allocation is shifting from risky financial assets toward a safer asset class. The main question to be asked further is whether this significant impact of demographic shifts on the prices of financial assets is caused by the direct investment behaviour of households in the financial market or by the trading activities of institutional investors that receive investment funds from the savings of households. A detailed study on this area will be presented in chapter 6 and 7.

5.6 Discussion

Results presented above have to be interpreted with cautions. There are some caveats that need to be considered. Firstly, the significant relationship found from the models that use the observations from 1965 could be confounded by the problem of data mining. This is because there is only one main demographic transition, which is the ageing of the baby boom generation. On the one hand, the post-1965 period represents an ideal period for testing the impact of demographic transitions on the financial market because it contains the ageing of a relatively large cohort from around 25-40 years old in 1965 to around 55-65 years old in 2010. This demographic shift is the main single unusual event of the dynamic of demographic patterns over the last century. On the other hand, it can also be considered that the history only contains one important realisation of demographic patterns, which is the ageing of baby-boomers. Although the time-series data of the post-1965 period has many annual observations, the effective numbers of the degrees of freedom or the information contained in the data may not be sufficiently large to yield reliable statistical inference. Therefore, it is possible that fifty annual observations of the time-series asset returns and demographic variables during the period after 1965 may only represent one main observation of the relationship between demographic structures and the financial market.

Secondly, there are some other non-demographic factors which may have a significant influence on asset prices and returns. These factors include the productivity of the economy, inflation rates, and the ageing of labour forces. Nevertheless, these economic variables also tend to be partly influenced by demographic shifts. Therefore, including only demographic variables in the regression models should not post a severe specification bias. Thirdly, coefficient estimates from the regression models shown in this chapter are not appropriate for an extrapolation process to estimate how the financial market would change in response to the shift in demographic variables. This is because results from the regression models only show statistical relationships among variables but the causal mechanism underlying the relationship has not been explored yet. Lastly, a strong correlation between demographic variables and asset prices or returns from the regression models may only reflect the accumulation process of financial assets from the baby-boom cohorts. Therefore, it may be difficult to state that there will still be a strong positive relationship between those variables if and when there is a sharp reduction in the working-age population. The decumulation process following the retirement of baby-boomers may be different from the accumulation stage in the lifecycle. Econometric approaches on historical data cannot test the decumulation effect from population ageing because the majority of samples represent the movement of baby boom cohorts from young to old working-age periods. In an attempt to understand how market prices will behave after the retirements of baby-boomers, some further analyses are necessary.

With those caveats in mind, the regression results in this chapter, which have been corrected for the existence of the unit-root, autocorrelation and heteroskedasticity problems in the error terms, should still shed some light on the long-term relationship between demographic structures and the financial market. The empirical evidence observed in this chapter only provide a first step for further studies to determine the underlying mechanism that links the dynamic of demographic structures with the movement of financial asset prices, specifically during the period after the 1960s. This thesis proposes that the stronger correlations between demographic patterns and the financial market may be caused by the presence of institutional investors such as pension funds, which has greatly increased household participations in the financial market. As a result, chapter 6 will present a household survey study in order to understand the lifecycle saving behaviour of households through a range of investment opportunities. Results from the research in chapter 6 will provide further evidence that can be used to understand the empirical results observed in this chapter more clearly.

5.7 Concluding remarks

This chapter presents a time-series regression analysis to investigate the empirical relationship between demographic variables and the financial market. The overall empirical result tends to support the hypothesis proposed in this paper that the presence of pension schemes after the 1960s may be the main underlying cause of the strong relationship between demographic structures and the financial market. According to the results of the Chow test statistic, the structural breaking point in the time-series relationship between equity returns and the percentage changes in demographic variables is 1965 at the 5 per cent significant level. This indicates that the relationship between these two factors during the period before 1965 is significantly different from the period after 1965. This research finding also suggests that the main source of inconsistent results among previous literatures, which arbitrarily use observations from different time frames, may result from the unawareness about this structural breaking point in the time-series data.

Instead of finding weak evidence of the relationship between real returns of equity and demographic variables as shown in Yoo (1994a) and Poterba (2001), this study shows statistically significant coefficients between the 5-year percentage changes in the fraction of the 35-44 age groups and 5-year real equity returns. These regression results are free from a spurious relationship because all the variables in the regression models are in the first difference form, which has been proved to significantly reject the null hypothesis of having a unit-root. The coefficient estimates of the 5-year age groups during 50-64 are all insignificantly different from zero. Because this paper does not find that the fraction of the population aged 45-54 has a significantly positive effect on asset prices at the 95 per cent confident level, the direct investments of these populations, who tend to have the largest net wealth relative to other age groups, may not actually have a significant influence on real asset prices. This implies that the strong relationship between demographic variables (the 35-44 age groups) and the financial market may come from other factors. When looking at the relationship with the forward P/E ratios and forward dividend yields, the only demographic variable that has a significant impact is the 35-39 age group. Regarding the impact on the bond market, changes in the proportions of the population aged 60-64 have a significantly negative relationship with the changes in GILT yields. This empirical evidence suggests that aggregate asset allocation of investors in the market may move toward less-risky financial assets such as government bonds when the proportion of the population mainly consists of retired people.

Based on the empirical results shown in this chapter, it is interesting to further examine the lifecycle saving behaviour of households. The significant impact of the 35-39 age group on equity prices implies that this age group should have a high participation rate in the financial market compared to other age ranges. This is because the high participation rates are associated with a large aggregate amount of net fund inflows to the financial market. These fund inflows represent substantial demands for financial assets, which may have an upward pressure on asset prices. Since the 1960s, households have been offered by a range of financial services from financial institutions. Accessing costs of the financial market have greatly declined. They can directly purchase equities in the market or they can invest indirectly through institutional investors such as mutual funds, occupational pension schemes, or personal pension plans. Therefore, a detailed analysis that investigates the lifecycle saving behaviour of households in these different types of investment opportunities will provide a useful insight to understand the empirical results observed in this chapter. Such analysis will be presented in chapter 6.

Chapter 6: Research which purports to understand the lifecycle saving decisions of British households through a range of saving opportunities

6.1 Introduction

The main objective of the research presented in this chapter is to investigate lifecycle saving patterns of households. Some economists claim that the recent rise in real asset values over the past 40 years may partly be explained by the saving motive of baby-boomers. By predictions based on this causality, asset prices may decline when baby-boomers reach retirement and start decumulating their savings. However, this relationship between demographic patterns and the financial market may exist only if the demand curve of financial assets is downward sloping and the lifecycle saving patterns of households is strongly hump-shaped. In chapter 5, it has previously been shown that the proportions of the population aged 35-44 tend to significantly affect the movement of real equity prices. This empirical evidence suggests that the hump-shaped lifecycle saving patterns of households should have a peak turning point during the age of 35-44. Because households can save and make investments in the financial market through various types of investment opportunities, the saving behaviour of British households through direct ownerships, investments in unit/investment trusts, savings in occupational pension schemes, and in personal pension plans is examined in this chapter.

This chapter begins by discussing existing literature that attempts to understand the lifecycle saving behaviour of households. It will be followed by an analysis on the lifecycle saving patterns of British households. The main data for this analysis are from the Family Expenditure Survey data, 1968 to 2007. As for the graphical illustration of the household saving patterns, the LOWESS smoothing technique will be imposed on the probability estimates of household ownership in certain types of investments in order to extract the main information from the raw data and reduce noise in the probability estimates. The logit regression technique will also be implemented to estimate the lifecycle saving patterns by controlling for a time-effect, a cohort-effect, an age-effect, and other variables that represents characteristics of households.

The main finding from this analysis is that British households appear not to have strong dissaving motives on their direct ownerships of financial assets and on their investments in the unit/investment trusts, but they tend to significantly reduce their contributions to pension plans when they approach retirement. In other words, the lifecycle saving pattern of British households is significantly inverted U-shape in the case of savings in occupational and personal pension plans. The peak in the probability of paying contributions into pension plans occurs at the age around 40-44. Households do consider reducing their savings and start planning about decumulation when they reach retirement, particularly in the saving portions of which the main purpose is to generate incomes during retirement. The evidence found in this chapter, when combined with the results from chapter 5, suggests that the main source of investment opportunities that link the dynamic of demographic patterns with the movement of the financial market is the emergence of pension schemes after the 1960s which has greatly increased household participations in the financial market.

6.2 Literature review

This section will analyse previous attempts by scholars to examine the lifecycle saving behaviour of households. It will show the main theoretical framework, namely the Modigliani and Brumberg’s lifecycle hypothesis, as the basis of the causality between demographic patterns and saving decisions of households. Following this, several pieces of existing literature that investigate the relationship between demographic variables and aggregate saving rates will be discussed. Previous research that uses household survey data to study the lifecycle saving behaviour of households will be reviewed thereafter. The relative strengths and weaknesses of each research approach will also be evaluated.

6.2.1 The lifecycle hypothesis as an established theory to explain household economic activities

A number of papers have examined the ways in which demographic variables can impact on the capital market. The existing literature attempts to develop insights as to which underlying mechanisms link demographic patterns with asset value at the same time as illustrating which other factors may attenuate or intensify the demographic effects. The main theoretical framework that underpins most of the literature in this area is the lifecycle hypothesis, which was initially proposed by Modigliani and Brumberg (1954). This hypothesis illustrates how economic agents make economic decisions about consumption and savings as they age from the childhood period, through the working-age period, followed by the retirement period until death.

According to this hypothesis, optimal household consumption and saving decisions depend on their expectations about future, rather than current, permanent income levels. Given this key assumption, Modigliani and Brumberg extend their model and conclude that there are three further key related variables that determine household consumption and saving behaviour: the short-term volatility of income, the discrepancies between realised permanent income and expectations from previous periods, and the elasticity of income expectation. Since the evolution of these factors is dependent on household age, Modigliani and Brumberg have identified a linkage between demographic patterns and aggregate household economic activities. Having incorporated the population numbers at each age range, aggregate optimal economic decisions can be derived. This hypothesis posits that national economic growth rates and national savings depend on the evolution of demographic patterns.

This well-defined framework has considerably improved understanding on household saving and consumption behaviour in comparison to early theories proposed by Keynes (1936) in his General Theory and from early empirical studies by Kuznets (1946) and Brady and Friedman (1947). Moreover, the lifecycle theory contrasts with the Permanent Income Hypothesis proposed by Friedman (1957) in the way that household lifespan is considered finite rather than occurring over an unrealistically lengthy and indefinite period. The lifecycle hypothesis is widely accepted to provide an accurate representation of economic behaviour made by actual households. Empirical studies supporting many aspects of this hypothesis can be found in Modigliani (1986).

6.2.2 Empirical evidence of the relationship between demographic patterns and household saving rates

Many researchers attempt to test the lifecycle hypothesis by analysing the relationship between demographic patterns and aggregate saving rates. Modigliani (1970), Graham (1987), and Lee, Mason and Miller (1997) all find evidence in supporting the lifecycle hypothesis. Population ageing tends to be associated with a decline in aggregate saving rates. Having analysed a panel data from 14 industrialised countries, Weil (1994) shows that changes in the proportion of age structures are a significant determinant of saving rates. The saving patterns appear to be consistent with the lifecycle hypothesis. His model is also robust from the fact that saving rates in each country can be affected by having different public pension systems. Disney (1996) also provides supporting empirical evidence of the lifecycle hypothesis by showing that countries with higher fraction of retirees will have lower saving rates. Moreover, most macro studies often find that the elasticity of saving rates to a change in the old-age dependency ratio tends to be negative. For example, Masson and Tryon (1990), who use a panel data including industrialised countries, find that the saving elasticity is -1 while Loayza, Schmidt-Hebbel and Serven (2000), who analyse a panel data of 49 developing countries and 20 industrialised countries, find that the saving elasticity will be around -0.2. The study by McMorrow and Roger (2003) also finds this number to be around -0.75. Based on this negative relationship, Roseveare, Leibfritz, Fore and Wurzel (1996) predicts that a rising old-age dependency ratio of around 20 per cent in the OECD countries over the next 20 years would entail a reduction in private saving rates by 6 per cent by 2030. In addition to the negative impact of the old-age dependency ratio on aggregate saving rates, the level of youth dependency ratios has also been shown to be negatively related with an incentive to save. For instance, Higgins and Williamson (1997) show that an increase in saving rates after 1960 among Asian countries was a result of a declining youth dependency ratio over the past decades. Masson, Bayoumi, and Samiei (1998), who analyse a time-series data from 21 industrialised countries and 40 developing countries, also find that both of the old-age and youth dependency ratios appear to significantly affect saving rates.

However, a few pieces of existing literature find inconsistent results with the lifecycle hypothesis. Over the lifecycle of households, there may be some unexpected factors that can influence saving and consumption decisions. For instance, uncertainties about unexpected shocks that affect future conditions of households' human capital has been proved to alter the lifecycle saving patterns (Skinner, 1988; Zeldes, 1989; Caballero, 1990). These uncertainties will lead to higher saving rates in the early life than the level suggested by the lifecycle hypothesis. These extra savings to hedge against future shocks will decline sharply when the uncertainty has been resolved at older ages. An unexpected increase in the life expectancy of the elderly is also apt to induce high saving rates at old age. Li, Zhang and Zhang (2007) argues that this positive effect from the reduction in mortality rates on saving rates can partly offset the decline in aggregate savings resulting from a lower fraction of working people. By incorporating an improvement in health and mortality rates in the lifecycle saving model, Bloom, Canning and Graham (2002) show that saving rates at old age will be higher than the conventional lifecycle model. This prediction supports empirical evidence of an increase in saving rates among the old populations in Asian countries. A study by Boersch-supan et al. (2003) also shows evidence of high saving rates among the elderly in Germany, France and Italy. Boersch-Supan and Stahl (1991) argue that precautionary savings to hedge against unexpected health deterioration are the main cause of high savings at old ages.

One main issue that needs to be considered for the literature in this area is the definition of saving rates. Principally, there are two main measures of the saving. The first measure identifies saving rates as the difference between income and consumption. This measure does not control for the revaluation of assets held in household portfolios. The second measure defines saving rates as a change in household net worth. This measure tends to be more relevant in measuring the households' well-being because it will include appreciations and depreciations of household assets. As noted in Poterba (1994), the first measure is more useful in capturing the consumption behaviour of households, while the second measure is important to reflect the implication of financial markets on household portfolio. In general, the saving rate measured by changes in net worth will give a larger estimate of the decline in saving rates during the old age. Bosworth, Burtless and Sabelhaus (1991), who analyse household saving behaviour among three industrialised countries, show that a drop in saving rates is larger when the saving is measured by changes in net worth compared to the estimates measured by differences between incomes and consumptions. However, measuring the saving rates by changes in net worth has one main drawback. If an appreciation in asset prices does not come from higher productivity but rather from changes in risk premiums or discount rates, higher net wealth from this price appreciation should not be considered as higher saving. This is because changes in risk premiums do not really contribute to an increase in future income and outputs.

Another crucial point about the measurement of saving rates is relevant to the consideration on the amount of contributions paid into pension funds and on the amount of pension benefits received from the funds. Generally speaking, contributions paid to a pension scheme should be considered as retirement saving of households but most of the household surveys consider these contributions as expenses deducted from gross household incomes. In a similar vein, pension benefits should be regarded as a dissaving rate from accumulated assets, not a regular income. This accumulation and decumulation of pension assets are often omitted in most microeconomic studies. The flat age-saving profiles found in many microeconomic studies often result from considering pension benefits as incomes rather than a dissaving from accumulated pension wealth. Bosworth et al. (1991)

show that the US saving rates will decline from around 11 per cent during 1982 to approximately -4 per cent if pension wealth had been adjusted correctly in the calculation of saving rates. Hochguertel, Alessie and Van Soest (1995) also present evidence that after including pension wealth in Dutch household portfolio, there was a sharp decline in total net assets after retirement which implies a high dissaving rate at old age. Jappelli and Modigliani (1998) show that if contributions paid to the pension system are considered as saving and pension benefits are considered as dissaving, a strong hump-shaped age-saving profile will normally be observed.

Retirement saving through pension schemes also causes some measurement errors in the estimate of national saving rates that uses data from the national account, though the errors may be lower than data from microeconomic studies. Typically, household saving rates shown in the national accounts are calculated from the total income concept which considers pension contributions paid by employers and investment incomes earned from the capital market as the gross income of households. Therefore, countries with a significant portion of funded pension systems will generally exhibit a strong hump-shape age profile for household saving patterns. This fact posts some challenges to the literature that uses international comparisons to investigate the relationship between demographic patterns and saving rates.

6.2.3 Household survey analysis to understand lifecycle saving and consumption decisions

A number of researchers attempt to investigate household saving and consumption decisions through household survey data in order to prove whether the assumption of high dissaving rates by the elderly is warranted. If there is no evidence to support high dissaving rates, the retirement of baby boom cohorts may not lead to the market meltdown scenario. In general, researchers in this area find mixed results regarding pensioners' saving behaviour. Bernheim (1987) reports that retired people do not show significant dissaving behaviour, while Hurd (1990), using the US Retirement History Survey, concludes that the elderly demonstrate dissaving once housing wealth is excluded. Kotlikoff (1989) discovers that social security provisions and the incompleteness of the annuity market leads to involuntary large savings by the elderly. An analysis of the earlier editions of the Survey of Consumer Finance (SCF), undertaken by Sabelhaus and Pence (1999), shows that old-age individuals do significantly draw down their accumulated assets. Their research takes into account a potential upward bias in the age-wealth profile, stemming from the fact that wealthy individuals tend to have low mortality rates. Therefore, asset ownership by the elderly may, generally speaking, represent the holdings of the wealthy. Because of their statistical techniques that adjust this upward bias, the dissaving rates of average pensioners are found to be higher than in other studies. Nonetheless, by using the SCF, Curcuru (2005) shows evidence that the elderly aged over 65 in 2001 has a greater percentage of wealth invested in financial assets than those in 1989. Equity represented around 50 per cent of the net wealth of this age group in 2001 compared to 22 per cent in 1989. He argues that the low dissaving rate of the elderly stems from the fact that retirees prefer to borrow from banks rather than selling their accumulated assets.

Aside from the analyses of US households, other researchers have analysed household consumption and saving decisions in other developed nations. Boersch-Supan and Essig (2003) analyse household saving behaviour from the first wave of SAVE survey data in Germany, finding that precautionary saving motives are the main factor determining saving behaviour of old people. The elderly still exert high saving rates, which is contrary to the studies in the US. Horioka (2007) argues that the high household saving rates in Japan are a temporary phenomenon. As a result of an ageing society, household saving rates appear to decline over time. Baldini and Mazzaferro (2000) uncover a strong cohort effect in the saving decisions among different generations in Italy. Even after taking into account the pension reforms that reduce aggregate household wealth, younger cohorts appear not to have been encouraged to make higher savings. Although a study by Demery and Duck (2006) finds a strong hump-shaped saving pattern of British households from the Family Expenditure Survey data, the declining rate in savings of the elderly is not large enough to reduce the UK aggregate saving rates in the next 40 years when population is ageing.

The other aspect which can be gleaned through the analysis of household survey data in testing the lifecycle hypothesis is to look at the lifetime asset allocation of households. Demographic transition could have an impact on the financial market if there is a significant shift in households' asset allocation over time. This shift could affect expected investment returns through different asset classes. Some of the literature has attempted to derive optimal lifecycle asset allocations based on certain assumptions. Samuelson (1989) allows for a time-varying risk aversion coefficient to explore asset holding preferences of individuals at different ages. The introduction of labour income risks as a key factor to determine asset allocation is analysed in Merton (1969). Bodie, Merton and Samuelson (1992) include uncertainty in future incomes, and allow for the decisions on labour supply to hedge against uncertainty in asset returns in the asset allocation model. This allowance leads to a higher preference for risky assets. Gomes and Michaelides (2005) propose a lifecycle asset allocation model with Epstein-Zin utility functions and labour earning shocks. Cocco et al. (2005) derive a lifecycle consumption and portfolio choice with more realistic constraints of non-tradable income risks and borrowing costs. In general, all of this research finds that the proportion of equity investment will decline over a lifetime.

Based on an analysis of household survey data, asset allocations of elderly individuals tend to be consistent with optimal lifecycle decisions derived from the theoretical models explained above. There are strong preferences for riskless asset classes, especially tax-exempt bonds, as individuals get older. Bodie and Crane (1997), who study household investment behaviour by looking at the saving inside and outside of pension accounts, find that households generally appear to change their investment behaviour according to what economic theory suggests. A fraction of cash is declining with total wealth and a fraction of equity investment is declining with age. Poterba and Samwick (1997) also study the SCF, distinguishing between age and cohort effects on asset preferences. They find that young households appear to prefer liquid financial assets and start increasing bond investments when they reach 60. Poterba and Samwick (1997) also find that older generations tend to hold a larger proportion of risky assets than younger generations.

Nevertheless, empirical studies based on household survey data also have some reservations when it comes to being used to verify particular hypotheses. The cross-sectional age profile of asset ownership is not the only factor that determines aggregate dissaving patterns over time. The age effect only considers the effect from the preferences on asset holdings at the point in the lifecycle. Even though the age-specific factor directly represents the impact of demographic patterns on the financial market, empirical evidence in the survey data pertaining to asset ownership at each age range also embodies the other two effects, namely, time-specific and cohort-specific factors. These may confound the observed cross-sectional age-wealth profile. The time-specific factor captures the effect of certain situations at the point in time when the survey is conducted. Household wealth shown in the survey data in the year following a period of high economic growth will be greater than the year after a period of recession. As a consequence, an increase in wealth with age is not always evidence of low asset drawdown. The cohort-specific effect refers to the effect from the date of birth. Individuals born in different years may have different preferences about saving and consumption decisions in response to different economic experiences over their lifetime. For instance, individuals born during an economic recession may have a stronger preference to save than other cohorts because of their fear of financial loss. Accumulation of human capital and financial assets over time by different cohorts may also experience different growth rates as each cohort may undergo different economic conditions through their lifecycle. Ameriks and Zeldes (2004) illustrate that a particular cross-sectional age-wealth profile can be obtained from different assumptions of time and cohort effects.

Furthermore, most household survey data only provide information about asset holdings owned directly by households. Therefore, household funds invested in pension funds, mutual funds, occupational pension plans, and PAYG-defined benefit pension plans are normally omitted. Financial assets in those household financial plans may represent a large proportion of household wealth. Therefore, the survey data on personal wealth may not represent the real asset allocations of households. In addition, evidence of the low proportion of wealth invested in the equity market when individuals age does not necessarily imply that the downward pressure on prices as a result of the sell-off of equity by the elderly will lead to a significant impact on the financial market. This results from the fact that the total amount of assets directly owned by individuals may account for only a small proportion of the total asset value of the market. Poterba (1998) also points out that the cross-sectional survey data may not provide robust results for proving the lifecycle hypothesis because the wealth data is normally skewed toward wealthy households who usually hold 70 per cent of the total financial assets directly owned by all households. This implies that results from the household survey analysis may not actually represent actual behaviour of average households.

6.3 An empirical analysis to investigate lifecycle saving patterns of households in various types of investment opportunities

6.3.1 The main reasons to study household saving decisions from the Family Expenditure Survey data

An analysis of the age-profile of household ownership of financial assets is necessary for understanding why a certain age group has a significant influence on asset prices and returns. As discussed in chapter 4, one mechanism that this research paper attempts to test is the interconnecting mechanism provided by institutional investors, particularly pension funds, a group which may amplify the impact of demographic patterns on the financial market through household investment in these financial institutions. This implies that the age-profile of financial assets directly owned by households is not sufficient to provide evidence to test this proposed mechanism. The cross-sectional age pattern of household participation in financial institutions is required to provide evidence as to how households contribute funds to financial institutions over their lifecycle. These contributions will include investments in unit or investment trusts, investments in personal retirement accounts and those contributions paid into employee occupational pension plans. An analysis in this chapter covering all the options that households can choose to participate in the financial market will provide a complete picture of lifetime household saving decisions.

As discussed previously, there are still a number of problems and limitations concerning the analysis to obtain a robust result on the lifecycle saving patterns of households. Most of the existing literature in this area tends to focus only on the direct investment of households in the financial market and their investment in unit or investment trusts. They often fail to incorporate crucial information about households' savings in defined-benefit pension plans. For example, the Government Accountability Office (GAO) in 2006 only analyses US households' direct investment in the financial market from the Health and Retirement Study (HRS) and the SCF. Their conclusions about the dissaving rates of the elderly may not be complete because household wealth in occupational pension plans is excluded. Typically, housing assets and pension accounts (including both of the private and public pensions) represent approximately 40 per cent of the total household retirement wealth. This implies that pension assets are one of the main households' financial assets that need to be considered when analysing saving behaviour of households. The exclusion of household wealth in pension accounts in most of the previous literature may possibly be owing to difficulties in the calculation of the present value of savings in such a scheme, but more likely due to a lack of the data. The exclusion of this wealth may be the main reason why some previous literature did not find any evidence of wealth decumulation by the elderly.

Not only would an analysis of household lifetime savings provides evidence to test the lifecycle saving decision of households, it would also be useful for understanding why particular age groups have a significant impact on the financial market. The cross-sectional age pattern of household participation for each type of saving opportunities (i.e. direct investment, saving in unit/investment trusts, or saving in pension schemes) will illustrate the age range that exhibits the highest participation rates in a certain type of investment opportunities. If this age group is similar to the age group found in chapter 5, which has a significant influence on asset prices and returns, it indicates that the aggregate investment activity of households in a specific investment option (i.e. direct investment, saving in unit/investment trusts, or saving in pension schemes) may explain the strong relationship between demographic variables and asset prices. This is because the high participation rates imply a large supply of and demand for, in relative terms, financial assets by a particular age group via savings in a specific investment option. Intuitively, an age group with high participation rates would be expected to demonstrate a statistically significant correlation with asset prices and returns. However, an age group that shows high direct ownership of financial assets may be different to an age group showing high participation rates in occupational pension plans. This means that the comparison of the coefficient estimates within these age groups (as shown previously in chapter 5) can provide evidence to test the hypothesis whether the existence of such financial institutions leads to a strong correlation between demographic variables and the capital market.

The household survey data used in this analysis is the UK Family Expenditures Survey (FES). The FES has been conducted annually since 1957, and is the most complete data source on household incomes and expenditures in the country. The historic nature of this data means that it is a rich source for an analysis of changes in household saving decisions based on the time, age, and cohort effect. Even though the FES is not a longitudinal survey that follows the same household over different periods of time, the cohort effect can still be extracted from the FES because the repeated cross-sectional samples of this survey data can be approximated to represent the whole population over time. To my knowledge, this is the first research paper that investigates the age pattern of lifetime household savings by looking at various types of saving opportunities utilising this repeated cross-sectional survey data. Little research in this area has been conducted using non-US data sources. Although Banks and Tanner (1996) and Banks and Smith (2000) do look at UK saving behaviour using FES data, they do not cover household savings in occupational pension plans and personal pension plans, as this paper does.

Early empirical investigation into the lifecycle hypothesis was based mainly on single-year cross-sectional survey data or some years of repeated cross-sectional data. For instance, King and Leape (1987) find a positive correlation between equity ownership and ages from a single cross-section of data. Bodie and Crane (1997) analyse lifetime portfolio allocation from the 1996 cross-sectional survey of TIAA-CREF data. The use of single cross-sectional survey data can only provide an estimation of the age effect, but other potential factors such as time effects or cohort effects cannot be examined. Other researchers use the repeated cross-sectional survey data in separate years to test the lifecycle hypotheses. Most of these (e.g. Yoo, 1994b; Poterba & Samwick, 1997; Poterba, 2001) rely on the SCF in analysing US households. However, this survey has not been conducted annually, but rather triennially, since 1989. Therefore, when observing the saving decisions of individuals born in a particular year, in order to extract the cohort effects, few specific ages can only be estimated. Additionally, since this dataset covers only a short period of time, information about the saving decisions of the oldest cohorts when they were younger is unavailable.

6.3.2 Understanding UK household lifetime saving decisions from the Family Expenditure Survey data

In this section, an analysis of the lifetime household saving decisions is presented. In an ideal world, data sources for this analysis would include information on the wealth holdings of each type of investment made by households, and should follow the same households over time. Unfortunately, there is no such panel dataset available in the UK. The most complete set of data containing information about income and expenditure in UK households is the Family Expenditure Survey (FES) data. Even though this data does not provide household wealth holdings, lifetime household saving decisions for each type of investment can be obtained via the detailed classifications of household income and expenditure components. These components include labour income from primary and subsidiary occupations, dividends or interest from investment in financial assets, income from investment in unit/investment trusts, income from Personal Equity Plans (PEPs), and income from GILTs. Based on this information, the investment portfolio of UK households can be obtained by calculating the probability of possessing each investment type, using Equation 6.1.

$$\text{Probability of owning a particular investment option} = \frac{\sum_{i=1}^{N} w_i \cdot \left[I_{x_{ij}>0}\left(x_{ij}\right) \right]}{\sum_{i=1}^{N} w_i} \qquad (6.1)$$

The subscription i is referred to each individual in the sample. The subscription j is referred to types of investment. The parameter w refers to the sample weight of household and x refers to the income flow. The indicator function I will equal 1 if the income flow is positive and 0 otherwise.

The FES data also provides information about the sources of deductions from labour income, including income tax, national insurance contributions and superannuation contributions, as well as other deductions on sport clubs and so on. Therefore, it is possible to calculate the proportion of working adults in both public and private sectors who have occupational pension plans. This element of household saving could enhance understanding of lifetime household saving decisions because savings in occupational pension plans have generally been excluded from the literature which has attempted to examine the lifecycle portfolio of households. However, information about contributions to occupational pension plans was not available on a personal level until 1973. In addition, the FES data provides information about household saving through personal pension plans. This data has been available since 1988. Prior to then, this information was included in the premiums paid to insurance companies. The probability of participation in each of these investment opportunities is derived from Equation 6.1, shown above.

The following figures (Figure 6.2 to Figure 6.24) demonstrate the lifetime probability of participation in each type of investment opportunity, based on time, a cross-sectional view of age, and a cohort view of ages. According to the time view, the probability estimates of a particular year are the fraction of adults in all ages owning a particular investment option. According to the cross-sectional and cohort view of ages, the probability estimates are the fraction of adults of a certain age who hold a certain investment opportunity. The main difference between the cross-sectional and the cohort view is that estimates of the former are calculated from samples in a particular year of the survey, while estimates of the latter are calculated from observing who was born in the same year. In other words, the cohort view illustrates how households in a specific birth cohort change their saving decisions over their own lifetime whereas the cross-sectional view represents a snapshot of saving decisions made by the population in different age ranges.

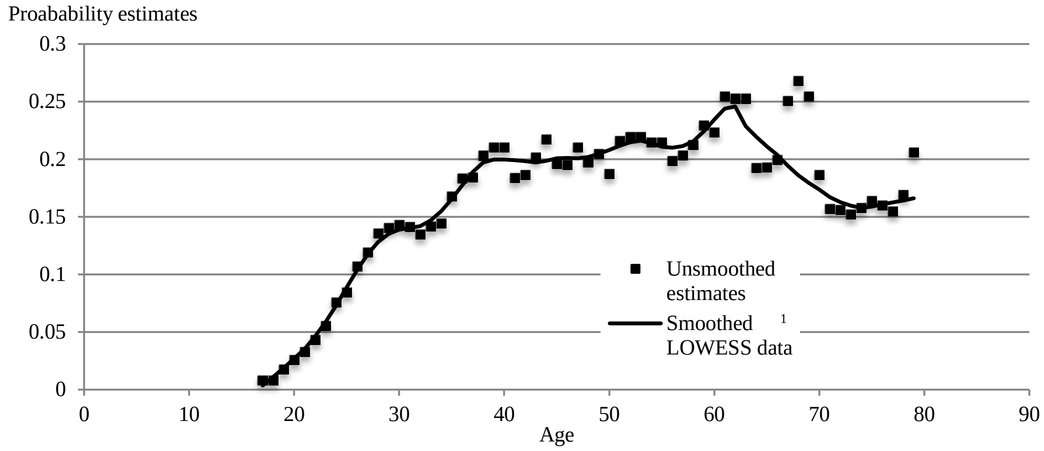
Allowing for a time effect provides a benefit of changes in the estimates over time but all cohorts are assumed to have similar lifecycle saving patterns. In contrast, controlling for a cohort effect offers a chance that the flat-age patterns observed in a single cross-sectional data can be a hump-shaped pattern when analysing from a panel data because the cohort effect allow the estimates to vary with cohorts. As a result, the cross-sectional view of the age profile will provide an accurate representation of household participation in the capital market only given the assumption that cohort effects are not significant. Likewise, the cohort view of the age profile will show accurate information only given the assumption that there are no time effects. Controlling for this cohort effect is important. Hildebrand (2001) has shown in his research using the Survey of Income and Program Participation (SIPP) data that, after controlling for the cohort effect, there appears to be little wealth decumulation for the elderly. Wang and Hanna (1998) also note that the generation born between 1897 and 1924 has different portfolio compositions from its succeeding cohorts because this generation experienced the great depression in 1929. In sum, the cohort effect represents the degree of risk preferences among population born in different years.

However, the probability estimates from Equation 6.1 may contain errors if observations in a particular segment are not sufficiently high to represent the actual population. For example, the probability of households aged 90 or above directly owning financial assets may be at the extreme value (0 or 1 probability) if there are very few observations (1 or 2 people) at this age. In an attempt to overcome this problem, the probability estimates of a particular age in the cross-sectional view are calculated from the average of adults in a 3-year age group in a specific year. For instance, the probability of adults aged 40 directly owning financial assets in 1992 is, in fact, the equally-weighted average of adults aged 39, 40 and 41 in that year. In the case of the cohort view, the problem of too few observations in estimating the probability is more severe. Therefore, the calculation of the probability at a given age will be derived from the average of adults in a 5-year age group, where the estimated point is in the middle of this range. Nevertheless, results from these adjustments still contain high noises or random errors in the estimates, especially in older households. A LOWESS-smoothed technique is, therefore, implemented over these probability estimates in order to extract the main information from the observed noise data.

LOWESS is a term meaning “locally weighted scatter plot smooth”, namely the locally-weighted linear regression of data that combines the benefits of both the linear and non-linear least squared regression. The main advantage of this smoothing technique is that no specific functions of any forms are required to compute the smoothed data. LOWESS uses the neighbouring data points, within a specified range, to determine the smoothed values. It is locally weighted in the sense that these neighbouring data points are imposed by different weights based on the weight function, which in the case of LOWESS is a linear first-degree polynomial that gives less weight to data points that are further away from the estimated location. Data points that are outside the span have zero weight.

The smoothing parameter that specifies the span or the bandwidth of the estimations in this analysis is 9. This means that the plotted value of the probability estimates of any given age in both the cross-sectional and cohort view is calculated from the span covering the neighbouring observations within four points either side of the estimated location. The robust LOWESS weight function, which includes an extension algorithm from the ordinary LOWESS weight function, is used in this analysis so that the smoothed values are resistant to the outliers. The comparison between unsmoothed data points and smoothed values of the probability estimates are illustrated in Figure 6.1. It is clear that LOWESS helps to extract the trend from the noise of raw data, while the information at each point is still preserved.

Figure 6.1 Comparison between the smoothed LOWESS data and the unsmoothed estimates



1 The span of the LOWESS covers 4 neighbouring data points on either side of the estimated location

6.3.3 The probability of directly owning financial assets within British households

Figure 6.2 and Figure 6.3 present the probability of directly owning financial assets for UK males and females between 1968 and 2007. Financial assets in the figure include corporate bonds, debentures, local authority securities and stocks. It is impossible to estimate the probability of ownership for each type of financial asset because the FES data clusters all the interest and dividend incomes from these financial assets into one single variable. It can be seen that both males and females experienced the same sharp increase in investment in the financial market during the 1980s. This evidence is consistent with the information provided by Davey (2001) which finds that the important of housing wealth relative to financial wealth has declined from about 60 per cent to approximately 40 per cent since the 1970s.

Figure 6.2 The time view of the probability of British males directly owning financial assets

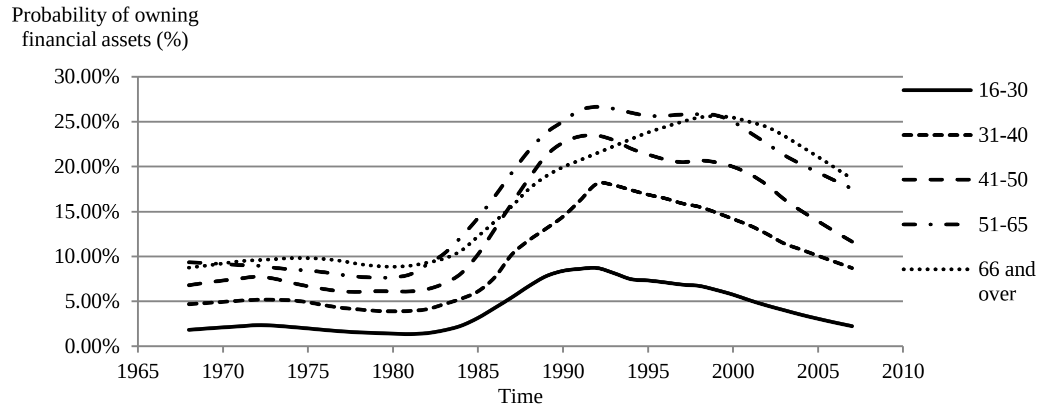
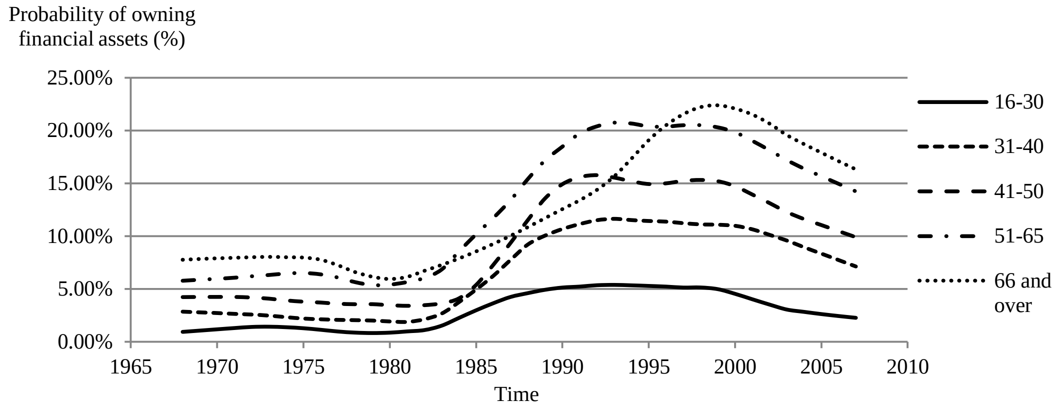


Figure 6.3 The time view of the probability of British females directly owning financial assets



The fraction of females directly owning financial assets was lower than males by approximately 5 per cent over the entire period. Before 1980, British households showed low investment in the financial market, at only 8 per cent for the male population aged between 41 and 50. The rapid increase in the participation of household in the financial market during the 1980s was mainly due to the privatization of many public utilities and building societies, such as British Telecom in 1984 and British Gas in 1986. The larger proportion of demutualisation shares owned by British households during the 1980s was also another main reason for the sharp increase in the fraction of direct share ownership by British households. The flotation of those national companies and a reduction in transaction costs such as stamp duty on share purchases during the early 1980s may also help to develop a learning effect in households towards investment in the financial market, thereby increasing the exposure of households to other investment opportunities. The sharp increase in financial asset ownership during the 1980s has led to an increase in the fraction of financial asset holdings per total wealth from 60 per cent to nearly 75 per cent by the end of the 1990s (Davey, 2001).

After the probability of owning financial assets reached plateau during the 1990s, there has been a gradual decline for all age ranges. The gradual decline in the probability of owning financial assets during the late 1990s can partly be explained by the selling of demutualisation shares. According to the Share Ownership survey, households' ownership of demutualised companies was around 60 per cent of the total share ownership at the end of 1997 and then declined to 48 per cent at the end of 1998 and 45 per cent at the end of 1999.

Figure 6.4 and Figure 6.5 show the cross-sectional view age profile of the probability of directly owning financial assets for both British males and females. Before the age of 40, the data shows a significant increase in the probability estimates of both males and females. The fraction of males directly holding financial assets rose from only 5 per cent at the age of 20 to around 20 per cent at the age of 45. The main reason for low participation rates in the financial market of young households may come from the fact that these young investors are liquidly constrained by an investment in housing. Because these young investors have low financial net worth and are exposed to large housing risks, the incentive to add equity risks in their portfolio may be low. As households age toward the mid age of their lifecycle (40-55), the participation rates in the financial market increase because future consumptions of households tend to be less related to the risk of their liquid portfolio in the financial market. On the contrary, their consumptions appear to be more correlated with accumulated housing assets and human capital assets which tend to peak at this stage of the lifecycle.

The peak of financial asset holding occurs between 60 and 70. There is no apparent decline in the probability estimates after the age of 65 in both males and females. British households tend to maintain their direct investment financial positions. This lifecycle pattern of households directly investing in the financial market is consistent with previous literature which finds relatively little evidence of asset run down at older age. For instance, Tracy and Schneider (2001) observe that the ageing of households does not lead to a decline in the fraction of households' invested in the equity market. Poterba (2001) also finds that US households' wealth in the stock market does not decline significantly when they age. On the contrary, households' investment in common stocks remain nearly constant after the age of 65. According to this empirical evidence, he projects that household asset demands will not decline significantly until 2020 and the "asset meltdown" scenario should not occur.

Figure 6.4 The cross-sectional view age profile of the probability of British males directly owning financial assets

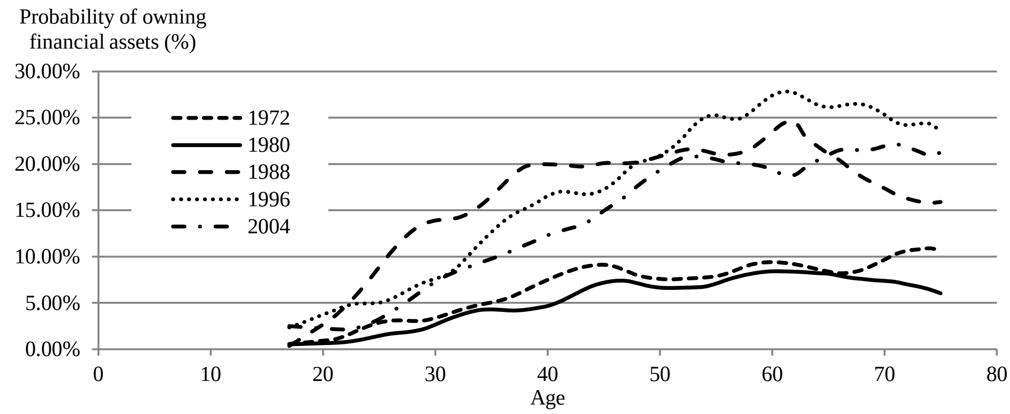
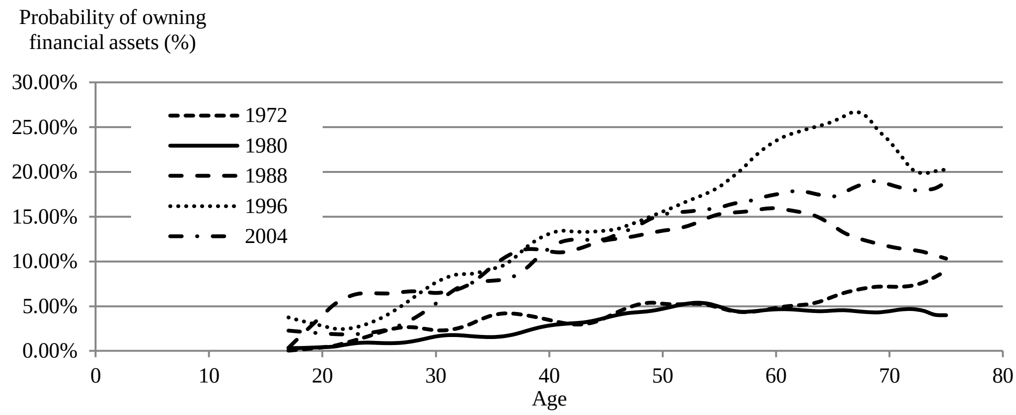


Figure 6.5 The cross-sectional view age profile of the probability of British females directly owning financial assets



The lifecycle probability of directly owning financial assets found in this paper is in contrast to the lifecycle hypothesis that assumes a dissaving motive of households upon retirement. However, this contradiction may result from the fact that the direct investment of households in the financial market is only one option that households can choose for their investments. This direct investment might be dissipated only when all retirement benefits from other sources, such as occupational pension plans or social security benefits, are insufficient to meet living costs.

Figure 6.6 and Figure 6.7 provide a cohort view of the lifetime direct investment in the capital market of British males and females respectively. They show remarkable discrepancies in terms of the probability of directly holding financial assets among different cohorts. At a given age range, younger cohorts appear to be more likely to invest directly in the financial market. An interesting fact from the cohort view is that the age profile does not seem to demonstrate a pattern similar to the cross-sectional view, but rather it is analogous to the time pattern as illustrated in Figure 6.2 and Figure 6.3. It seems clear that the probability of each cohort holding financial assets increases during the privatization period of the late-1980s. Even the oldest cohort, born between 1906 and 1910, showed a dramatic increase in probability estimates after the age of 72. What can be learned from this cohort view is that the time effects may be an important factor in determining the probability of direct investment in the financial market; therefore the cohort view age profile that assumes no time effects may be invalid. The empirical evidence found in this section also indicates that the cross-sectional saving age patterns change over time and cohorts. Therefore, previous research that uses single-year cross-sectional data to imply the lifecycle pattern may not be robust or reliable.

Figure 6.6 The cohort view age profile of the probability of British males directly owning financial assets

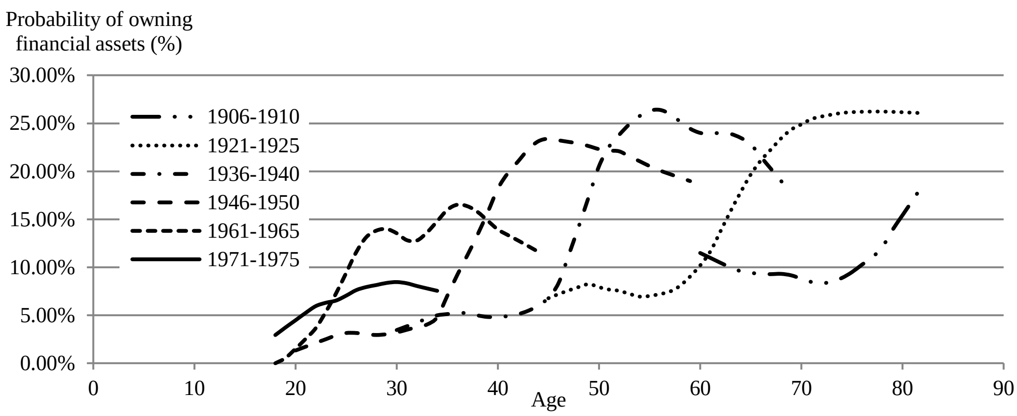
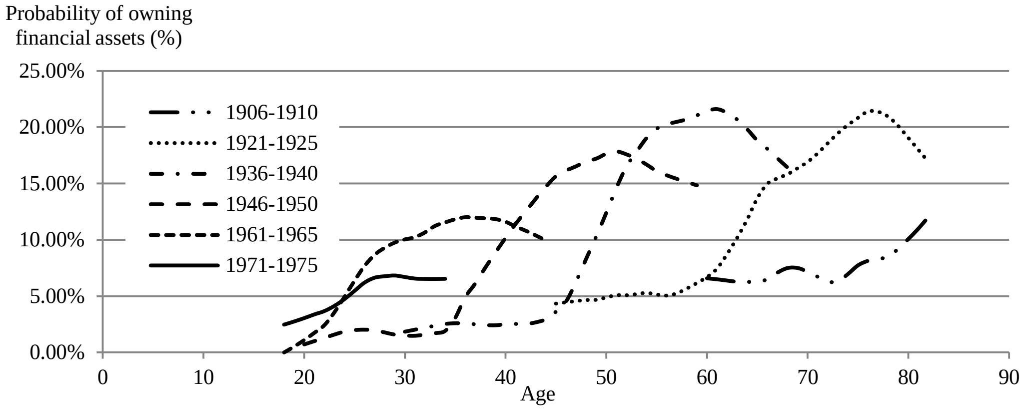


Figure 6.7 The cohort view age profile of the probability of British females directly owning financial assets



6.3.4 The probability of directly owning unit/investment trusts and Personal Equity Plans (PEPs) within British households

Figure 6.8 and Figure 6.9 compare the probability of owning unit/investment trusts and the probability of owning Personal Equity Plans (PEPs) for British males and females respectively. There was a sharp increase in investment in unit/investment trusts during the mid-1980s, showing a pattern similar to the probability of directly owning financial assets. In 1986 the Thatcher government introduced Personal Equity Plans as an attempt to increase equity ownership in British households[20]. A large proportion of households, who had previously owned unit/investment trust accounts, transferred their investment to PEPs so as to reap their tax-privileged benefits. Households are only required to pay tax on capital gains if the returns are greater than the annual allowance. Based on these illustrations, it seems obvious that the government's effort to increase the overall rate of equity ownership did not achieve much success. The proportion of males holding investments in these two financial institutions appeared to stay stable at around 7 per cent between 1985 and 2000, before gradually declining. The size of total PEPs in 1999 was around £58.6 billion and one-tenths of Britons hold PEPs by April 1999. The gradual decline in the participation rates in PEPs during the 2000s was primarily owing to the fact that PEPs and TESSAs have been replaced by a new saving account, namely ISAs, since

[20] PEPs were launched in 1987. The tax relief on investment returns is limited only up to the investments of £6,000 annually in a general PEP and up to £3,600 in a single company PEP.

April 1999. This new account offer lower tax benefits to British households. The upper limit of the total amount of investment each year is reduced to £5,000 with further limitations on the amount invested in life insurance at £1,000 and the amount invested in cash at £1,000. Dividend tax credits have also been cut from 20 per cent in a PEP to 10 per cent in an ISA.

Figure 6.8 The time view of the probability of British males owning unit/ investment trusts and Personal Equity Plans (PEPs)

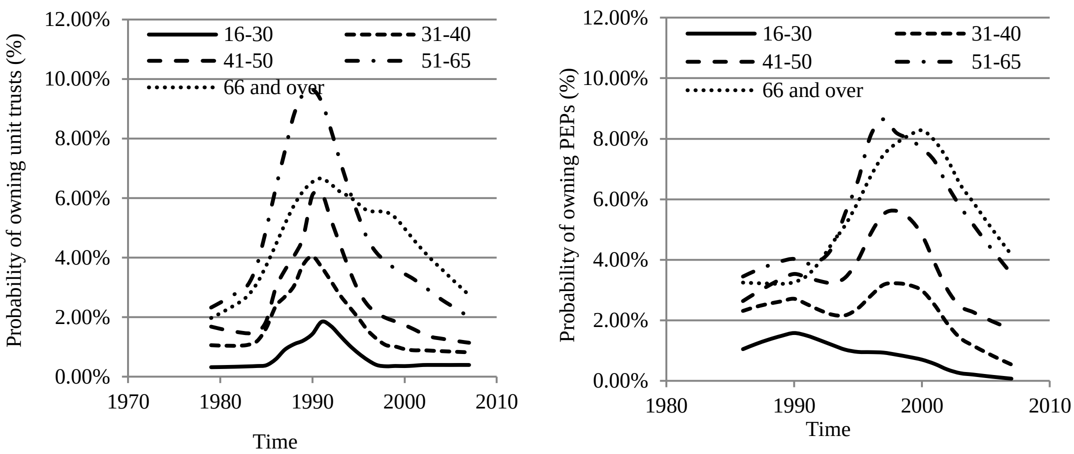
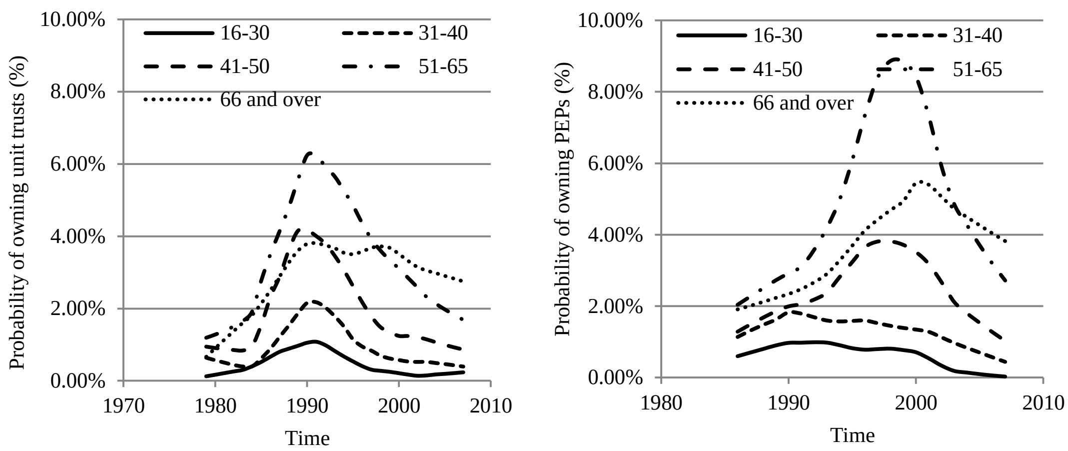


Figure 6.9 The time view of the probability of British females owning unit/ investment trusts and Personal Equity Plans (PEPs)



The age group which participates most in unit/investment trusts and PEPs is that between 50 and 65 years old, as shown in Figure 6.10 and Figure 6.11. The age patterns appear to be similar for both males and females holding unit/investment trusts and PEPs. Unlike the cross-sectional age pattern of household direct ownership of financial assets, the participation rates in these financial institutions declined after the households reached retirement. However, the decline in the participation rates of elderly households in this cross-sectional view may not represent the actual lifetime saving decisions if there were cohort effects. The low fraction of households at the high age ranges may result from the fact that those earlier-born cohorts are less likely to invest in these financial institutions than the younger cohorts. For example, the male cohorts aged 70 in 2004, who had PEP participation rates of around 8 per cent, had a PEP participation rate in 1998 of only 5 per cent, when they were 54. From this example, the age patterns of the participation rate in PEPs should show a gradual, monotonic increase with age. The cohort view of the age profile in Figure 6.12 and Figure 6.13 illustrate this point.

Figure 6.10 The cross-sectional age view of the probability of British males owning unit/investment trusts and Personal Equity Plans (PEPs)

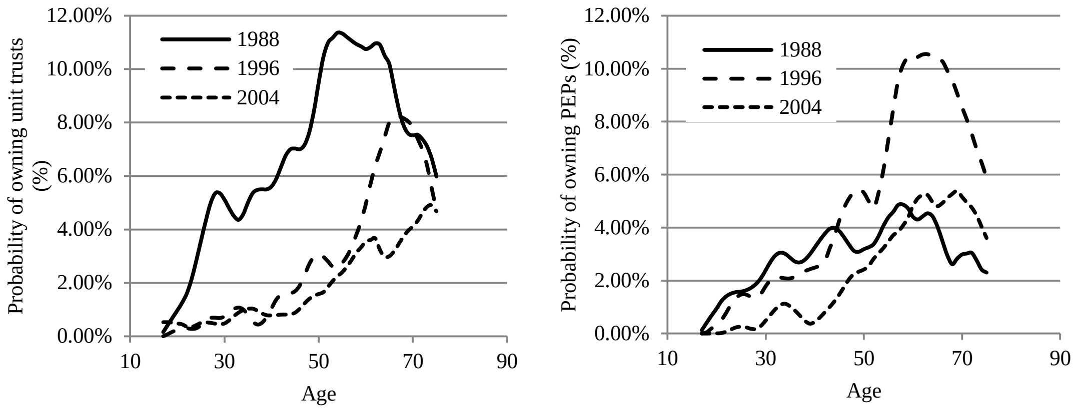
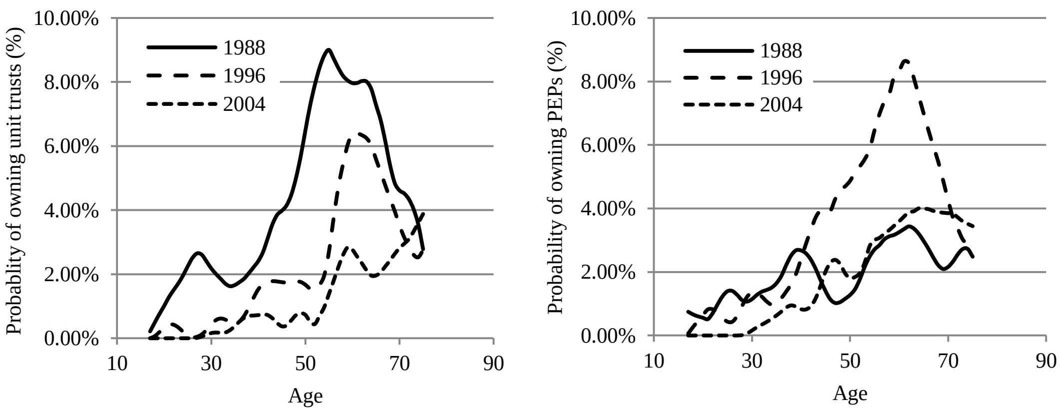


Figure 6.11 The cross-sectional view of the probability of British females owning unit/investment trusts and Personal Equity Plans (PEPs)



After controlling for the cohort effects, the age profiles were strikingly different from the patterns shown in the cross-sectional view. The age pattern of each particular cohort appears to have been affected significantly by time effects, as indicated in Figure 6.12 and Figure 6.13. For the male cohorts born between 1936 and 1940, the probability of owning investment trusts peaks at around 52 years old, corresponding to the peak of this probability estimate in 1990 (see Figure 6.8). This corresponding evidence was also presented for investment in PEPs. It makes no sense to think that the lifetime investment pattern in these financial institutions would follow this shape. This is because the patterns shown in Figure 6.12 and Figure 6.13 will be correct only on the condition that the time effect is insignificant; it is fairly clear that these age patterns are largely influenced by time effects. If we plot a graph based on the cohort view, the pattern in the graph will be correct only if there are no time effects. But if we look at the pattern of each cohort in the cohort view, it appears that the pattern contains time effects. Therefore, the assumption of having no time effects in the cohort view is not justified.

Figure 6.12 The cohort view of the probability of British males owning unit/investment trusts and Personal Equity Plans (PEPs)

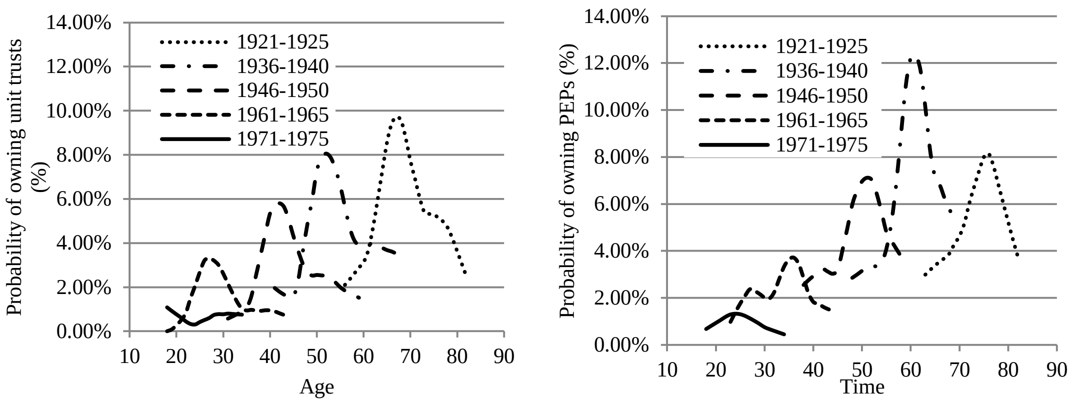
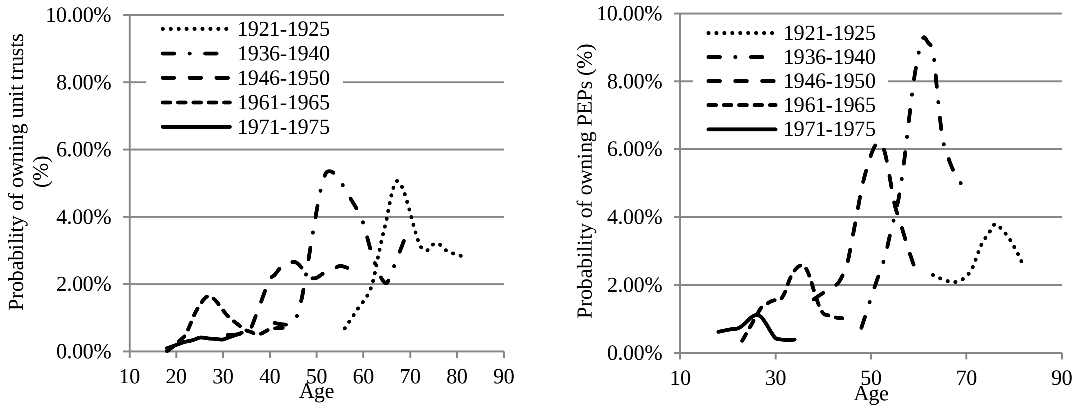


Figure 6.13 The cohort view of the probability of British females owning unit/investment trusts and Personal Equity Plans (PEPs)

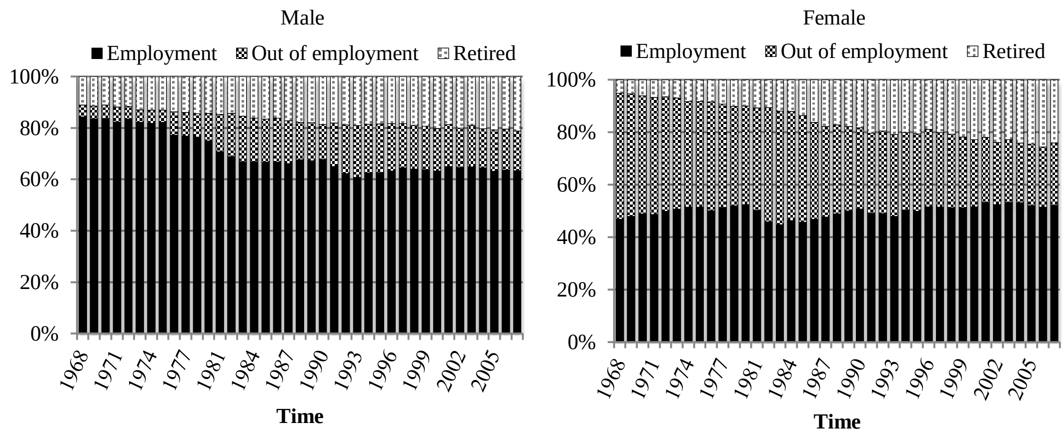


6.3.5 The probability of British households directly owning Occupational Pensions and Private Personal Pensions

The above probability estimates are calculated by using all adults at a given age range in the denominator of Equation 6.1. However, these weights in the denominator may not be useful for estimating the probability of participation in occupational pension plans and personal retirement plans. This is because occupational pension plans are available only to adults who have been an employee during any period of their working life. Moreover, investment decisions in personal retirement plans may differ between the self-employed, for whom personal retirement plans are the only available option for retirement savings, and employees, who may also have employer pension plans. In an attempt to see how individuals in different economic positions are dissimilar in the way they save for retirement, working adults from the FES data are categorized into three main working categories: a) full-time employees, b) part-time employees, and c) the self-employed.

Figure 6.14 illustrates the proportion of adults in each employment category. As can be seen, the proportion of male adults in employment has declined gradually over time from around 82 per cent in 1968 to approximately 60 per cent, while the proportion of females in employment slightly increased from 45 per cent to 53 per cent over the period. Figure 6.14 also demonstrates, interestingly, that the proportion of the retired population was increasing rapidly for both males and females, peaking at 20 per cent in 2007.

Figure 6.14 Employment status of British households as a percentage of the total adult population



The proportion of the British adult population working full-time, part-time or as self-employed is illustrated in Figure 6.15. Predominantly, females worked part-time, accounting for approximately 40 per cent of the total female working population, while approximately 80 per cent of males in employment were full-time. The proportion of females in each type of economic position was fairly constant over time. This is in contrast to working males that had seen a moderate increase in the proportion of the self-employed and part-time employees.

Figure 6.15 Economic positions of British working adults as a percentage of the total working adult population

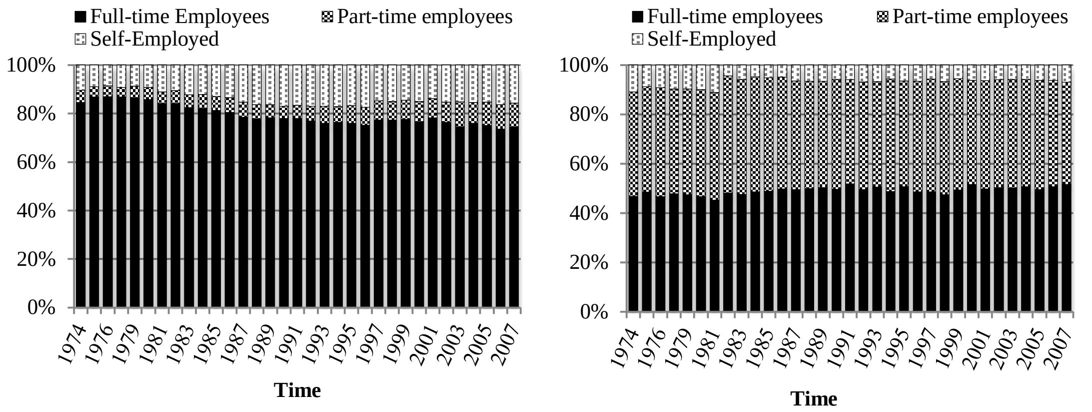


Figure 6.16 presents the time view of the probability of participation in employer pension plans, private personal pensions and both of these provisions for full-time employees. There seems to be parallel changes in the probability of participation in occupational pension plans between different age ranges. Male employees participating in employer pensions declined over time from around 55 per cent of all male full-time employees in 1968 to only 45 per cent in 2007, while female participation gradually increased from 30 per cent to around 50 per cent. There was a sharp increase in the probability of owning personal retirement plans at the beginning of the 1990s. This pattern was similar to the time view of the probability of owning PEPs as illustrated in Figure 6.8 and Figure 6.9. This sharp increase in both PEPs and private personal pensions during this period may have been driven by the Thatcher government’s policy to encourage British households to invest in the financial market. The proportion of both male and female full-time employees having both pension savings with employers and their own private pensions has been increasing over the past 20 years. This group may represent the increased percentage of the population concerned about their retirement savings.

Figure 6.16 The time view of the probability of British full-time employees having employer pension plans, private personal pensions and both of these provisions

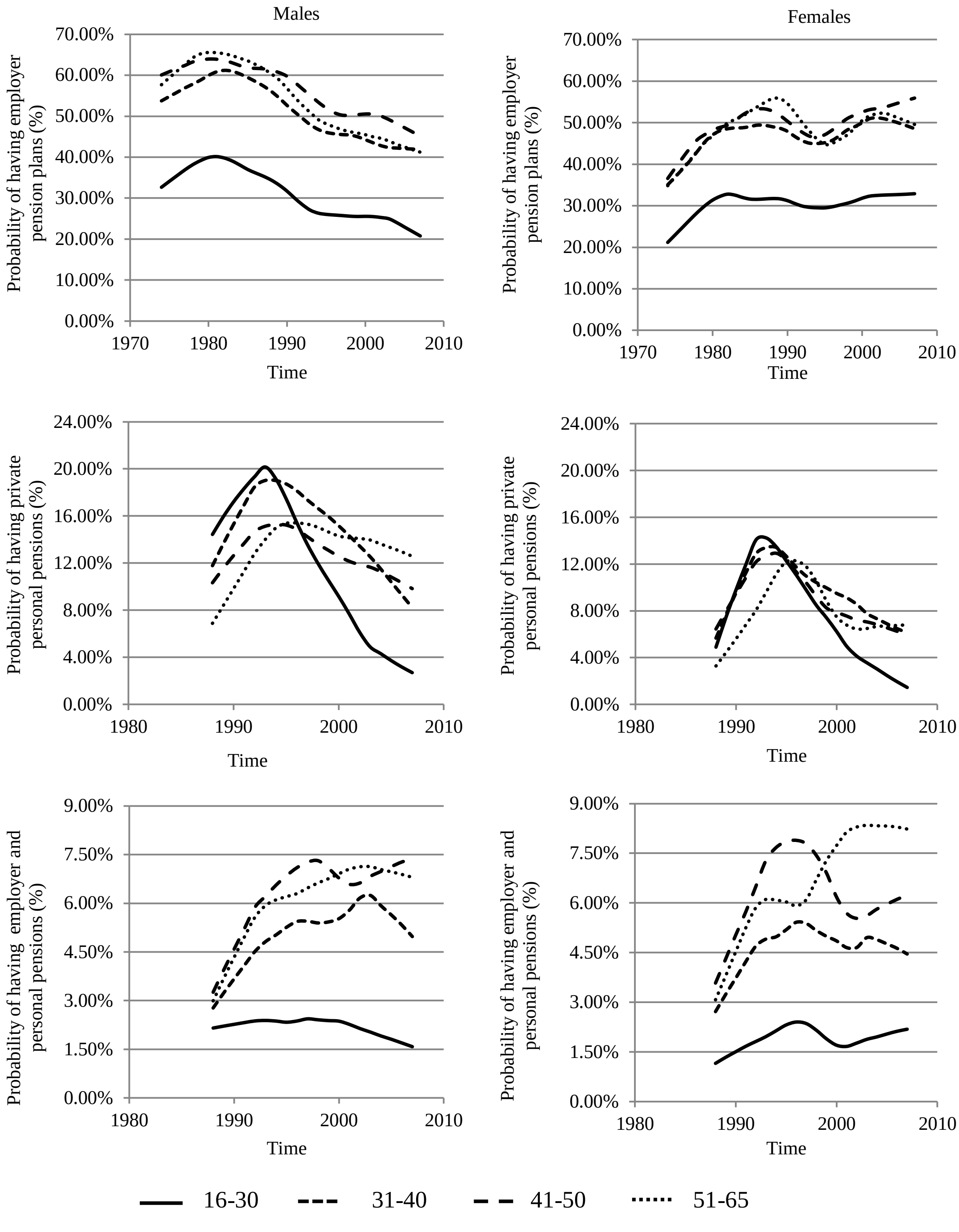
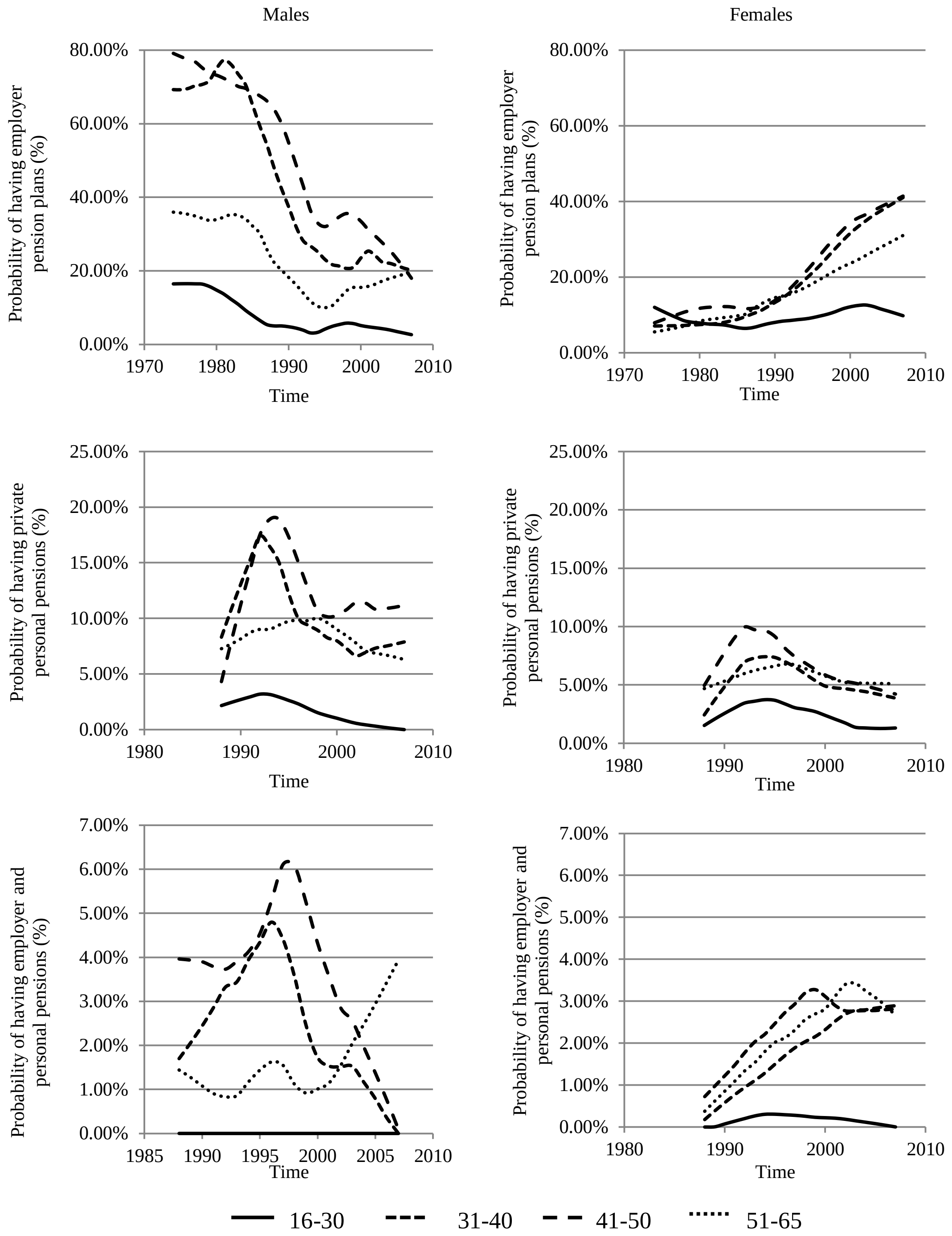


Figure 6.17 shows the time view of the probability of participation in each of those retirement plans for part-time employees. There was a remarkable decline in occupational pension provision for male part-time employees, dropping from around 70 per cent in 1973 to just 20 per cent in 2007. However, employer pension provisions for female part-time workers rose sharply during the 1990s, rising from 10 per cent in 1973 to approximately 40 per cent in 2007. The probability of part-

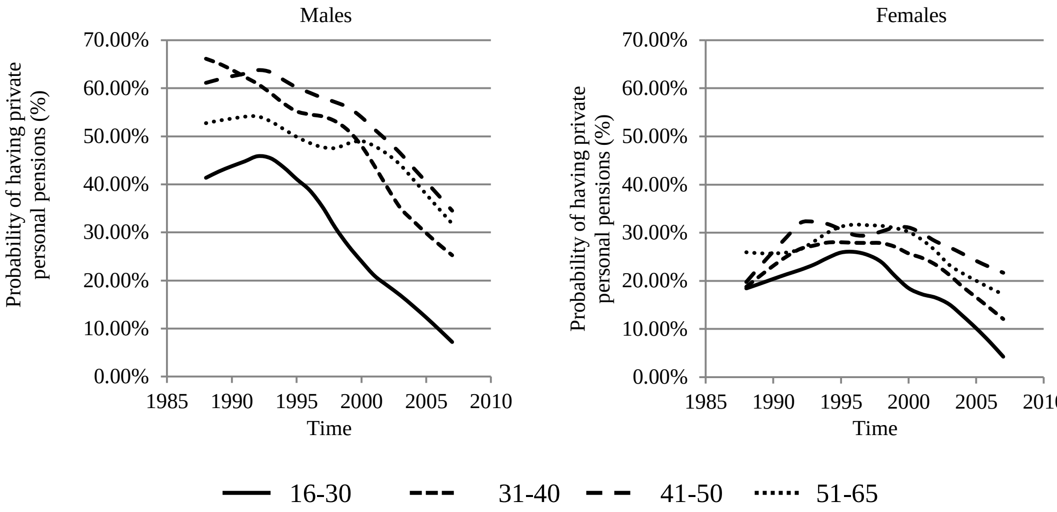
time employees owning personal private pensions shows the same pattern as with full-time employees, peaking in 1993. Part-time females show more concern for their retirement savings than their male counterparts. There was a high and stable probability that part-time females would own both occupational and private pensions from 2000 onwards, while since 1997 there was a rapid decline for males.

Figure 6.17 The time view of the probability of British part-time employees having employer pension plans, private personal pensions and both of these provisions



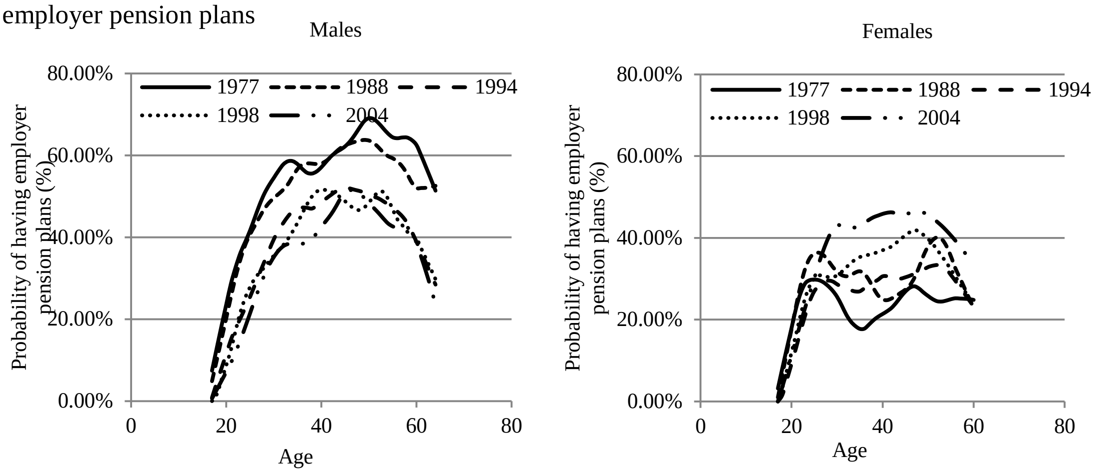
A large percentage of the self-employed had no investment in private personal pensions. The probability of owning such retirement accounts has been declining, from 60 per cent of all male self-employed in 1988 to only 30 per cent in 2007 (see Figure 6.18). This pattern is similar for self-employed females, although with a slower rate of decline. This evidence increases the concern that the majority of the self-employed have not planned for their retirement. Retirement incomes of the self-employed tend to be largely dependent on earnings generated by their own business. This is an inappropriate portfolio for retirement savings because such earnings can be highly volatile from one period to another.

Figure 6.18 The time view of the probability of the British self-employed having private personal pensions



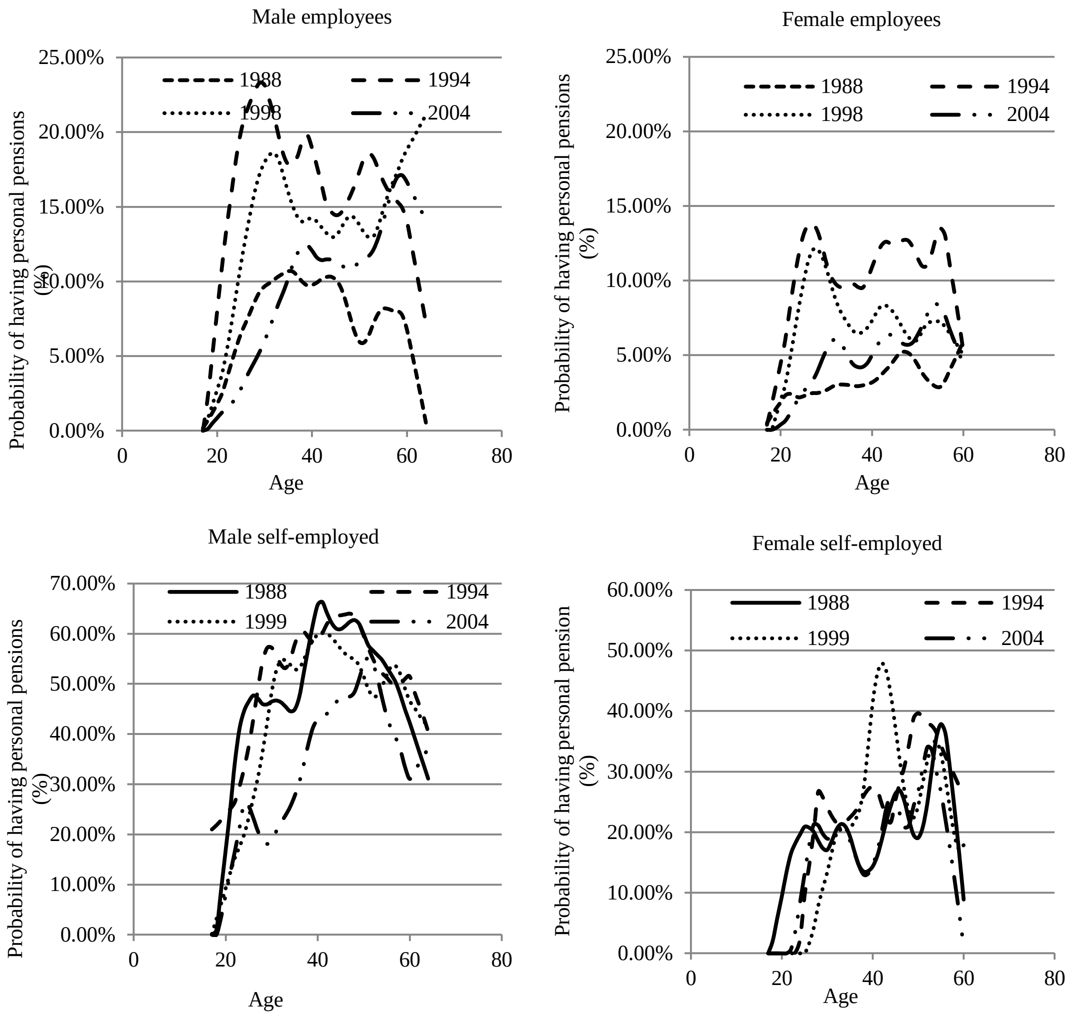
The cross-sectional age profiles of the probability of participation in employer pensions for employees (including full-time and part-time) are illustrated in Figure 6.19. Male and female employees alike have the same age participation patterns in occupational pension plans. Young employees appear to have very low participation rates. The probability of owning occupational pension plans gradually increased to a peak between the ages of 40 and 50 before declining afterwards. This decline in the proportion of employees with occupational pension plans reflects a reduction in the contributions paid to employer pensions as employees reach retirement. This evidence suggests that net cash flow to pension funds in the coming decades will be negative because the amount of funds flowing into pension funds may be dropping as the proportion of the population aged over 55 expands. The age patterns also appear to be consistent with the lifecycle hypothesis that the motive for saving is highest when real labour income peaks (around the age of 40-44). Once individuals approach the age of retirement, dissaving motives tend to be dominant.

Figure 6.19 The cross-sectional view age profile of the probability of British employees having employer pension plans



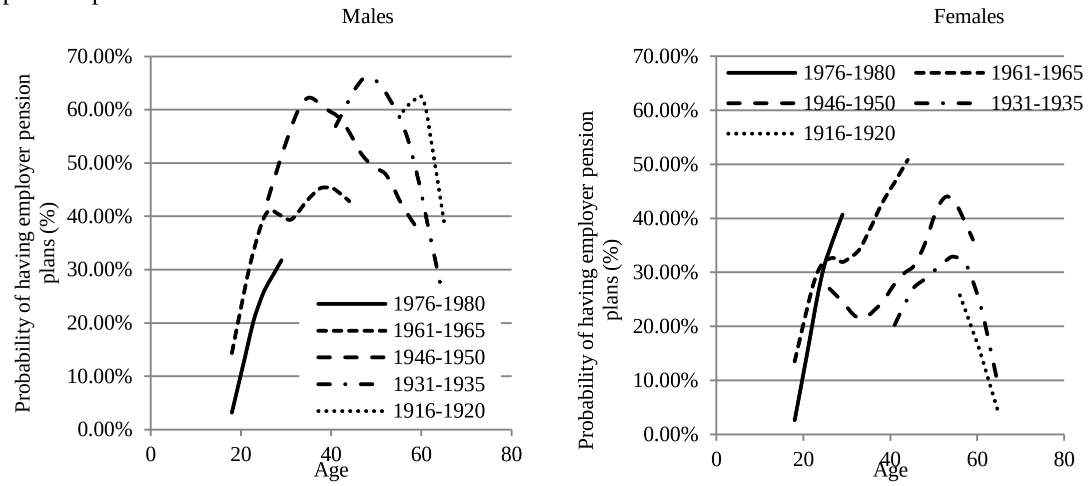
The inverted U-shape saving pattern presented in Figure 6.20 illustrates the cross-sectional age profile of the probability of owning private personal pensions for both employees and the self-employed. The hump-shaped pattern appears to be weaker when employees participate in personal pension accounts owing to the fact the number of observations of this group in the FES data is too low. This could lead to higher random errors in the probability estimates. From all of these graphs, an apparent decline in the participation rates for males and females 5 years before their formal retirement ages (60 for females and 65 for males) can be seen. The peak level of participation occurs around 40, which is consistent with the previous evidence.

Figure 6.20 The cross-sectional view age profile of the probability of British employees and the self-employed having private personal pensions



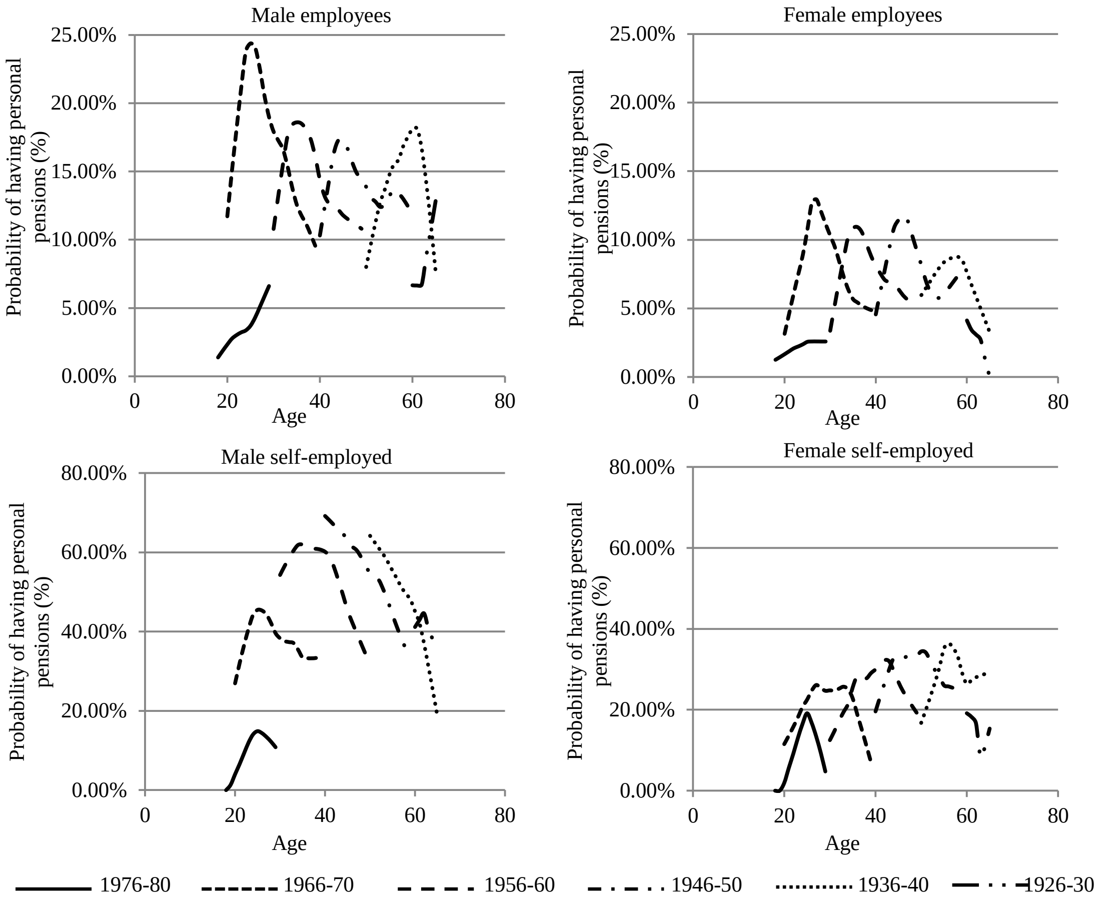
However, those figures from the cross-sectional view may not be correct if there are significant cohort effects on the participation rates for employer and private pensions. Figure 6.21 shows the cohort view age profile of the probability of employees having employer pensions. In the case of males, it is obvious that the probability of having occupational pension plans for older cohorts was greater than younger cohorts. The reverse is true in the case of females. The lifecycle age profiles from the cohort view also provide evidence to support the lifecycle hypothesis. It seems clear that the participation rates in occupational pension plans of each particular cohort are highest between the ages of 35 and 45, before declining afterwards. Another interesting feature is that the age patterns of each cohort appear not to have been particularly affected by time effects.

Figure 6.21 The cohort view age profile of the probability of British employees having employer pension plans



The cohort view age profiles of the lifetime participation rate in private personal pensions for employees and self-employed are shown in Figure 6.22. Lifetime age patterns appear to be significantly influenced by the time effect for the probability estimates of employees owning personal pensions. However, there was only a minor impact of the time effects on the lifetime probability estimates for the self-employed. The reason that time effects significantly affect lifetime saving in employee personal pensions may be due to observations in the FES data which are too low. As a consequence, the probability estimates may contain high random errors. Consistent with Figure 6.21, the probability of the self-employed saving in personal pension accounts was higher for earlier-born cohorts than later-born ones. The strong hump-shaped age pattern of lifetime saving in private pension accounts shown in Figure 6.22 provides evidence to support the lifecycle hypothesis of saving in financial institutions, the purpose of which is to generate returns to support income during the retirement period.

Figure 6.22 The cohort view age profile of the probability of British employees and the self-employed having private personal pensions



6.3.6 The probability of receiving pension incomes in British households

The analysis above, related to the probability of owning employer and private pensions, is based on information about contributions which each adult paid into those pension funds. FES data has only provided details of contributions paid into occupational pensions since 1973, and for contributions paid into personal private pensions only since 1988. In an attempt to investigate the probability of owning these two types of pension funds in previous periods, information about the pension incomes of the elderly population would provide a rough picture of changes in participation rates over time. This is because only adults who have owned these pension funds in the working period could have been eligible to receive pension incomes from these sources. However, there is one significant factor which may bias the inference of the probability of owning pension funds from the probability of receiving pension incomes, and this factor is the mortality rate. Individuals who pay contributions into occupational or personal pensions may be more likely to have a lower mortality rate than individuals, who do not.

Figure 6.23 presents the probability of retirees receiving occupational pensions over time. There was an increase in the fraction of the elderly receiving employer pensions from around 40 per cent of all male retirees in 1969 to around 60 per cent in 2007. For female retirees, the growth rate of the proportion of retirees receiving occupational pensions is faster than for males, reaching 40 per cent in 2008 from only 10 per cent in 1969. This evidence suggests that the period between 1950 and 1960 experienced a sharp increase in the provision of occupational pensions. In the case of private pension incomes (Figure 6.24), a dramatic growth in the probability of retirees receiving this pension occurred during the 1990s for both males and females. This evidence implies that the probability of British households investing in private personal pensions rose sharply around 1970. This empirical evidence indicates that the proportion of wealth in financial assets held through pension schemes have been increasingly being more important than the fraction of wealth in saving accounts since the 1960s. This result is consistent with Banks and Tanner (1996) who show that the combined wealth of housing and pension assets accounts for around two-third of the total household wealth.

Figure 6.23 The time view of the probability of British retirees receiving occupational pensions

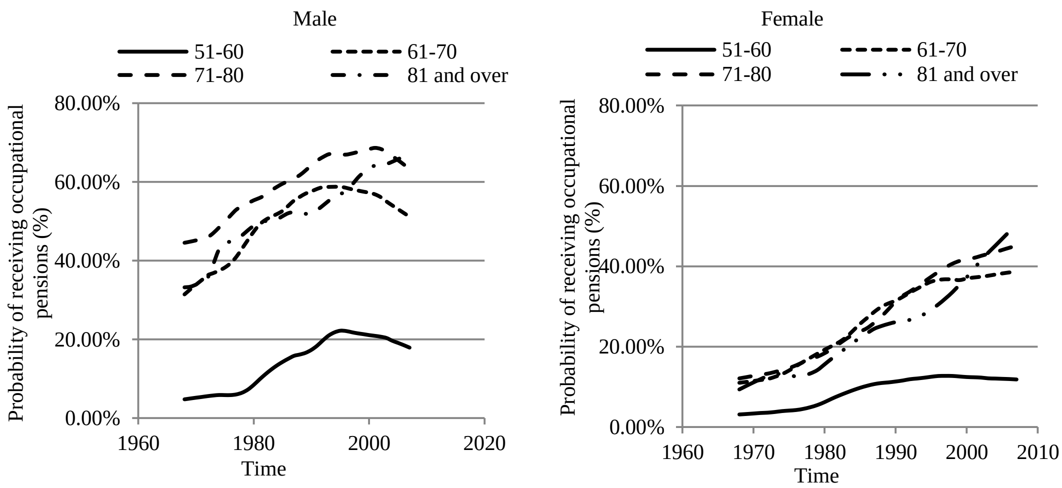
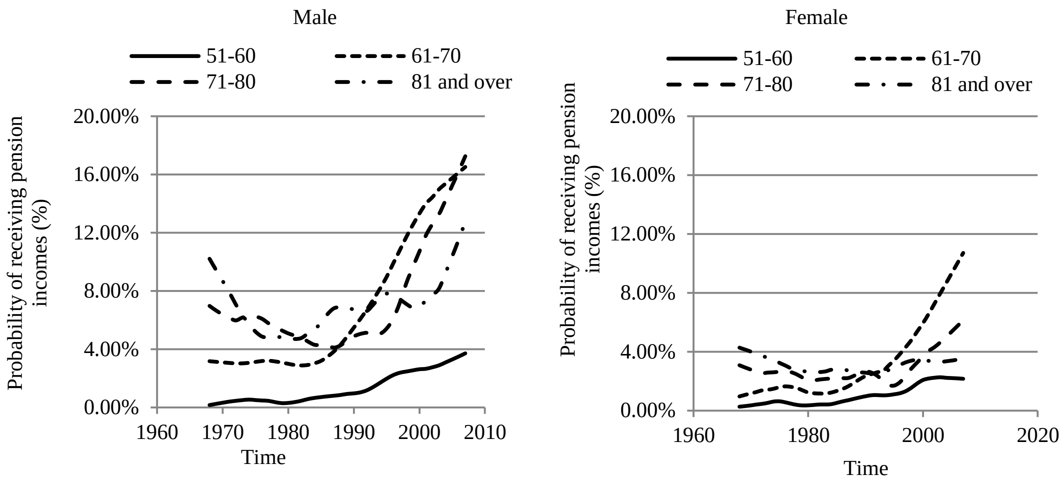


Figure 6.24 The time view of the probability of British retirees receiving private personal pensions



6.3.7 Conclusion from the graphical analysis of the FES data

Empirical results shown in this section indicate that the lifecycle saving of households is significantly hump-shaped only for investment decisions, the main purpose of which is for retirement. There was no significant decumulation of the direct ownership of financial assets when individuals retire. This may suggest that households do not see their own direct investments in financial markets as a means to provide retirement income, but rather that they may consider these investments as a means to generate extra income in order to boost their current and future consumption. Therefore, the decision to directly buy, hold or sell financial assets may not be predominantly based on lifetime age considerations. This saving component may also serve as a last source of income to finance pension benefits if the income from occupational pensions, private personal pensions, and state pensions is insufficient. Participation rates in unit/investment trusts also support the view that investment in these financial institutions is not primarily to provide retirement income. This is in contrast to the inverted U-shape lifetime age patterns of participation in occupational and private pensions.

Even though there are no restrictions about the withdrawal of funds from private personal pensions, the data indicate that households tend to participate less in these accounts once they approach retirement. Increased proportions of individuals decide to either stop paying or reduce contributions to pension accounts once they are within five years of their expected retirement age, at which point households start to consider withdrawing from these savings in order to finance their pension incomes. In the case of occupational pensions, it is fairly clear that the pattern of saving and dissaving from these funds will be consistent with the lifecycle saving hypothesis because a large proportion of occupational pensions for the current elderly generations are defined-benefit funded systems. It is an obligation that accumulated assets in the majority of DB pension funds have to be dissipated as annuity arrangements to those fund members who have retired.

Moreover, evidence regarding the increased probability of participating in occupational and private pensions during the 1950s and 1960s suggested that these financial institutions would become one of the main institutional investors, which could have an influence on the stability of the financial market. The evidence of the probability estimates from the FES data is consistent with the share ownership statistics shown in Figure 4.11, namely that the proportion of shares owned by autonomous pension schemes increased dramatically after the 1960s. Therefore, the process of how these pension funds will decumulate their assets to finance retirement incomes may be problematic in terms of the prices and returns of financial assets.

6.4 Logit regression analysis on the FES data

The previous analysis was unable to provide robust results regarding the age profile of households' decisions concerning participation in each type of investment opportunity. There may be other factors which significantly impact household saving decisions, thereby leading to changes in lifetime saving patterns. Those factors may include a combination of time effects, cohort effects, sex, marital status, household incomes, and the socio-economic status of the household. Regression analysis is the statistical method that can estimate the impact of particularly interesting parameters on specified dependent variables while ensuring that other potential factors have been controlled for.

Because the dependent variables in this analysis are random variables that take two finite values of outcomes (0 representing no participation and 1 representing participation in a particular investment option), an ordinary linear least square regression (OLS) is not appropriate to provide robust estimates of the coefficients. The Linear Probability model (the ordinary linear regression) does not guarantee that the estimates will lie between 0 and 1 unless the model is severely restricted. For any given values of coefficient estimates, it is always possible that some certain values of explanatory variables can generate the estimated response probability outside the unit interval. Moreover, the Linear Probability model will provide inconsistent estimates of the coefficients because homoskedasticy and normality assumptions are violated. Heteroskedasticity-robust standard errors have to be used in the estimations instead of the usual OLS standard errors. Another main issue about the problems of using the OLS technique in the binary response model is that the ceteris paribus effect of a unit increase in the explanatory variable (X_j) on the response probability will be the same irrespective of the initial value of X_j. This characteristic of the Linear Probability Model implies that the response probability can be outside of the unit interval if the values of explanatory variables are continually increasing to the extreme.

Other accepted techniques that can be used in order to overcome those weaknesses of the Linear Probability Model are the maximum likelihood estimation of the Probit or the Logit regression. The direction of the estimates from the Probit and Logit model will be the same as the Linear Probability model except that the response probability estimates will always lie between zero and one regardless of the values of all explanatory variables in the model. This property is achieved by specifying a certain form of function that links explanatory variables with the response probability, as shown by Equation 6.2 (Wooldridge, 2002). The function G is the cumulative normal distribution function in the Probit model, while it is a log function in the Logit model (Equation 6.3). In this analysis, the Logit model has been used.

$$P(y = 1|x) = G(x\beta) \qquad \text{\_\_\_\_\_(6.2)}$$

$$G(x\beta) = \frac{\exp(x\beta)}{1+\exp(x\beta)} \qquad \text{\_\_\_\_\_(6.3)}$$

6.4.1 Logit regression model specifications

In an attempt to estimate the lifecycle age profile of households participating in each type of investment opportunity, other potential factors need to be controlled in the regression models. As shown by the time and cohort view age profile of the probability estimates in the previous section, the time and cohort effects may significantly affect household saving decisions. Time effects may represent any changes in the structure, regulation or composition of the capital market, or changes in the value of financial assets over time. For instance, the sharp increase in the direct household ownership of financial assets during the 1980s was due to the privatisation of many public utilities and building societies. The introduction of Personal Equity Plans (PEPs) by the Thatcher government also created greater incentive for British households to invest in the financial market. Cohort effects may be present as a result of developments in financial literacy and increased awareness about savings and investments among households born in different periods. Economic conditions faced by a particular cohort may also lead to different perceptions about savings and investments from other cohorts. For example, cohorts born during the Great Depression may be more concerned about saving for future consumption than cohorts born in a period of high economic growth rates.

However, it is impossible to include age, time, and cohort effects in a single regression model because these three factors are linearly related to each other. Age is a linear difference between time and year of birth, as illustrated in Equation 6.4. If all these three variables are included in the model, multicolinearity will be present. The regression technique will be unable to estimate the coefficients of any variable unless one of these three variables is excluded from the model.

$$Age_{it} = time - cohort_i \qquad \text{(6.4)}$$

One possible way to overcome this problem is to compare results from regression models corresponding to different identifying assumptions. A parsimony criterion could be used to decide which models would be best to explain the empirical evidence with the simplest specifications. The empirical specification models to estimate the lifetime age effects in this analysis are illustrated as per the below:

Model 1: $Z = x\beta = \beta_0 + \beta_1(Age_{it}) + \beta_2(Age_{it})^2 + \epsilon_{it}$ ______(6.5)

Model 2: $Z = x\beta = \beta_0 + \beta_1(Age_{it}) + \beta_2(Age_{it})^2 + \sum \alpha_j(Time) + \epsilon_{it}$ ______(6.6)

Model 3: $Z = x\beta = \beta_0 + \beta_1(Age_{it}) + \beta_2(Age_{it})^2 + \sum \gamma_k(Cohort_i) + \epsilon_{it}$ ______(6.7)

In Model 1, only age effects are included in the regression model. A quadratic polynomial form is imposed to the age variables in order to allow for a hump-shaped pattern. The combination of age and dummy time effects are included in Model 2, while age and dummy cohort effects are included in Model 3. The coefficient estimates of the quadratic terms of the age variables will determine the shape of the curve. The turning point can be approximated from $|\beta_1/2\beta_2|$.

Other household characteristics may significantly influence the household saving decisions. Such household characteristics include sex, marital status, household income, size of household, numbers of children in the household, and the socio-economic status of each individual. All these factors are included in the specification Model 4 and Model 5. The sex variable is a dummy variable which equals 1 if an individual is male. The “marital_status” variable is a dummy variable which equals 1 if an individual is either married or has been married but is currently living alone. Socio-economic status is classified based on the type of occupation (professional, non-professional, manual worker and HM forces) and economic position (full-time employee, part-time employee, self-employed, retired, and unoccupied) of the individual. The unoccupied status is the reference of the dummy variables that represent these socio-economic classes.

Model 4:

$$Z = x\beta = \beta_0 + \beta_1(Age_{it}) + \beta_2(Age_{it})^2$$
$$+\sum \alpha_j(Time) + sex_{it} + marital\_status_{it} + Equivalised\_income_{it} + H\_sizes_{it}$$
$$+no\_children_{it} + fulltim\_prof_{it} + fulltime\_nonprof_{it} + fulltime\_manual_{it}$$
$$+fulltime\_HMforces_{it} + parttime\_prof_{it} + parttime\_nonprof_{it}$$
$$+parttime\_manual_{it} + self\_prof_{it} + self\_nonprof_{it} + self\_manual_{it}$$
$$+retired_{it} + \varepsilon_{it}$$

_____(6.8)

Model 5:

$$Z = x\beta = \beta_0 + \beta_1(Age_{it}) + \beta_2(Age_{it})^2$$
$$+\sum \alpha_j(Cohort_i) + sex_{it} + marital\_status_{it} + Equivalised\_income_{it} + H\_sizes_{it}$$
$$+no\_children_{it} + fulltim\_prof_{it} + fulltime\_nonprof_{it} + fulltime\_manual_{it}$$
$$+fulltime\_HMforces_{it} + parttime\_prof_{it} + parttime\_nonprof_{it}$$
$$+parttime\_manual_{it} + self\_prof_{it} + self\_nonprof_{it} + self\_manual_{it}$$
$$+retired_{it} + \varepsilon_{it}$$

_____(6.9)

Regarding the income variable, the personal level data of income is inappropriate to be used in the analysis because married females normally have zero gross income due to their lack of employment. But this zero income data does not mean that females actually have zero economic income. In reality, earnings from each individual in a household will be shared with each other. Therefore, the household level data of income is a better variable in capturing the real economic welfare of the household. However, merely using household gross incomes provided by the FES data is still not applicable since these data do not control for the difference in the size and composition of households. At a given £ amount of gross household income, the standard of living level may be different between a household composed of two married adults and a household, composed of one adult and one child. Therefore, some estimation techniques will need to be specified in order to control for the size and composition of households. As such, the concept of equivalised incomes is used.

Equivalised household income refers to household income that has been adjusted by a specified equivalence scale. The main purpose of this adjustment is to enable real economic welfare comparisons within households. There are a variety of equivalence scales proposed by researchers in order to measure the economic well-being of households. The equivalence scale used in this analysis is the Engel Scales estimation (Food sharing concept) "Model 6", developed by Banks and Johnson (1993). This specification model assumes that the age bands of children and fixed costs of having a child are the most significant factors in determining household equivalence scales. The main reason to use these estimates to adjust household income is that they most effectively fit with the FES data in 1989 and 1990, which is the same underlying data source as this analysis. After the equivalised household incomes have been estimated for each survey year, the £ amounts are deflated by the consumer price index in order to take inflation into account.

6.4.2 Descriptive statistics of the variables from the FES data

Table 6.1 presents descriptive statistics on the demographic structure and size of observations, classified separately for males and females, from the repeated cross-sectional FES data between 1968 and 2004. FES observations from 2005 onwards are excluded because individuals aged over 80 were all coded as 80. Therefore, it is impossible to identify the exact age of these elderly people. The FES data in 1978 are also excluded because the database in this year provided by the UK Data Achieve is incomplete, lacking information about the income components of households as it does. Demographic data in Table 6.1 shows the gradual increase in the average age of British households for both males and females. Standard deviation of the age variable has been relatively stable throughout the sample.

Table 6.1 Descriptive statistics of the age variable from the FES survey between 1968 and 2004, sorted by years

Year	Male				Female			
	Numbers of observations	Mean	Std. Dev.	Max	Numbers of observations	Mean	Std. Dev.	Max
1968	7310	43.1	17.1	95	8007	44.9	18.2	99
1969	7113	43.6	17.3	94	7743	45.3	18.2	98
1970	6345	43.3	17.3	97	7024	45.0	18.4	94
1971	7123	43.4	17.4	95	7920	45.4	18.6	99
1972	6943	43.3	17.2	92	7629	44.9	18.4	96
1973	6887	44.1	17.7	95	7625	45.8	18.7	97
1974	6393	44.0	17.7	99	7211	45.6	18.7	98
1975	6878	43.5	17.8	94	7693	45.5	18.7	99
1976	6614	43.9	18.0	99	7519	46.1	18.9	97
1977	6631	43.7	17.9	96	7596	45.7	19.0	99
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	6173	43.5	18.1	96	7009	45.7	19.2	98
1980	6259	43.8	17.9	95	7223	45.5	19.0	96
1981	6748	43.7	18.1	95	7785	45.7	19.0	99
1982	6590	43.6	18.1	93	7530	45.4	19.1	99
1983	5952	43.9	18.1	96	6873	46.2	19.1	97
1984	6134	44.7	18.2	93	7205	45.9	19.1	99
1985	6158	44.2	18.2	99	7049	45.9	19.1	95
1986	6192	44.2	18.3	95	7078	45.9	19.1	98
1987	6595	43.9	18.0	95	7429	45.6	19.2	98
1988	6575	44.6	18.2	94	7223	45.8	19.2	96
1989	6618	44.5	18.1	95	7378	45.8	19.1	99
1990	6076	45.1	18.2	97	6881	45.9	19.3	99
1991	5917	45.1	18.1	93	6777	46.7	19.4	99
1992	6113	45.3	18.2	99	7061	46.5	18.9	97
1993	5777	45.3	18.3	91	6642	46.4	19.0	98
1994	5562	45.4	18.1	95	6513	46.1	19.2	96
1995	5510	45.8	18.0	96	6443	46.8	18.9	99
1996	5280	45.5	18.1	97	6052	45.8	18.9	95
1997	5291	45.6	18.0	97	6071	45.9	18.8	95
1998	5622	45.6	18.2	99	6312	46.2	18.6	99
1999	5800	46.1	18.1	96	6632	46.4	18.6	102
2000	5562	46.3	18.1	95	6315	46.9	18.7	96
2001	6604	45.6	17.8	99	7327	46.3	18.4	98
2002	6051	46.5	18.0	98	6827	47.2	18.7	98
2003	6204	46.0	17.9	97	6917	46.7	18.5	100
2004	6010	46.9	18.2	100	6667	47.4	18.6	96

Table 6.2 illustrates demographic variables and the size of the observations, sorted by years of births of households. The classification of data in this way is useful in terms of assessing the results from the regression models that include dummy cohort

variables. One advantage of the sample used in this analysis, compared to previous pieces of research, is the range of ages observed in each particular cohort. Since the sample used in this analysis is derived from survey data between 1968 and 2004, it is possible to observe changes in the lifetime savings for each cohort over a period as broad as 36 years. For example, for the cohort born between 1941 and 1945, the lifetime economic decisions from the earliest year this cohort participated in the labour market to the period approaching retirement can be observed. The minimum age for recently-born cohorts is 16 because the sample includes only individuals above this age. Individuals born between 1941 and 1950 are among the highest observations in the sample.

Table 6.2 Descriptive statistics of the age variable from the FES survey year 1968 to 2004, sorted by cohorts

Cohort	Male					Female				
	Number of observations	Mean	Std. Dev.	Min	Max	Number of observations	Mean	Std. Dev.	Min	Max
Born before 1990	4749	77.9	5.8	68	99	8696	79.2	6.1	68	102
1901-1905	5305	72.2	6.3	63	100	7245	73.4	6.9	63	100
1906-1910	8170	69.3	7.4	58	97	10514	70.5	8.0	58	97
1911-1915	10694	66.5	8.5	53	93	13155	67.5	8.9	53	93
1916-1920	11677	63.4	9.6	48	88	14158	64.1	9.7	48	88
1921-1925	15806	59.8	10.2	43	83	17890	60.6	10.2	43	83
1926-1930	15399	55.6	10.6	38	78	17122	56.0	10.6	38	78
1931-1935	15894	51.0	10.9	33	73	17005	51.5	10.9	33	73
1936-1940	17058	46.1	10.9	28	68	17824	46.5	10.9	28	68
1941-1945	19155	41.2	10.7	23	63	20037	41.2	10.9	23	63
1946-1950	22623	37.0	10.7	18	58	24094	36.9	10.7	18	58
1951-1955	19558	33.1	10.4	16	53	20998	33.0	10.2	16	53
1956-1960	17353	31.1	9.0	16	48	18833	31.1	8.8	16	48
1961-1965	15576	28.8	7.6	16	43	17414	28.8	7.5	16	43
1966-1970	11540	26.1	6.4	16	38	13430	26.3	6.2	16	38
1971-1975	7308	23.6	5.0	16	33	8364	23.9	4.9	16	33
1976-1980	4290	20.8	3.4	16	28	4898	21.1	3.4	16	28
1981-1985	2752	18.4	1.9	16	23	2847	18.6	2.0	16	23
1986-1990	703	16.6	0.7	16	18	662	16.6	0.7	16	18

Table 6.3 provides summary statistics about the household level of the sample. The average age of the head of the household is fairly stable over time at around 50 years old. Sizes of household have declined over time from around 3 per household to just 2 in 2004. In recent years, the majority of households have not had children. The

average number of children in a household has declined to just 0.6 in 2004, from a situation of near parity in the years prior to 1977.

Table 6.3 Descriptive statistics of some variables at the household level

Year	Number of surveyed households	Age of head			Size of household			Number of children		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1968	7182	50.0	17	97	3.0	1	18	0.9	0	13
1969	7008	50.2	17	98	3.0	1	15	1.0	0	13
1970	6390	49.9	18	97	2.9	1	14	1.0	0	11
1971	7237	50.0	18	97	2.9	1	12	0.9	0	9
1972	7014	49.5	17	96	2.9	1	16	1.0	0	11
1973	7107	50.5	16	95	2.8	1	12	0.9	0	10
1974	6689	50.3	18	99	2.8	1	12	0.9	0	9
1975	7190	50.2	16	99	2.8	1	12	0.9	0	10
1976	7149	50.4	16	95	2.8	1	12	0.8	0	10
1977	7152	50.1	16	97	2.8	1	11	0.9	0	9
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	6734	50.2	16	97	2.7	1	12	0.8	0	9
1980	6877	50.3	16	96	2.7	1	12	0.8	0	7
1981	7421	50.4	16	99	2.7	1	12	0.8	0	8
1982	7316	50.0	16	96	2.7	1	14	0.8	0	10
1983	6776	50.3	16	94	2.7	1	14	0.8	0	11
1984	6935	50.7	16	99	2.6	1	12	0.7	0	8
1985	6884	50.7	16	99	2.6	1	12	0.7	0	10
1986	7039	50.3	16	98	2.6	1	11	0.7	0	6
1987	7335	50.1	16	97	2.5	1	10	0.7	0	7
1988	7206	50.6	16	96	2.5	1	15	0.7	0	12
1989	7345	50.3	16	99	2.5	1	12	0.7	0	9
1990	6959	50.5	17	97	2.5	1	12	0.7	0	10
1991	6933	50.6	17	97	2.4	1	10	0.6	0	9
1992	7245	50.4	16	99	2.5	1	10	0.7	0	7
1993	6805	50.4	16	94	2.5	1	10	0.7	0	9
1994	6681	50.2	16	96	2.4	1	11	0.7	0	8
1995	6641	50.6	16	99	2.5	1	12	0.7	0	10
1996	6262	50.0	16	95	2.5	1	10	0.7	0	7
1997	6264	50.2	16	97	2.4	1	9	0.7	0	7
1998	6524	50.5	16	99	2.5	1	13	0.7	0	7
1999	6935	50.7	16	102	2.4	1	10	0.6	0	8
2000	6527	51.1	16	96	2.4	1	11	0.6	0	7
2001	7457	50.8	16	98	2.4	1	12	0.7	0	9
2002	6919	51.6	17	98	2.4	1	11	0.6	0	10
2003	7034	51.3	16	100	2.4	1	10	0.6	0	6
2004	6790	52.0	18	100	2.4	1	10	0.6	0	8

Table 6.3 (continued) Descriptive statistics of some variables at the household level

Year	Raw gross weekly income				Equivalised gross weekly income			
	Mean	Median	Min	Max	Mean	Median	Min	Max
1968	304.72	275.04	0.05	3410.79	146.98	127.45	0.03	1798.55
1969	316.35	284.28	0.59	6069.88	152.92	130.92	0.30	2656.81
1970	320.11	290.09	0.44	2810.10	155.16	132.30	0.27	1692.83
1971	321.76	287.83	0.29	5370.45	157.58	133.05	0.29	2115.35
1972	331.67	300.24	0.69	2533.38	161.25	140.69	0.41	1237.63
1973	346.91	313.67	0.14	5844.14	171.99	146.74	0.08	3520.56
1974	344.14	307.91	0.11	4234.98	170.68	144.64	0.11	4072.60
1975	345.62	310.18	0.96	4208.72	171.70	146.67	0.58	2330.79
1976	338.01	300.38	0.36	3846.15	169.84	146.93	0.22	3130.92
1977	341.66	310.32	0.39	5192.50	170.84	147.74	0.24	3128.01
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	348.56	312.33	6.25	2349.90	176.34	153.14	3.74	1140.03
1980	371.57	332.78	0.03	4864.62	186.05	157.89	0.03	2930.49
1981	378.04	326.26	0.04	8857.23	190.17	159.60	0.03	5335.68
1982	380.28	332.93	0.11	17040.88	192.07	160.43	0.11	4580.88
1983	386.73	337.13	0.08	3997.27	198.37	165.62	0.08	2408.00
1984	385.47	330.18	0.02	4298.96	197.54	165.94	0.01	2045.74
1985	402.09	342.06	0.02	3977.81	208.16	174.18	0.01	2396.27
1986	403.07	329.92	0.23	10340.87	211.65	173.11	0.23	6229.44
1987	423.74	345.48	0.10	6759.26	226.32	178.96	0.08	4366.73
1988	467.04	384.65	0.31	16473.37	247.12	199.44	0.31	9923.72
1989	468.49	391.63	0.02	5209.88	249.39	204.94	0.02	3138.48
1990	488.41	406.32	0.01	8916.81	266.44	211.03	0.01	6508.93
1991	489.73	401.86	0.03	12242.99	269.13	217.37	0.01	7375.29
1992	454.02	370.54	0.03	5785.98	248.96	199.89	0.03	3180.23
1993	440.86	342.88	0.13	7675.90	240.82	186.59	0.13	4624.04
1994	451.62	351.01	0.04	11457.85	249.27	192.27	0.02	4889.55
1995	452.48	361.63	0.04	5672.52	248.81	197.99	0.04	3124.39
1996	461.92	364.68	0.05	9373.40	254.48	202.73	0.03	5646.63
1997	476.94	372.15	0.06	6512.45	264.24	207.33	0.06	3176.01
1998	490.13	364.97	0.03	22447.83	269.77	208.75	0.02	7941.45
1999	510.56	381.71	0.02	22716.95	285.90	219.02	0.01	13684.91
2000	530.86	408.63	0.05	12527.85	295.95	230.96	0.05	7452.93
2001	558.61	427.16	0.11	10857.41	309.49	238.49	0.07	5400.39
2002	551.39	424.14	0.33	8039.66	308.57	242.10	0.20	5906.73
2003	569.17	439.61	0.11	14237.12	315.70	247.69	0.07	7129.17
2004	594.74	457.86	0.11	25098.99	328.03	258.82	0.05	15119.88

Note: The money amounts are in the constant-2007 price; Equivalised household incomes are based on the Engel scales estimated by Banks and Johnson (1993) on the FES data year 1989 and 1990.

Table 6.3 also demonstrates, in constant 2007 dollar amounts, the household gross weekly income on both a raw and equivalised basis. Equivalised incomes are lower than the raw data because the former takes into account household size and composition. The data show significant real growth rates in household income between 1968 and 2004. Median gross household income rose from £275 to £457, an increase of nearly 70 per cent. The growth rates for equivalised income were higher, with an increase of 100 per cent from £127 in 1968 to £258 in 2004. This evidence implies that the real personal gross income of working adults has increased dramatically over the past 40 years.

6.4.3 Logit regression results to estimate the probability of directly owning financial assets

The logit regression results of all specification models for each dependent variable are illustrated in Table 6.4 to Table 6.8. The dependent variable in Table 6.4 is the probability of direct ownership of financial assets. As can be seen, the coefficients of the age variables are statistically significant, with a 95 per cent confidence interval in all specification models. However, the turning points of the hump-shaped age patterns related to the direct ownership of financial assets are different, especially in the models with time and cohorts effects. The peak in financial asset ownership, as estimated from Model 1 and 2, are relatively close to each other at around 65 years old. Model 4, on the other hand, which includes other household characteristics, indicates a peak at 71 years old. Models 3 and 5, which include cohort effects, provide a completely different age pattern. These models estimate that the probability of directly owning shares will increase with age, with a peak in share ownership not being reached until the age of 95.

Table 6.4 Logit regression results to estimate the probability of owning stocks, bonds and debentures

Dependent Variable: Probability of holding stocks, bonds, and debentures					
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-5.41147*	-6.32638*	-9.45806*	-6.53197*	-9.62554*
	(0.04179)	(0.05750)	(0.06845)	(0.06909)	(0.09147)
age	0.11399*	0.11952*	0.15347*	0.09962*	0.14663*
	(0.00170)	(0.00173)	(0.00224)	(0.00217)	(0.00294)
age^2	-0.00088*	-0.00093*	-0.00080*	-0.00070*	-0.00078*
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00003)
Time dummy variables					
Time_1969		0.02401		-0.01483	
		(0.05396)		(0.05504)	
Time_1970		0.14219*		0.09868	
		(0.05409)		(0.05516)	
Time_1971		0.09699		0.03060	
		(0.05303)		(0.05409)	
Time_1972		0.08080		0.01056	
		(0.05368)		(0.05458)	
Time_1973		0.10260		-0.02425	
		(0.05329)		(0.05439)	
Time_1974		0.09202		-0.04201	
		(0.05436)		(0.05544)	
Time_1975		0.07367		-0.06077	
		(0.05378)		(0.05480)	
Time_1976		-0.02958		-0.16077*	
		(0.05531)		(0.05630)	
Time_1977		0.03314		-0.10687	
		(0.05456)		(0.05553)	
Time_1979		-0.20022*		-0.37544*	
		(0.05913)		(0.06000)	
Time_1980		-0.21296*		-0.45918*	
		(0.05883)		(0.06003)	
Time_1981		-0.12767*		-0.39466*	
		(0.05639)		(0.05752)	
Time_1982		-0.08046		-0.34761*	
		(0.05630)		(0.05745)	
Time_1983		0.05485		-0.26315*	
		(0.05573)		(0.05695)	
Time_1984		0.09618		-0.20771*	
		(0.05456)		(0.05573)	
Time_1985		0.35587*		0.00777	
		(0.05191)		(0.05314)	
Time_1986		0.33062*		-0.05157	
		(0.05216)		(0.05356)	
Time_1987		1.03015*		0.61759*	
		(0.04638)		(0.04782)	
Time_1988		1.11735*		0.63715*	
		(0.04599)		(0.04752)	
Time_1989		1.22493*		0.74997*	
		(0.04539)		(0.04684)	
Time_1990		1.36043*		0.82050*	
		(0.04530)		(0.04694)	
Time_1991		1.42777*		0.88951*	
		(0.04511)		(0.04669)	
Time_1992		1.41679*		0.93856*	
		(0.04489)		(0.04638)	
Time_1993		1.36879*		0.89375*	
		(0.04548)		(0.04704)	
Time_1994		1.32265*		0.81581*	
		(0.04590)		(0.04754)	
Time_1995		1.30769*		0.79380*	
		(0.04593)		(0.04755)	
Time_1996		1.28459*		0.74351*	
		(0.04655)		(0.04826)	
Time_1997		1.39566*		0.82466*	
		(0.04597)		(0.04777)	
Time_1998		1.46721*		0.89538*	
		(0.04530)		(0.04709)	
Time_1999		1.42935*		0.79673*	
		(0.04514)		(0.04702)	
Time_2000		1.32592*		0.65346*	
		(0.04583)		(0.04785)	
Time_2001		1.28140*			
		(0.04500)			

Table 6.4 (continued) Logit regression results to estimate the probability of owning stocks, bonds and debentures

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Time_2002		1.17834*			
		(0.04590)			
Time_2003		1.11557*			
		(0.04611)			
Time_2004		1.06653*			
		(0.04653)			
Cohort dummy variables					
Birth_1901~1905			0.20260*		0.10377*
			(0.04462)		(0.04567)
Birth_1906~1910			0.33862*		0.17393*
			(0.04095)		(0.04231)
Birth_1911~1915			0.54144*		0.31737*
			(0.03917)		(0.04112)
Birth_1916~1920			0.81931*		0.51460*
			(0.03865)		(0.04153)
Birth_1921~1925			1.11686*		0.76968*
			(0.03778)		(0.04147)
Birth_1926~1930			1.46306*		1.07966*
			(0.03864)		(0.04298)
Birth_1931~1935			1.67607*		1.23868*
			(0.03969)		(0.04476)
Birth_1936~1940			1.86862*		1.39162*
			(0.04082)		(0.04635)
Birth_1941~1945			2.14037*		1.56439*
			(0.04159)		(0.04768)
Birth_1946~1950			2.39504*		1.76621*
			(0.04198)		(0.04869)
Birth_1951~1955			2.62026*		1.95622*
			(0.04347)		(0.05108)
Birth_1956~1960			2.91278*		2.26752*
			(0.04441)		(0.05294)
Birth_1961~1965			3.20611*		2.55020*
			(0.04545)		(0.05523)
Birth_1966~1970			3.30644*		2.65221*
			(0.04857)		(0.06020)
Birth_1971~1975			3.24847*		2.63584*
			(0.05632)		(0.07245)
Birth_1976~1980			3.19947*		2.84074*
			(0.07264)		(0.09585)
Birth_1981~1985			3.14260*		2.84237*
			(0.09975)		(0.16006)
Birth_1991~1990			3.29424*		
			(0.19381)		
male				0.36586*	0.37592*
				(0.01312)	(0.01312)
marital_status				0.10834*	0.09570*
				(0.01458)	(0.01463)
Equivalised income				0.00278*	0.00285*
				(0.00003)	(0.00003)
Size of household				-0.10925*	-0.10562*
				(0.00891)	(0.00893)
Number of Childrens				0.11319*	0.10874*
				(0.01080)	(0.01097)
Full-time_Professionals				0.61859*	0.56304*
				(0.02306)	(0.02312)
Full-time_non-Professionals				0.33837*	0.35504*
				(0.02326)	(0.02332)
Full-time_Manual workers				-0.40521*	-0.42169*
				(0.02452)	(0.02461)
Full-time_HMForces				0.17738	0.15621
				(0.11237)	(0.11191)
Part-time_Professionals				0.64432*	0.52452*
				(0.04263)	(0.04228)
Part-time_non-Professionals				0.31407*	0.34418*
				(0.02660)	(0.02659)
Part-time_Manual workers				-0.57273*	-0.59547*
				(0.04084)	(0.04079)
Self-Employed_Professionals				0.75071*	0.73105*
				(0.03305)	(0.03298)

Table 6.4 (continued) Logit regression results to estimate the probability of owning stocks, bonds and debentures

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Self-Employed_non-Professionals				0.14434*	0.20874*
				(0.03709)	(0.03721)
Self-Employed_Manual workers				-0.21772*	-0.30226*
				(0.05986)	(0.05990)
Retired				0.32686*	0.36988*
				(0.02121)	(0.02128)
Number of observations	480796	480796	480796	428189	428189
Log-likelihood value	-149346.57	-141825.69	-143760.12	-111946.12	-113059.68
Pseudo R-squared	0.038	0.0864	0.074	0.1602	0.1519
Estimated turning point	64.97	64.17	95.65	71.17	93.88

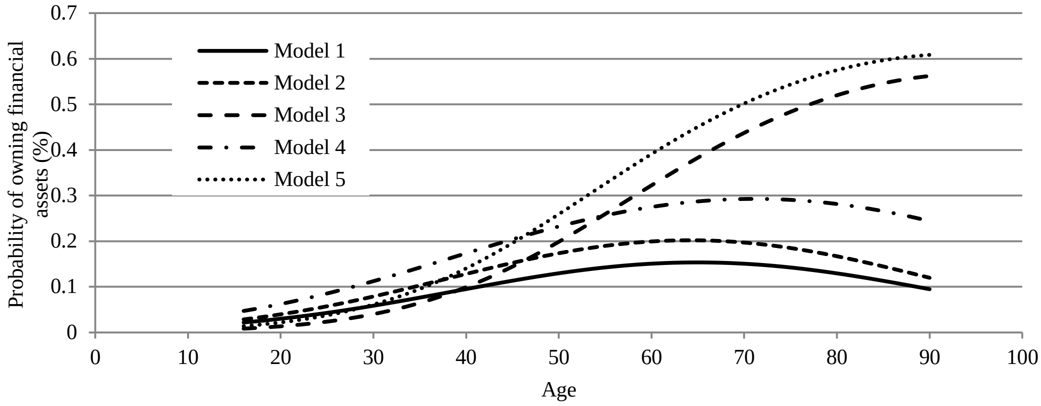
Notes: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05; Numbers in parentheses are standard errors; Pseudo R-squared is the McFadden's R-squared.

Those empirical results are similar to some of the previous literature. For example, King and Leape (1987) demonstrate that the probability of holding Treasury bills is decreasing with ages whereas the probability of holding equities and corporate bonds is positively related with ages from the cross-sectional 1978 Survey of US Consumer Financial Decisions. Bertaut (1998), who uses a panel data from the SCF 1983-1989, shows that the probability of holding equities increase positively with ages. The low rate of dissaving in old age for household direct investment found in this study is also consistent with Poterba and Samwick (1997) who found the same lifecycle saving pattern for US households.

The coefficients of dummy time effects are significantly different from zero for the years after 1985 (year 1968 is the reference). This regression result is consistent with Figure 6.2 in the previous section, which shows a sharp increase in financial asset ownerships during the 1980s. Dummy cohort effects in Models 3 and 5 are both statistically significant, with the results implying that years of birth may be a significant factor in determining the probability of holding financial assets. The regression results of the coefficient estimates for the variables, which control for household characteristics, are as would be intuitively expected: males have a significantly higher probability of holding financial assets than females; real household income has a strong positive influence on the probability of holding shares, although the economic effect appears to be small; full-time, part-time and self-employed professionals have the highest chance of holding financial assets when compared to other socio-economic classes; being a manual worker significantly reduces the probability of stock ownership; and the likelihood of retired individuals holding financial assets is significantly higher than that of unemployed individuals. The statistically significant positive coefficient of the full-time professional employment status is consistent with a study by Gale and Pence (2004) who find a larger cross-sectional age wealth for households with college degree compared to other households with no degree.

A graphical illustration of the probability estimates from the logit regressions is presented in Figure 6.25. The regression predictions from Models 1, 2, and 4 suggest that the lifetime age profile of direct participation in the financial market is an inverted U-shape pattern. The regression from these models will be correct if the assumption of no cohort effects is valid. Individuals between 65 and 70 are estimated to have a higher probability of owning financial assets than those in the younger and older age ranges. In contrast to these age profiles, the regression estimates from Models 3 and 5, which include cohort effects, show that the probability of holding financial assets rises with age. These regression results suggest that older individuals, even after retirement, will continue to invest in the financial markets. This evidence completely contradicts the lifecycle hypothesis. However, the regression results from Models 3 and 5 will be valid only if time effects are not significant. Even though the result in this section illustrates a lifecycle probability of directly owing financial assets, its lifecycle pattern can also represent an approximate lifecycle proportion of household wealth invested in risky assets. This is because Banks and Smith (2000) have shown that the variation in the unconditional investment proportion in risky assets largely depends on the probability of owning financial assets. In other words, conditioning on the ownership of financial assets, households that have owned financial assets tend to hold relatively similar proportion of risky assets.

Figure 6.25 Regression predictions of the probability of household direct ownership of financial assets



Notes: The probability estimates from Model 3 and Model 5 in the figure represent individuals born between 1946 and 1950; the probability estimates from Model 2 and Model 4 in the figure represent all individuals in 1988; household characteristic variables used in Model 4 and Model 5 are as follows: male = 1, married = 1, equivalised income = 217, sizes of household = 3, number of children = 1, and Full-time_professional = 1.

6.4.4 Logit regression results to estimate the probability of owning unit/investment trusts and PEPs

Table 6.5 presents logit regression results of the probability of owning unit/investment trusts and Personal Equity Plans (PEPs). Unit/investment trusts and PEPs are grouped together in this analysis because Figures 6.8 to 6.13 in the previous section suggest that households may perceive these financial institutions as being similar investment opportunities in term of the risk-return payoff, except that PEPs provide extra benefit from tax-exemption status. The estimated turning points of the age profile in Models 1, 2, and 4 are similar to the age pattern of the probability of directly owning financial assets. The probability of owning Unit Trusts and PEPs peaks when individuals are aged about 63, slightly below the age where the direct holding of financial assets peaks. The estimated turning points in Models 3 and 5 are in the extreme age range at 122 and 146 respectively. This evidence not only contradicts the lifecycle hypothesis, but it is also virtually impossible in reality. The estimated coefficients of other household characteristic variables show the same significant direction of impacts on the probability estimates as in the case of directly holding financial assets.

Table 6.5 Logit regression results to estimate the probability of owning unit/investment trusts and PEPs

Dependent Variable: Probability of owning Unit Trusts and Personal Equity Plans					
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-7.31619*	-7.27555*	-9.66883*	-7.32664*	-11.09414*
	(0.08505)	(0.09549)	(0.23067)	(0.11632)	(0.26590)
age	0.15385*	0.15655*	0.09696*	0.13151*	0.10267*
	(0.00332)	(0.00335)	(0.00484)	(0.00403)	(0.00647)
age^2	-0.00121*	-0.00124*	-0.00039*	-0.00107*	-0.00035*
	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00006)
Time dummy variables					
Time_1979		-1.50083*		-1.17555*	
		(0.09116)		(0.09201)	
Time_1980		-1.68549*		-1.42336*	
		(0.09667)		(0.09783)	
Time_1981		-1.73820*		-1.49794*	
		(0.09580)		(0.09724)	
Time_1982		-1.75196*		-1.51753*	
		(0.09781)		(0.09931)	
Time_1983		-1.43125*		-1.22262*	
		(0.08926)		(0.09015)	
Time_1986		-0.51364*		-0.35659*	
		(0.06592)		(0.06714)	
Time_1987		0.10493		0.21556*	
		(0.05671)		(0.05775)	
Time_1988		0.32476*		0.39253*	
		(0.05469)		(0.05582)	
Time_1989		0.34770*		0.42098*	
		(0.05434)		(0.05532)	
Time_1990		0.28231*		0.29090*	
		(0.05573)		(0.05689)	
Time_1991		0.33350*		0.35139*	
		(0.05538)		(0.05642)	
Time_1992		0.18807*		0.23471*	
		(0.05628)		(0.05730)	
Time_1993		0.17084*		0.21545*	
		(0.05722)		(0.05831)	
Time_1994		0.20876*		0.23110*	
		(0.05724)		(0.05845)	
Time_1995		-0.16473*		-0.14916*	
		(0.06169)		(0.06279)	
Time_1997		0.24024*		0.21517*	
		(0.05759)		(0.05879)	
Time_1998		0.36241*		0.33100*	
		(0.05568)		(0.05693)	
Time_1999		0.38923*		0.32097*	
		(0.05489)		(0.05620)	
Time_2000		0.19108		0.09742	
		(0.05720)		(0.05857)	
Time_2001		-0.07544			
		(0.05825)			
Time_2002		-0.23718*			
		(0.06118)			
Time_2003		-0.39043*			
		(0.06325)			
Time_2004		-0.55473*			
		(0.06632)			
Cohort dummy variables					
Birth_1901~1905			0.83715*		0.75517*
			(0.21678)		(0.21829)
Birth_1906~1910			1.15455*		1.07580*
			(0.20245)		(0.20468)
Birth_1911~1915			1.52407*		1.44955*
			(0.19793)		(0.20170)
Birth_1916~1920			1.91949*		1.88045*
			(0.19688)		(0.20220)
Birth_1921~1925			2.29720*		2.29739*
			(0.19661)		(0.20355)
Birth_1926~1930			2.76171*		2.82862*
			(0.19772)		(0.20603)
Birth_1931~1935			2.94615*		3.10533*
			(0.19913)		(0.20864)
Birth_1936~1940			3.07299*		3.33178*
			(0.20064)		(0.21099)

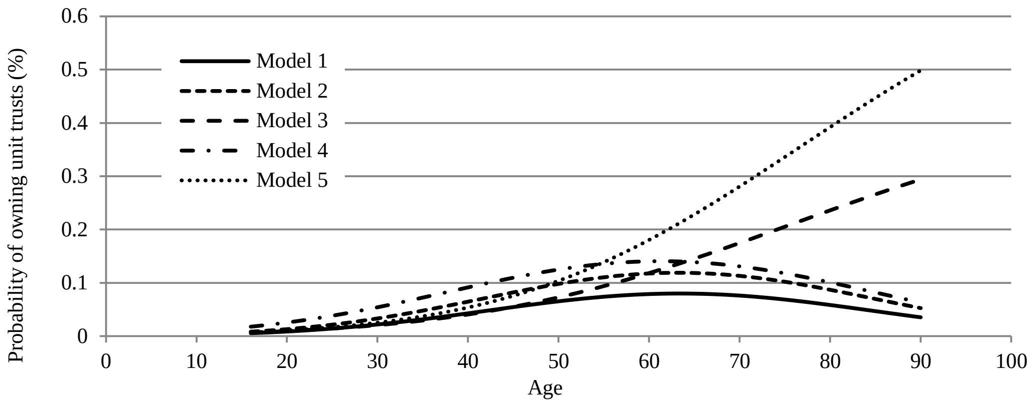
Table 6.5 (continued) Logit regression results to estimate the probability of owning unit/investment trusts and PEPs

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Birth_1941~1945			3.20030*		3.47166*
			(0.20187)		(0.21308)
Birth_1946~1950			3.26439*		3.60985*
			(0.20268)		(0.21466)
Birth_1951~1955			3.21410*		3.68538*
			(0.20415)		(0.21704)
Birth_1956~1960			3.38803*		3.93148*
			(0.20487)		(0.21868)
Birth_1961~1965			3.45309*		4.10411*
			(0.20592)		(0.22062)
Birth_1966~1970			3.43641*		4.14033*
			(0.20856)		(0.22475)
Birth_1971~1975			3.28171*		4.25370*
			(0.21541)		(0.23390)
Birth_1976~1980			2.50596*		3.60627*
			(0.25244)		(0.28839)
Birth_1981~1985			1.56604*		2.46282*
			(0.39273)		(0.63906)
Birth_1991~1990			0.94602*		
			(1.02185)		
male				0.35341*	0.37861*
				(0.02174)	(0.02176)
marital_status				0.26570*	0.23179*
				(0.02576)	(0.02579)
Equivalised income				0.00173*	0.00183*
				(0.00004)	(0.00004)
Size of household				-0.13162*	-0.12969*
				(0.01640)	(0.01649)
Number of Childrens				0.01845	0.03167
				(0.01992)	(0.02044)
Full-time_Professionals				0.48483*	0.42857*
				(0.04014)	(0.04018)
Full-time_non-Professionals				0.29350*	0.32357*
				(0.04082)	(0.04089)
Full-time_Manual workers				-0.31929*	-0.39167*
				(0.04556)	(0.04555)
Full-time_HMForces				0.30627	0.29566
				(0.19756)	(0.19640)
Part-time_Professionals				0.77895*	0.58274*
				(0.07642)	(0.07523)
Part-time_non-Professionals				0.36491*	0.42519*
				(0.04473)	(0.04474)
Part-time_Manual workers				-0.37807*	-0.45609*
				(0.07605)	(0.07589)
Full-time_HMForces				0.30627	0.29566
				(0.19756)	(0.19640)
Part-time_Professionals				0.77895*	0.58274*
				(0.07642)	(0.07523)
Part-time_non-Professionals				0.36491*	0.42519*
				(0.04473)	(0.04474)
Part-time_Manual workers				-0.37807*	-0.45609*
				(0.07605)	(0.07589)
Self-Employed_Professionals				0.52167*	0.48884*
				(0.05884)	(0.05876)
Self-Employed_non-Professionals				0.24800*	0.30925*
				(0.05555)	(0.05580)
Self-Employed_Manual workers				0.09583	-0.23032
				(0.12970)	(0.12849)
Retired				0.55471*	0.55177*
				(0.03725)	(0.03804)
Number of observations	310046	310046	310046	257439	257439
Log-likelihood value	-56041.193	-53903.453	-55209.096	-43097.003	-43769.584
Pseudo R-squared	0.0437	0.0802	0.0579	0.1319	0.1184
Estimated turning point	63.36	63.22	122.79	61.25	146.75

Notes: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05; Numbers in parentheses are standard errors; Pseudo R-squared is the McFadden’s R-squared.

Figure 6.26 shows the regression result of the probability of owning Unit trusts and PEPs at different household ages. Consistent with the age profile of financial asset ownership, Models 3 and 5 suggest that the probability of owning these investments increase with age. Regression predictions from Models 1, 2, and 4 show the same age patterns as Figure 6.25, with the peak in ownership occurring at around 60.

Figure 6.26 Regression predictions of the probability of owning unit trusts and PEPs



Notes: The probability estimates from Model 3 and Model 5 in the figure represent individuals born between 1946 and 1950; the probability estimates from Model 2 and Model 4 in the figure represent all individuals in 1988; household characteristic variables used in Model 4 and Model 5 are as follows: male = 1, married = 1, equivalised income = 217, sizes of household = 3, number of children = 1, and Full-time_professional = 1.

6.4.5 Logit regression results to estimate the probability of directly owning financial assets from the subsample (1968-1986)

The regression estimates from the time and cohort effects model begs the question as to which pattern best represents the actual age effects. These contradictory results are similar to what Ameriks and Zeldes (2004) uncover from their analysis of US households. If lifetime saving decisions actually follow the findings of specification models that include cohort effects, the retirement of baby-boomers will not create a situation where there is a large capital supply. In fact, the saving demands will increase since the proportion of the elderly is expected to rise over the coming decades. However, it is difficult to believe that the regression results from the model with cohort effects would be an appropriate representation of the actual age effects. Based on the plausibility consideration, the economic magnitude of such an increase in the probability estimates is too large to be actually possible. Figure 6.26 suggests that the probability of owning Unit trusts would increase from only 15 per cent at the age of 60 to approximately 50 per cent at the age of 90 (based on Model 5 estimates). This evidence is not grounded in reality. Since the income flows of retirees will be based largely on pension benefits provided by occupational pension plans and social security benefits, the amount of money available for investment in the capital market during retirement should be lower than the period of employment.

For reasons of plausibility, therefore, the regression estimates from the specification models which include cohort effects may be biased and inconsistent. Models 3 and 5 may suffer from the problem of omitted variables. If the regression model excludes certain variables which have a significant effect on the dependent variables, the coefficient estimates will be biased and inconsistent. Models 2 and 4 indicate that time dummy variables are significant factors in determining the probability estimates. Therefore, the exclusion of time effects may lead to biased estimates in Models 3 and 5. Nevertheless, some researchers may argue that the cohort effects of Models 3 and 5 are also significant. As a consequence, the omission of cohort effects in Models 2 and 4 may also lead to a problem of misspecification.

One methodology which may be able to test which identifying assumptions are more appropriate is to identify the period of the sample where time dummy effects are statistically insignificant, and to run the logit regression on this subsample. When the time effects are no longer significant, regression results from Models 3 and 5, which include cohort effects but exclude time effects, should not suffer from the problem of omitted variables. If the age patterns from these models using the subsample still have the same characteristics as the logit regressions on the full sample, the implication is that the biased estimates from these models may arise from other specification issues. The logit regressions on the subsample also test the sensitivity of the hump-shaped age profile. If the lifetime age patterns from the regression on the subsample are not significantly different from the full sample, this indicates that the age effects are robustly hump-shaped, and peak at a particular age range.

According to Table 6.4, most of the time dummy variables before 1986 are not significantly statistically different from zero. This implies that there are no specific years before 1986 that lead to a significantly different impact on the probability estimates from the reference year 1968. Therefore, the subsample chosen is the period between 1968 and 1986. Table 6.6 shows the logit regression result of all specification models on the subsample. It can be seen that, as expected, most time dummy variables are not statistically significant different from zero.

Table 6.6 Logit regression results to estimate the probability of directly owning financial assets based on the subsample

Dependent Variable: Probability of owning financial assets (before 1986)					
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-6.23362*	-6.28108*	-6.97551*	-6.77177*	-4.63834*
	(0.08157)	(0.09005)	(0.18539)	(0.10635)	(0.20320)
age	0.11032*	0.11035*	0.13047*	0.10530*	0.06328*
	(0.00326)	(0.00327)	(0.00614)	(0.00374)	(0.00658)
age^2	-0.00079*	-0.00079*	-0.00091*	-0.00067*	-0.00051*
	(0.00003)	(0.00003)	(0.00005)	(0.00004)	(0.00006)
Time dummy variables					
Time_1969		0.02251		-0.03990	
		(0.05403)		(0.05673)	
Time_1970		0.14091*		0.07187	
		(0.05417)		(0.05697)	
Time_1971		0.09316		-0.01934	
		(0.05310)		(0.05595)	
Time_1972		0.07958		-0.03380	
		(0.05375)		(0.05626)	
Time_1973		0.09555		-0.11548*	
		(0.05337)		(0.05631)	
Time_1974		0.08498		-0.12942*	
		(0.05444)		(0.05733)	
Time_1975		0.06681		-0.14271*	
		(0.05386)		(0.05661)	
Time_1976		-0.04044		-0.24153*	
		(0.05539)		(0.05802)	
Time_1977		0.02356		-0.18693*	
		(0.05464)		(0.05724)	
Time_1979		-0.21241*		-0.48503*	
		(0.05922)		(0.06166)	
Time_1980		-0.22319*		-0.61471*	
		(0.05891)		(0.06212)	
Time_1981		-0.13886*		-0.58361*	
		(0.05647)		(0.05962)	
Time_1982		-0.09102		-0.52576*	
		(0.05638)		(0.05944)	
Time_1983		0.04227		-0.48162*	
		(0.05582)		(0.05920)	
Time_1984		0.08339		-0.42521*	
		(0.05465)		(0.05801)	
Time_1985		0.34422*		-0.22936*	
		(0.05200)		(0.05540)	
Time_1986		0.31831*		-0.31441*	
		(0.05226)		(0.05620)	
Cohort dummy variables					
Birth_1901~1905			-0.05953		-0.10497*
			(0.04932)		(0.05129)
Birth_1906~1910			-0.09894		-0.23256*
			(0.05079)		(0.05312)
Birth_1911~1915			-0.06877		-0.32681*
			(0.05456)		(0.05747)
Birth_1916~1920			-0.07557		-0.50604*
			(0.06078)		(0.06427)
Birth_1921~1925			0.00828		-0.57739*
			(0.06463)		(0.06847)
Birth_1926~1930			0.06699		-0.73215*
			(0.07053)		(0.07486)
Birth_1931~1935			0.15721*		-0.79111*
			(0.07550)		(0.08033)

Table 6.6 (continued) Logit regression results to estimate the probability of directly owning financial assets based on the subsample

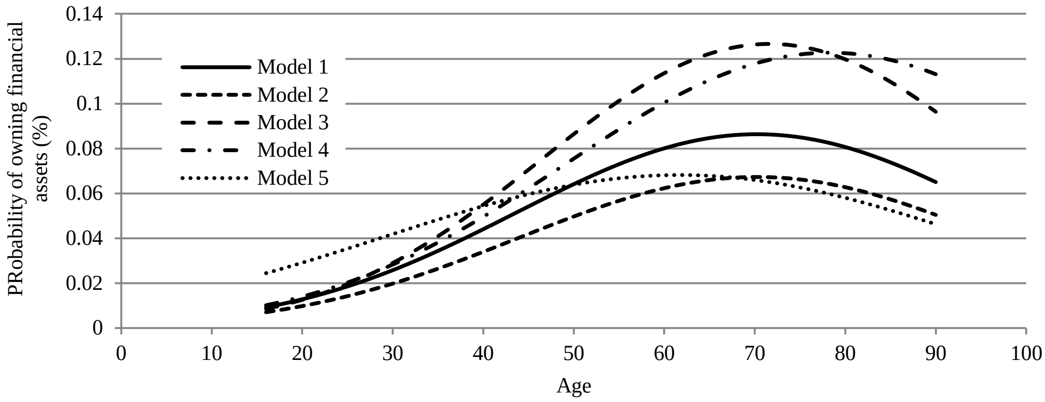
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Birth_1936~1940			0.15646		-0.96936*
			(0.08086)		(0.08650)
Birth_1941~1945			0.23500*		-1.16164*
			(0.08626)		(0.09286)
Birth_1946~1950			0.37033*		-1.22773*
			(0.09182)		(0.09896)
Birth_1951~1955			0.27191*		-1.56887*
			(0.10440)		(0.11199)
Birth_1956~1960			0.27226*		-1.71879*
			(0.11976)		(0.12818)
Birth_1961~1965			0.39736*		-1.56575*
			(0.14024)		(0.14875)
Birth_1966~1970			-0.14398		-2.28500*
			(0.24224)		(0.24909)
male				0.53773*	0.53739*
				(0.02481)	(0.02486)
marital_status				-0.18508*	-0.18876*
				(0.02504)	(0.02523)
Equivalised income				0.00495*	0.00497*
				(0.00007)	(0.00007)
				(0.03826)	(0.03860)
Full-time_non-Professionals				-0.06740	-0.07331
				(0.04419)	(0.04437)
Full-time_Manual workers				-1.14681*	-1.14518*
				(0.04375)	(0.04392)
Full-time_HMForces				0.10962	0.10680
				(0.16929)	(0.16970)
Part-time_Professionals				0.29061*	0.27987*
				(0.05888)	(0.05900)
Part-time_non-Professionals				0.02508	0.01454
				(0.05718)	(0.05723)
Part-time_Manual workers				-1.20281*	-1.20753*
				(0.07432)	(0.07432)
Self-Employed_Professionals				0.76705*	0.76518*
				(0.04859)	(0.04866)
Self-Employed_non-Professionals				0.57941*	0.54742*
				(0.14289)	(0.14259)
Self-Employed_Manual workers				-0.47709*	-0.47280*
				(0.07508)	(0.07511)
Retired				0.12747*	0.11008*
				(0.03454)	(0.03467)
Number of observations	252162	252162	252162	252162	252162
Log-likelihood value	-48150.628	-48027.61	-48119.08	-41803.005	-41901.36
Pseudo R-squared	0.0418	0.0442	0.0424	0.1681	0.1661
Estimated turning point	70.25	70.24	71.65	78.29	61.70

Notes: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05; Numbers in parentheses are standard errors; Pseudo R-squared is the McFadden's R-squared.

The turning point of the age patterns estimated from Models 3 and 5 are 71 and 62 respectively. The turning points for Models 1, 2, and 4 from the subsample regression are approximately at the same location as in the full sample. All other household characteristic variables have significant effects on the probability estimates, similar to the regression results of the full sample.

Although there are some slight variations around the age ranges that lead to peak participation in the financial market, Figure 6.27 shows that the hump-shape age profiles of the probability of directly owning financial assets coming from the subsample are similar to those of the full sample. The probability of owning financial assets for households aged above 70 is no longer positively related with age. According to the age profiles shown in Figure 6.27, it seems clear that the coefficient estimates from Models 3 and 5 no longer suffer adversely from the problem of misspecification. A hump-shaped age pattern with turning points at the ages of around 65 and 70 would be the actual age effect of household lifetime direct ownership of financial assets.

Figure 6.27 Regression predictions of the probability of directly owning financial assets based on the subsample



Notes: The probability estimates from Model 3 and Model 5 in the figure represent individuals born between 1946 and 1950; the probability estimates from Model 2 and Model 4 in the figure represent all individuals in 1980; household characteristic variables used in Model 4 and Model 5 are as follows: male = 1, married = 1, equivalised income = 217, sizes of household = 3, number of children = 1, and Full-time_professional = 1.

As shown in this section, the time effect is an important factor in the regression model particularly for the full sample size, which covers the period of a sharp increase in household participations in the financial market during the late 1980s. Therefore, omitting this time effect leads to severe biases in the coefficient estimates from Models 3 and 5, which include only age and cohort effects. Even though Poterba (2001) points out that the cohort effect is more important to create the hump-shaped age pattern than the time effect, his argument is based on the analysis on the age-wealth profile. However, this chapter is looking at the lifecycle pattern of the probability of owning a certain investment opportunity. The omission of the cohort effect would not create significant biases. On the contrary, if the time effect is omitted, this will even generate more severe biases in the estimation due to the omission of significant explanatory variables in the regression model. Moreover, the regression results from Poterba (2001) shows that the cohort effect has only a surprisingly small impact on the age-wealth profile. The standard errors on the coefficients of cohort effects are large, which lead to a failure to reject the null hypothesis of similar effects among different cohorts. Therefore, the omission of the cohort effect is not as severe as the omission of the time effect. An upward-sloping age-wealth profile shown in Ameriks and Zeldes (2004) from the model with only age and cohort effects should also be misspecified as a result of omitting the time effect.

6.4.6 Logit regression results to estimate the probability of having occupational pension plans

Apart from the direct ownership of financial assets and investment in unit trusts and PEPs, households also have portions of their savings in personal retirement accounts and occupational pension plans. The ages at which households decide to reduce their savings in these pension funds may be different to the same decision regarding their direct investment in the financial markets. The age profile of the probability of participation in pension funds may provide a better representation for the lifecycle hypothesis because saving decisions in these particular financial institutions are based mainly on their concern regarding the lack of income from work during retirement.

Table 6.7 presents the logit regression results of the probability of having occupational pension plans. The coefficient estimates of the age variables from Models 1, 2, and 3 indicate that the turning point of the inverted U-shape age patterns occurs at the age of about 40. Models 4 and 5, which include household characteristic variables, produce hump-shaped age patterns which peak at around 45. There is no inconsistency in age patterns between those models that include time effects and those that include cohort effects. As expected, other household characteristic variables impact on the probability estimates: males are more likely to participate in occupational pension plans compared to females; there is a significant positive relationship between the level of income and the probability of having employer pensions; and full-time employees tend to have a higher probability of participating in employer pension plans than part-time employees.

Table 6.7 Logit regression results to estimate the probability of participation in occupational pension plans

Dependent Variable: Probability of having occupational pension funds					
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-7.01897*	-7.16167*	-9.54130*	-13.99949*	-14.89581*
	(0.03978)	(0.04698)	(1.00111)	(0.34032)	(1.06789)
age	0.32112*	0.32304*	0.31460*	0.23436*	0.20831*
	(0.00197)	(0.00198)	(0.00236)	(0.00304)	(0.00353)
age^2	-0.00390*	-0.00393*	-0.00386*	-0.00262*	-0.00232*
	(0.00002)	(0.00002)	(0.00003)	(0.00004)	(0.00004)
Time dummy variables					
Time_1973		-0.36313*		-0.47613*	
		(0.03454)		(0.04028)	
Time_1974		0.05905		0.09845*	
		(0.03328)		(0.03973)	
Time_1975		0.17247*		0.20422*	
		(0.03244)		(0.03881)	
Time_1976		0.22968*		0.28821*	
		(0.03263)		(0.03920)	
Time_1977		0.22970*		0.28986*	
		(0.03254)		(0.03911)	
Time_1979		0.30165*		0.35955*	
		(0.03293)		(0.03963)	
Time_1980		0.30738*		0.35801*	
		(0.03269)		(0.03942)	
Time_1981		0.30089*		0.43232*	
		(0.03224)		(0.03913)	
Time_1982		0.26412*		0.40710*	
		(0.03250)		(0.03950)	
Time_1983		0.19182*		0.30043*	
		(0.03346)		(0.04054)	
Time_1984		0.13925*		0.25202*	
		(0.03333)		(0.04026)	
Time_1985		0.14221*		0.25961*	
		(0.03339)		(0.04049)	
Time_1986		0.10883*		0.19131*	
		(0.03344)		(0.04033)	
Time_1987		0.03694		0.16868*	
		(0.03322)		(0.04020)	
Time_1988		0.11954*		0.22814*	
		(0.03306)		(0.04010)	
Time_1989		0.10387*		0.19445*	
		(0.03301)		(0.03997)	
Time_1990		0.12130*		0.14726*	
		(0.03355)		(0.04055)	
Time_1991		0.10927*		0.13474*	
		(0.03376)		(0.04084)	
Time_1992		-0.02448		0.03009	
		(0.03385)		(0.04080)	
Time_1993		-0.07587		-0.01903	
		(0.03454)		(0.04166)	
Time_1994		-0.06643		-0.02725	
		(0.03469)		(0.04172)	
Time_1995		-0.05687		-0.02661	
		(0.03465)		(0.04173)	
Time_1996		-0.00326		0.05070	
		(0.03485)		(0.04214)	
Time_1998		0.02366		0.06042	
		(0.03432)		(0.04161)	
Time_1999		0.09305		0.10721*	
		(0.03375)		(0.04104)	
Time_2000		0.11320		0.12064*	
		(0.03413)		(0.04155)	
Time_2001		0.07559			
		(0.03285)			

Table 6.7 (continued) Logit regression results to estimate the probability of participation in occupational pension plans

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Time_2002		0.13325*			
		(0.03340)			
Time_2003		0.13315*			
		(0.03319)			
Time_2004		0.12418*			
		(0.03356)			
Cohort dummy variables					
Birth_1901~1905			-0.49772		-0.68078
			(1.15501)		(1.17037)
Birth_1906~1910			1.71131		0.73319
			(1.00482)		(1.01893)
Birth_1911~1915			2.88231*		1.52181
			(1.00102)		(1.01470)
Birth_1916~1920			2.99485*		1.61416
			(1.00085)		(1.01459)
Birth_1921~1925			2.94219*		1.61965
			(1.00081)		(1.01461)
Birth_1926~1930			2.86770*		1.66524
			(1.00086)		(1.01477)
Birth_1931~1935			2.69489*		1.58084
			(1.00093)		(1.01492)
Birth_1936~1940			2.59448*		1.54165
			(1.00097)		(1.01506)
Birth_1941~1945			2.61174*		1.55125
			(1.00100)		(1.01519)
Birth_1946~1950			2.67578*		1.61635
			(1.00102)		(1.01529)
Birth_1951~1955			2.75522*		1.68848
			(1.00105)		(1.01536)
Birth_1956~1960			2.75585*		1.68368
			(1.00107)		(1.01539)
Birth_1961~1965			2.73462*		1.60884
			(1.00109)		(1.01545)
Birth_1966~1970			2.66439*		1.38493
			(1.00113)		(1.01556)
Birth_1971~1975			2.69353*		1.22638
			(1.00121)		(1.01580)
Birth_1976~1980			2.49952*		0.91569
			(1.00152)		(1.01722)
Birth_1981~1985			1.65429		-0.18175
			(1.00366)		(1.04849)
Birth_1991~1990			-0.05203		
			(1.08131)		
male				0.55028*	0.54812*
				(0.01305)	(0.01304)
marital_status				0.17791*	0.16479*
				(0.01342)	(0.01344)
Equivalised income				0.00105*	0.00101*
				(0.00004)	(0.00004)
Size of household				-0.06807*	-0.05902*
				(0.00731)	(0.00733)
Number of Childrens				-0.03617*	-0.04217*
				(0.00898)	(0.00899)
Full-time_Professionals				8.76539*	8.75049*
				(0.33381)	(0.33372)
Full-time_non-Professionals				8.70857*	8.68238*
				(0.33376)	(0.33367)
Full-time_Manual workers				8.21737*	8.20305*
				(0.33377)	(0.33367)
Full-time_HMForces				6.63254*	6.62742*
				(0.34633)	(0.34618)
Part-time_Professionals				8.20221*	8.22903*
				(0.33477)	(0.33466)
Part-time_non-Professionals				7.01316*	6.98862*
				(0.33413)	(0.33403)

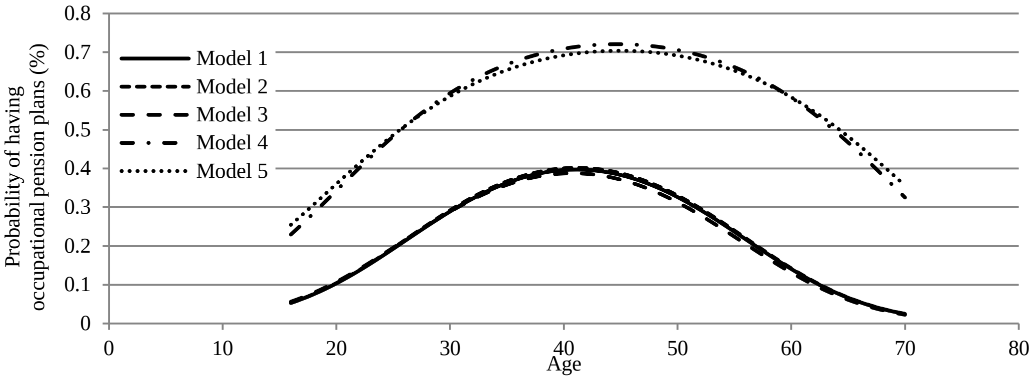
Table 6.7 (continued) Logit regression results to estimate the probability of participation in occupational pension plans

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Part-time_Manual workers				6.21718*	6.23916*
				(0.33491)	(0.33480)
Self-Employed_Professionals				1.47744*	1.49349*
				(0.44114)	(0.44010)
Self-Employed_non-Professionals				1.22740*	1.16955*
				(0.50845)	(0.50693)
Self-Employed_Manual workers				0.85355	0.89821
				(0.66700)	(0.66693)
Retired				0.31416	0.25717
				(0.55831)	(0.55828)
Number of observations	407639	407639	407639	355032	355032
Log-likelihood value	-184116.74	-183584	-183485.75	-108034.21	-108353.76
Pseudo R-squared	0.1292	0.1317	0.1322	0.4116	0.4098
Estimated turning point	41.12	41.13	40.74	44.70	44.92

Notes: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05; Numbers in parentheses are standard errors; Pseudo R-squared is the McFadden's R-squared.

Figure 6.28 illustrates the lifetime age profile of the probability of having an employer pension plan. It is fairly clear that working adults between the ages of 35 and 45 have the highest probability of participation in occupational pension plans. Regression predictions from all the specification models yield the same hump-shaped age profile. This robust result from the regression models provides strong evidence in support of the lifecycle hypothesis: working adults appear to reduce their contributions to pension funds as they are approaching retirement. However, some researchers argue that this age pattern of the probability of participation in occupational pensions may be influenced largely by the decisions of employers in providing pensions to their employees. The decline of probability estimates after the age of 50 may stem from the fact that employers benefit less by providing pensions to elderly workers, who may have lower productivity than younger workers. However, a regression analysis on the probability of participation in private personal pensions may provide evidence that eliminates this possible influence.

Figure 6.28 Regression predictions of the probability of participation in occupational pension plans



Notes: The probability estimates from Model 3 and Model 5 in the figure represent individuals born between 1946 and 1950; the probability estimates from Model 2 and Model 4 in the figure represent all individuals in 1988; household characteristic variables used in Model 4 and Model 5 are as follows: male = 1, married = 1, equivalised income = 217, sizes of household = 3, number of children = 1, and Full-time_professional = 1.

6.4.7 Logit regression results to estimate the probability of having private personal pensions

The logit regression results of the probability of having private personal pensions are demonstrated in Table 6.8. The turning point of the age pattern is at around 40, according to Models 1, 2, 3 and 4. Using Model 5, the peak in the probability of having a personal pension is estimated at 46. After adding household characteristic variables into the regression model, cohort effects are no longer present. This evidence may indicate that the presence of cohort effects in Model 3 could be explained by household characteristic variables. The significant direction and magnitude of the impact of most household characteristic variables on probability estimates are similar to the regression estimates of the probability of having an occupational pension plan. Self-employed individuals are more likely to participate in personal pensions than both full-time and part-time employees.

Table 6.8 Logit regression results to estimate the probability of participation in personal pension plans

Dependent Variable: Probability of having personal pension plans					
Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-7.40366*	-7.34299*	-8.48429*	-7.39857*	-7.25032*
	(0.07512)	(0.08079)	(0.58326)	(0.11710)	(0.74165)
age	0.28901*	0.29139*	0.18017*	0.18179*	0.13945*
	(0.00362)	(0.00363)	(0.00579)	(0.00518)	(0.00888)
age^2	-0.00346*	-0.00348*	-0.00229*	-0.00224*	-0.00151*
	(0.00004)	(0.00004)	(0.00007)	(0.00006)	(0.00011)
Time dummy variables					
Time_1988		-0.58574*		-0.67941*	
		(0.04503)		(0.04798)	
Time_1989		-0.24940*		-0.30849*	
		(0.04190)		(0.04489)	
Time_1990		0.00187		-0.04656	
		(0.04091)		(0.04393)	
Time_1991		0.09629*		0.07474	
		(0.04051)		(0.04358)	
Time_1992		0.16663*		0.18540*	
		(0.03966)		(0.04277)	
Time_1993		0.16056*		0.20669*	
		(0.04023)		(0.04339)	
Time_1994		0.08642*		0.10879*	
		(0.04089)		(0.04406)	
Time_1995		0.05849		0.09937*	
		(0.04104)		(0.04411)	
Time_1996		-0.01128			
		(0.04201)			
Time_1997				0.03731	
				(0.04496)	
Time_1998		-0.09667*		-0.06499	
		(0.04209)		(0.04510)	
Time_1999		-0.18884*		-0.15883*	
		(0.04233)		(0.04532)	
Time_2000		-0.23497*		-0.22628*	
		(0.04331)		(0.04636)	
Time_2001		-0.26646*			
		(0.04157)			
Time_2002		-0.31100*			
		(0.04297)			
Time_2003		-0.39541*			
		(0.04334)			
Time_2004		-0.33229*			
		(0.04333)			
Cohort dummy variables					
Birth_1901~1905			3.98552*		
			(0.92416)		
Birth_1906~1910			2.93450*		-0.77467
			(0.74022)		(0.84305)
Birth_1911~1915			2.19559*		-1.17640
			(0.66638)		(0.78319)
Birth_1916~1920			1.56019*		-1.76846*
			(0.63559)		(0.76411)
Birth_1921~1925			2.10719*		-1.24674
			(0.59405)		(0.73682)
Birth_1926~1930			2.89676*		-0.61244
			(0.58497)		(0.73558)
Birth_1931~1935			3.30064*		-0.27735
			(0.58285)		(0.73947)
Birth_1936~1940			3.64429*		0.04517
			(0.58194)		(0.74343)
Birth_1941~1945			3.72907*		0.13649
			(0.58150)		(0.74733)
Birth_1946~1950			3.62870*		0.18413
			(0.58116)		(0.75035)
Birth_1951~1955			3.47556*		0.21624
			(0.58085)		(0.75249)
Birth_1956~1960			3.37846*		0.31122
			(0.58041)		(0.75347)
Birth_1961~1965			3.41902*		0.46972
			(0.57987)		(0.75333)

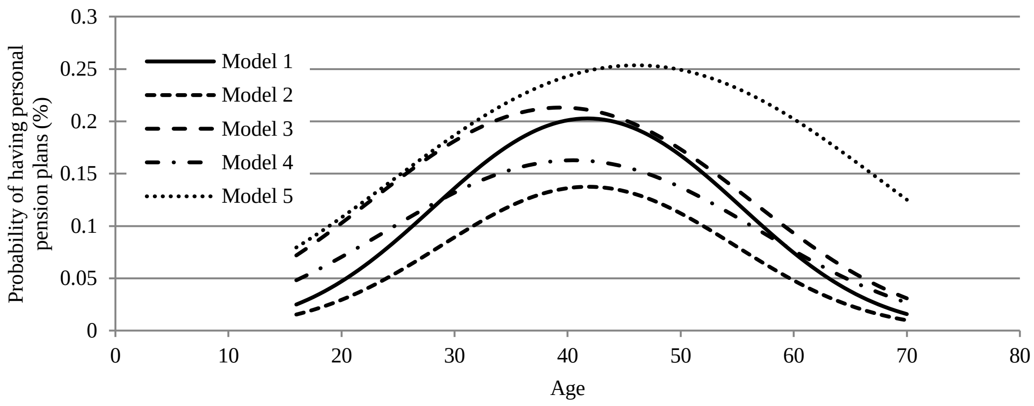
Table 6.8 (continued) Logit regression results to estimate the probability of participation in personal pension plans

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Birth_1966~1970			3.49849*		0.68604
			(0.57938)		(0.75239)
Birth_1971~1975			3.04005*		0.30844
			(0.57931)		(0.75157)
Birth_1976~1980			2.01955*		-0.86956
			(0.58214)		(0.75767)
Birth_1981~1985			0.79655		-2.92796*
			(0.60383)		(1.02949)
male				0.49725*	0.50166*
				(0.02098)	(0.02100)
marital_status				0.17933*	0.13426*
				(0.02234)	(0.02227)
Equivalised income				0.00026*	0.00024*
				(0.00004)	(0.00004)
Size of household				-0.02148	-0.01377
				(0.01257)	(0.01277)
Number of Childrens				-0.16017*	-0.14108*
				(0.01516)	(0.01559)
Full-time_Professionals				2.23700*	2.22128*
				(0.05229)	(0.05227)
Full-time_non-Professionals				2.03113*	2.01272*
				(0.05108)	(0.05110)
Full-time_Manual workers				2.27034*	2.24318*
				(0.05092)	(0.05093)
Full-time_HMForces				0.68361*	0.66084*
				(0.23058)	(0.23032)
Part-time_Professionals				2.26116*	2.23710*
				(0.08858)	(0.08850)
Part-time_non-Professionals				1.57081*	1.58968*
				(0.05639)	(0.05645)
Part-time_Manual workers				1.23117*	1.23971*
				(0.07400)	(0.07402)
Self-Employed_Professionals				3.99201*	3.97003*
				(0.05975)	(0.05969)
Self-Employed_non-Professionals				3.37319*	3.34293*
				(0.05341)	(0.05337)
Self-Employed_Manual workers				3.60034*	3.55886*
				(0.09662)	(0.09652)
Retired				0.04997	0.10082
				(0.09267)	0.09473
Number of observations	214610	214610	214610	162003	162003
Log-likelihood value	-67054.384	-66627.924	-66364.929	-44116.719	-44165.999
Pseudo R-squared	0.0888	0.0946	0.0982	0.2303	0.2294
Estimated turning point	41.76	41.82	39.40	40.49	46.09

Notes: * indicates the statistically significant different from zero (2-tailed p-value) at alpha=0.05; Numbers in parentheses are standard errors; Pseudo R-squared is the McFadden's R-squared.

Figure 6.29 indicates that the age profile is significantly hump-shaped for all specification models. The peak in participation rates is at around 40. This hump-shaped age profile is not significantly different from the age profile of the probability of having an occupational pension. Individuals aged over 50 appear to reduce contributions paid into their retirement account. The inverted U-shape age patterns of voluntary savings in private pensions provide strong evidence supporting the lifetime saving patterns suggested by the lifecycle hypothesis: households reduce saving rates for retirement and plan to dissipate their accumulated account upon reaching retirement.

Figure 6.29 Regression predictions of the probability of participation in personal pension plans



Notes: The probability estimates from Model 3 and Model 5 in the figure represent individuals born between 1946 and 1950; the probability estimates from Model 2 and Model 4 in the figure represent all individuals in 1988; household characteristic variables used in Model 4 and Model 5 are as follows: male = 1, married = 1, equivalised income = 217, sizes of household = 3, number of children = 1, and Full-time_professional = 1.

6.5 Discussion

In this chapter, Family Expenditure Surveys (1968 to 2007) have been used to examine the lifetime saving behaviour of British households. The long history of these repeated cross-sectional surveys provide complete observations of household saving behaviour over their lifetime. For a particular year of birth, it is possible to observe changes in the saving decisions over an entire lifetime, from young working age until retirement. Nonetheless, the main caveat from this survey data is the impossibility of constructing household portfolio allocations over time. The survey only provides comprehensive information about the composition of income and expenditure, with no information provided about the financial wealth of households and which asset classes they have made their investment decisions. The probability to own or rent a house is not included in the analysis in this paper because housing assets have a feature to provide current consumption. This means that a decision to buy or sell a house is not purely made from an investment aspect. Generally speaking, pensioners may only dissipate housing wealth only when other accumulated financial assets have been greatly dissipated because they can benefit from housing consumption.

According to the results found in this chapter, it appears that the emergence of pension schemes provides a main mechanism that forces households to behave rationally as what would be suggested by the lifecycle hypothesis. Retirement saving through either occupational pension schemes or personal pension plans encourages households to explicitly consider their lifecycle budgetary management. Pension schemes act like professional advisors who make optimal lifecycle saving decisions for households. Without these institutions, it may be difficult for households to individually make rational saving and consumption decisions over different periods of their life. The main reason is that this lifecycle optimization problem is particularly complicated and requires a high level of financial literacy. After having had pension schemes to manage their retirement saving, it appears that households may perceive their own direct investment in the financial market as a last source for their savings in retirement. Lifetime investment in occupational pension plans and personal pensions seems to be consistent with the view that savings in these financial institutions are perceived to provide pension benefits; therefore, when individuals approach retirement age, the incentive to invest in these financial institutions becomes much lower. They plan to start dissipating their savings in these financial institutions during retirement before decumulating their own direct investment in the financial market. The insight gleaned from this research may explain why some previous literatures do not find consistent results of household saving decisions with the lifecycle hypothesis.

Furthermore, the importance of households’ saving through pension schemes indicates that it is necessary to study and understand asset allocation of these institutional investors in order to investigate whether the asset meltdown scenario will occur after the retirement of baby-boomers. When households approach retirement, this research finds that they significantly reduce saving through these financial institutions, but not saving through their own investment. This implies that the amount of money flowing into pension schemes will be lower as the population is aging. There may be fewer demands for financial assets from all pension schemes in the market while the supply of financial assets may be greater as these institutional investors begin to sell their assets to finance pension benefits. This line of reasoning suggests that previous literatures which only investigate the lifecycle behaviour of household direct investment in the financial market in order to test the asset meltdown scenario may not provide correct results. For example, the proposition by Poterba (2001), who argues that the projected demands for financial assets will not decline significantly in the future, may not be conclusive because his analysis only focuses on household direct investments without considering household accumulated wealth in pension funds. A study by the US Government Accountability Office (GAO) in 2006, which argues that the downward pressure on asset prices should not occur in the next decades, is also not convincing. This is because they support the argument only by showing that the dissaving rates of the first 10 per cent wealthiest elderly, who own around two-thirds of financial assets directly held by all households, are not as high to cause a precipitation in financial asset prices. They do not include the effect of trading by pension schemes which are one of the main market participants in the financial market.

Interestingly, the age range (35-45) that exhibits the highest participation rates in occupational pension schemes and private personal pension plans is similar to the age group that has a positive significant impact on equity returns over the long horizon as shown previously in chapter 5. These consistent results from chapter 5 and 6 strongly suggest that the presence of pension funds in the market since the 1960s may be the main underlying mechanism that makes the movement of asset prices to be highly correlated with demographic patterns. This proposed hypothesis is plausible because household direct investment in the financial market have steadily been becoming less important relative to the wealth in personal pension and occupational pension schemes. Households' direct investment in the financial market should not expect to create any significant influence on the movement of asset prices and returns. In contrast, asset allocation of pension schemes in the market may have a significant impact on asset prices and returns because the aggregate amount of funds managed by these institutional investors are relatively large. Even though trading activities of a certain pension scheme may not have any significant impact on asset prices, aggregate investment decisions of all pension schemes in the market can significantly affect asset prices and returns if these pension schemes have the same investment strategy in dealing with the movement of underlying demographic structures. Therefore, it is interesting to analyse and understand investment principles and asset allocation behaviour of pension schemes. A detailed analysis about this issue will be presented in chapter 7.

6.6 Concluding remarks

The retirement of baby boom generations has engendered significant debate regarding the impact of their dissaving behaviour on the stability of the financial market. The lifecycle hypothesis proposed by Modigliani and Brumberg (1954) suggests that individuals will decumulate their accumulated savings accounts once they reach retirement due to the absence of labour income during the retirement period. This dissaving motive of the elderly has led to concern that the relative supply of capital will be larger than the demand for capital from successive generations. This is because the proportion of working adults is expected to be much lower than the proportion of the retirees over the coming decades.

Empirical evidence from previous literature has frequently found that the household ownership of financial assets slowly decline following retirement. This evidence appears to be in contrast to the economic behaviour suggested by the lifecycle hypothesis. Because most of the existing literature only tests the lifecycle hypothesis through an investigation of household direct investment in the financial market, such examinations may overlook other investment opportunities which can be used by households to save for their retirement, such as investment in mutual funds or private personal pension funds, or saving through occupational pension schemes.

This research finds that household direct ownership of financial assets rose dramatically during the 1980s primarily due to the privatisation of many public utilities and building societies. The cross-sectional view age profile, which connects the probability estimates of individuals at different age ranges from a certain year of the cross-sectional survey, indicates that the age groups which have high direct ownership of financial assets, and high participation rates in unit/investment trusts and Personal Equity Plans, are between 60 and 70. After 70, participation rates in the capital market through these investments show a marginal decline. This indicates low dissaving rates of individuals after retirement. In contrast, the cross-sectional age patterns of participations in occupational pension plans and private personal pensions are an inverted U-shape pattern. The peak in the participation rates occurs at between 35 and 45. Individuals appear to reduce their contributions to occupational and private pensions when they reach retirement. This hump-shaped age pattern provides strong evidence in support of the lifecycle hypothesis.

However, the cohort view age profiles, which connect the probability estimates of individuals at different age ranges based on year of birth, appear to provide different lifetime patterns, particularly in the cases of direct ownerships and investments in unit/investment trusts. The age patterns for each particular cohort are influenced predominantly by time effects. The appearance of time effects in the cohort view contradicts its underlying assumption, under which time effects are assumed to have no impact on the probability estimates. This influence of time effects on the cohort view analysis has led to biased estimates of the coefficients from the logit regression models, where cohort effects are included but time effects are excluded. The regression predictions from these models imply that the probability of participation in the financial market increase with age. In reality, this evidence is implausible because retirees are expected to have low incomes during retirement. One of the main reasons for these biased estimates may come from the omission of time effects, which have a significant impact on probability estimates. Having chosen the period (1968–1986) where time effects seem to be statistically indifferent to each other, the regression predictions from the models with cohort effects produce age patterns that are similar to other specification models. Participation rates in the financial market through direct investments and through mutual fund investments peak at between 60 and 70

Consistent results between the age group (35-44) that has the highest participation rates in occupational pension and personal pension plans and the age group (35-44) that has a positive significant effect on equity prices found previously in chapter 5 strongly suggest that the investment behaviour of pension schemes may be the main linking mechanism for the strong correlation between demographic patterns and the financial market observed after the 1960s. This finding sheds some interesting light on the behaviour of fund flows and asset allocations across pension funds, which may significantly be dependent on the dynamic of demographic patterns. Chapter 7 will present an analysis that investigates asset allocation and investment strategies of pension schemes in detail.

Chapter 7: Research which attempts to understand the investment principles of defined-benefit pension schemes

7.1 Introduction

The results from chapters 5 and 6 suggest that the emergence of pension schemes from the 1960s onwards may be the critical underlying mechanism which causes the dynamic of demographic structure to have a significant impact on financial asset prices and returns. While direct investment by households in financial markets does not seem to significantly affect asset prices, high household saving demands (via their participation in both pension schemes and personal pension plans between the ages of 35 and 45) appear to have had a significant positive impact on equity prices in recent decades. Equity prices have steadily become more expensive as measured by price-to-earning ratios and dividend yields. This empirical evidence implies that when policyholders are mostly young and middle-aged, the asset allocation of pension schemes may largely be concentrated in risky assets such as equities. Chapter 5 also illustrates that the fraction of the population aged between 60 and 64 is negatively significantly associated with the movement of GILT yields. This result suggests that when a large proportion of pension fund members approach the age of retirement, the majority of pension schemes may begin to increasingly allocate their investments in a safer asset class such as GILTs and corporate bonds.

According to the implications that can be gleaned from the results in chapters 5 and 6, this chapter attempts to explicitly examine the causal relation between the investment principles of pension schemes and the demographic structure of policyholders. Results from this analysis will provide additional evidence to support the proposed hypothesis that the significant correlation between demographic patterns and the financial market observed post-1960 is caused by the investment behaviour of pension schemes, which is dependent on the lifecycle saving and dissaving demands of households.

This chapter begins by discussing the various factors that may significantly influence the asset allocation of occupational DB pension schemes in the UK. These factors include the regulatory and accounting framework, the governance structure of pension schemes, the moral hazard incentives of plan sponsors, and the characteristics of plan liabilities. An analysis of DB pension schemes' asset allocation will follow. The main data for this research is obtained from the company accounts of FTSE100 firms during the 6-year period from 2006 to 2011.

This analysis can be separated into two main sections. The first section involves an examination to test whether the observed asset allocation of pension schemes is a result of the continuously changing investment policies or if it stems from relative changes in the prices of different asset classes. This study is necessary and important because the significant relationship identified between asset allocation and demographic patterns may represent a contemporaneous relationship if the changes in asset allocations are mainly influenced by the relative price changes across different financial assets. The second section will present a panel data regression in order to test the causal relationship between pension schemes' investment strategies and the demographic structures of policyholders. However, because UK companies are not required to disclose demographic information about their fund members, a maturity measure of pension obligations is constructed as a proxy for the age structure of fund members. The maturity measure used is the ratio between the amount of pension benefits paid to retired members and the amount of regular contributions paid by employers and active members. By using the aggregate data from the MQ5 survey, the movement of this maturity measure is shown to mirror the movement of aggregate demographic patterns.

The main finding from this analysis is that annual changes in the observed asset allocation of pension schemes are, generally speaking, significantly influenced by changes in long-term strategic investment policies. Therefore, by using the annual percentage changes of portfolio weights in each financial asset class as dependent variables in the panel regression analysis, it can be shown that the strategic investment strategy of pension schemes is significantly related to the demographic structures of plan members. The large proportion of retired members relative to active members is significantly associated with greater investments in fixed-income securities, annuity contracts and short-term money market instruments. Furthermore, occupational pension schemes with an old-age structure of policyholders appear to have significantly lower proportions of equity investment compared to the schemes with a young-age structure. These findings suggest that the shift in the demographic structure to a high old-age dependency ratio in forthcoming decades may cause pension schemes to increase their supply of risky assets, as these institutional investors shift their asset allocation from risky assets into safe assets. The downward pressure on equity prices and the upward pressure on bond prices over the coming decades will be caused by the trading activities of these pension schemes rather than the dissaving behaviour of the households' direct investment in the financial market.

7.2 The main reasons for focusing the investment behaviour of DB pension schemes

The first UK occupational pension scheme dates to around the 14th century (Blake, 1999). Provisions of occupational pension schemes have begun to grow significantly since the end of the World War II. As previously shown in chapter 4, more than 30 per cent of total UK equities are currently held by pension funds (including occupational pension schemes and personal pension plans). When compared to ownership levels of other institutional investors, this proportion is relatively large, suggesting that the quantity of fund flows and the trading activities of pension schemes may have some influence on the stability of financial asset prices and returns.

In order to understand the investment principles and trading activities of pension schemes in the market, this chapter analyses the investment behaviour of large occupational DB pension schemes employed by FTSE100 firms. This sample can be used to provide an approximate representation of the investment behaviour of the whole pension fund industry because their asset allocation and investment principles are generally considered to be an industry benchmark which is derived from sophisticated and professional risk management procedures. The pension trustees of the majority of other smaller schemes typically feel comfortable complying with this industry norm.

The research in this chapter does not analyse the investment behaviour of DC-type pension plans because the aggregate amount of these plans is still relatively lower than the value of assets managed under DB schemes. Recent estimates conducted by UBS Global Asset Management (2006) show that the proportion of DC assets was only around 20 per cent of the total UK pension assets, with the remainder belonging to DB schemes. Although it has been shown that more than 80 per cent of the respondents in the survey undertaken by Greenwich Associates (2005) were offered DC plans, the total value of assets invested in the DC plans was only 3 per cent. These figures demonstrate that even though DC plans are more prevalent in the market, they are still in the early stage of asset accumulation, with a total asset value that is far lower than that of matured traditional DB schemes. The main reason for the currently large value of assets managed by DB schemes is that the funded occupational pension schemes provided by employers over recent decades, in both the public and private sector, generally had a DB structure. The significance of DB schemes in the financial market is not only limited to the UK market. Broadbent, Palumbo and Woodman (2006) also show that the aggregate asset value of DB pension plans of Australia, Canada, the US, the UK, the Netherlands and Japan in 2004 was approximately US$14.4 trillion, accounting for more than 90 per cent of the total occupational pension assets in OECD countries. The asset values of DC plans in these countries are, on average, less than 30 per cent of the total pension assets. Therefore, when compared to DB schemes, the investment activities of DC plans are not expected to pose any significant challenges to the stability of financial asset prices in the near future.

Although some researchers may argue that a continual increase in the provision of DC plans in both the public and private sector will lead to a situation where DC assets will eventually surpass the value of assets managed by traditional DB schemes, it may take more than 20 to 30 years for DC plans to be one of the main institutional investors in the market. According to the Pension Commission (2004), contribution rates to DC schemes are only in the range of 7-11 per cent of total wage bills while the levels of current contributions to DB schemes are around 16-20 per cent. In addition, individuals tend to cease making contributions to personal pension plans well before their retirement[21]. This is highlighted by a large discrepancy between the amount of outstanding premiums and the number of new personal pension schemes. Therefore, the growth of personal pensions in term of the market value may not be as high and rapid as expected. Within approximately the next 10 years, the investment decisions of traditional DB schemes are still expected to have a significant influence on the financial market.

7.3 Literature review on factors which are expected to influence the asset allocation of pension schemes

7.3.1 Regulation framework for the asset allocation of pension schemes

Generally speaking, one direct factor that determines the portfolio distributions of pension schemes is the regulatory framework, which may limit the range of financial assets and the extent of the concentration of risk that pension schemes can get exposed to. In principle, pension portfolio regulations can be distinguished into two broad categories, namely “Prudent Person Rules” and “Quantitative Restriction Rules”. The former is based on the concept that investments should be managed prudently by showing an adequate degree of diversification and appropriate consideration in protecting the benefits of plan beneficiaries. The latter, however, explicitly specifies the quantitative limits of investment in certain financial asset classes which typically exhibit high price volatility or low liquidity. For instance, portfolio limits usually specify either a minimum allocation in government bonds at

[21] When contributions cease, personal pensions will typically be converted into a paid-up status. However, a plan provider still extracts annual management fees at the same rate as an active policy. Therefore, the terminal value of the fund will normally be low.

around 15-50 per cent of total pension assets or a maximum allocation in equities at around 20-30 per cent. The quantitative limits do not normally extend to cover detailed information about the use of certain investment methodologies or risk management procedures.

Typically, the Quantitative Restriction Rules tend to be prevalent in countries which have a strong link to civil law, such as France, Germany, Denmark and Switzerland, while the Prudent Person Rules tend to be prevalent among common law countries. Since they are easier to supervise, less-developed countries in Asia, Latin America and Central and Eastern Europe also prefer the Quantitative Restriction Rules. In these countries, quantitative restrictions are sometimes used politically as a means of achieving certain government agenda. For example, stringent controls on the international investments by pension schemes may be used to enhance the security of monetary sovereignty and to promote the stability of national macro-economy (Fontaine, 1996). Detailed descriptions of pension portfolio restrictions within OECD countries can be found in OECD (2010). A detailed comparison regarding the degrees of stringency of the Quantitative Restriction Rules among developed countries is discussed cogently in Davies (2002).

The main advantage of Prudent Person Rules over Quantitative Restriction Rules is that pension fund managers are given a higher degree of flexibility to adjust pension assets in order to match their own pension liability parameters. As a result, immunization strategies or portfolio insurances can be performed more effectively. It has often been argued that quantitative limits generally lead to inefficient portfolios. The investment returns from portfolios that are governed by quantitative limits are usually lower than the returns from portfolios that are composed of the asset allocations along the efficient frontier. In addition, there is a possibility that quantitative restrictions may cause fund managers to change their perspective from a long-term investment horizon to a short-term regulatory period. For example, if fund managers are uncertain about future changes in the quantitative limits, they may show caution by investing too heavily in certain asset classes that are less likely to be affected by quantitative restrictions, or else by investing too little in risky assets in order to reduce the risk of breaching the quantitative limits when prices appreciate.

This investment behaviour is inefficient and suboptimal from the point of view of both fund members and plan sponsors. As shown in Davies (1988), in response to the changes in short-term relative asset returns, pension schemes in the UK and the US are more likely to adjust their asset allocations than those in Germany, Japan and Canada, where higher transaction costs and more stringent degrees of portfolio limits exist. Furthermore, Davies (2002), analysing asset allocations of pension schemes within OECD countries, also finds that the investment performance of pension schemes regulated by Prudent Person Rules is, on average, superior to those regulated by Quantitative Restriction Rules – by around 200 basis points. Portfolio distributions of pension schemes which follow Prudent Person Rules are more likely to have fewer fixed-income securities but higher proportions of equities and foreign assets. He further shows that the use of Quantitative Restriction Rules does not necessary reduce the overconcentration of risk in certain asset classes. This is the case in Swedish pension schemes that invest too heavily (at more than 35 per cent) in mortgage-related financial instruments.

However, the Prudent Person Rules can also impact negatively on the portfolio distributions of pension schemes. In certain circumstances it may be difficult to determine whether the process of making investment decisions is taken with great care, good skills, diligence and prudence. Since the prudent-person legislation does not explicitly specify any quantitative portfolio allocations or any quantitative standards that can be directly measured, fund managers may be cautious when executing new investment strategies, even though the new strategies may be more efficient and optimal than traditional investment principles. This implies that the Prudent Person Rules may encourage a degree of herding behaviour because fund managers can greatly reduce the risk of breaching due diligence conditions by allocating assets very similar to the norm of the industry benchmark which has been identified as being an acceptably prudent investment.

In the UK, Prudent Person Rules are the main regulation instrument of the pension industry. Quantitative portfolio limits are not strictly specified in most financial asset classes. There is also no limitation on the concentration of ownership. The only limitation of the UK pension portfolio is that investment in employer-related financial assets (self-investment) is limited at 5 per cent of the scheme's total asset value. In general, diversification rules and the requirements for maturity matching of UK pension schemes are significantly less stringent and onerous than those of UK life insurers. The main focus of UK pension regulators is on the behaviour of fund managers during the process of conducting investment strategies. Therefore, most UK pension schemes are expected to provide a coherent Statement of Investment Principles (SIPs) to plan beneficiaries and authorities in order to explicitly explain their process of "due diligent" decision-making. In other words, a course of conduct, but not investment outcomes, is the key factor indicating the form the prudence takes. As a result of this, the portfolio distributions of UK pension schemes are more influenced by other factors such as the characteristics of pension liabilities, associated agency costs in the governance structure of pension schemes, the implementation of some alternative investment models, and the investment beliefs or consensus of most financial advisors in the industry. A detailed discussion of these factors will be given in the following sections.

7.3.2 The governance structure and associated agency costs of occupational DB pension schemes

In the UK, funded system pension schemes are usually established in trust, with responsible trustees overseeing a schedule of pension contributions, benefit payments, the funding status of the schemes, and the asset allocations of pension assets. Trust systems became widely used following the introduction of the Superannuation and Other Trust Funds (Validation) Act in 1927. Pension trustees are deemed to balance and protect the benefits of both pension plan members and sponsoring firms. If they are unsure whether they have the appropriate expertise, they are expected to seek advice from qualified actuaries and investment advisors.

When managing pension assets, pension trustees normally establish both the main objective and long-term strategic asset allocations of the schemes. This may include the setting up of broad asset allocations in all eligible financial asset classes. Within each of these asset classes, pension trustees normally delegate asset allocation decisions to specialized divisions, which may be either internal or external to the sponsoring firms. The strategic asset allocation of pension assets is typically based on the investment horizons of between three and five years. Pension trustees may explicitly provide tracking errors or drift allowances for actual asset allocation to deviate from the long-term strategic investment strategy. The main reason for these allowances is to provide some degrees of flexibility to fund managers to generate extra short-term returns through active market timing. This short-term trading strategy is sometimes referred to as "tactical asset allocation". However, there is concern that pension trustees may not have sufficient knowledge or skills to investment in the most effective way. For example, a recent report by NAPF (2005b) shows that pension trustees have poor skills in assessing probability problems. This report shows that pension trustees sometimes do not realize that the sum of the probability cannot exceed 1 when dealing with complex situations.

Performance measurement methods also tend to have some influence on the asset allocation of occupational pension funds. Pension trustees normally evaluate the performance of fund managers through a peer group benchmark (Myners, 2001). Although this measurement provides an incentive for fund managers to outperform others, it can also create a herding effect because fund managers will be safe from falling below the median benchmark if they allocate pension assets in a nearly identical fashion to industry norms[22]. By following the average asset allocation of the industry, fund managers can significantly reduce the risk of losing their jobs. According to Prosser (1995), the average tenure length of UK pension fund managers is around 7.25 years. Therefore, pension fund managers tend to be less innovative in their allocation of pension assets. Rather than seeking to optimize the risk-return trade-offs and to hedge the risks of their own pension liabilities, the investment strategy of UK pension schemes is often simply to match the performance of other peer pension funds, thereby implying that certain financial asset classes may be ignored by the whole pension fund industry.

The negative effect from the peer group benchmark on pension asset allocation is further exacerbated by the high concentration structure of the UK fund management

[22] Pennacchi & Rastad (2010) also discover that herding behaviour is prevalent among US state pension plans.

industry. Lambert (1998) presents evidence that the top five UK asset management companies have a total market share of nearly 80 per cent. Recent statistics from the Pensions and Investments Survey illustrate that a five-firm and twenty-firm concentration ratio in the UK was approximately 36 and 72 per cent respectively, which were much higher than those in the US at around 20 and 40 per cent. As a consequence, UK fund management firms will place significant emphasis on their relative track record performance in order to protect themselves from losing their market share (Kay, Laslett, & Dufry, 1994). It is therefore unsurprising to find remarkably similar performances in UK pension funds (Thomas & Tonks, 2001). Tonks (2005) presents evidence that the cross-sectional standard deviation of UK pension funds' quarterly returns in each period is quite low when compared to the time-series standard deviation. Blake, Lehman and Timmerman (2002), focusing on the return distributions of UK pension funds, also show that total returns of pension funds between the 5th and 95th percentile differ by just less than 300 basis points. These findings suggest that the asset distributions of UK pension funds tend to follow each other quite closely over time, which is clearly an indication of the herding behaviour among UK pension schemes. The high concentration ratio in the UK fund management industry has also led to a situation where fund managers are able to request high management fees, despite the fact that passive manager fee levels appear to be more appropriate.

Moreover, the management of UK pension schemes is generally suboptimal due to the presence of agency problems. These agency costs arise because most pension trustees serve concurrently as executives of sponsoring companies, meaning that conflicts of interest are inevitable. Even though the shareholders of a sponsoring company and the policyholders of a pension scheme can be thought of as debt-holders of the company, insider pension trustees may prefer to favour the interests of shareholders to those of pension members. From the viewpoint of the plan sponsors, pension assets should be invested in the way that maximizes the value of shareholders. Investment outcomes from this consideration may significantly deviate from an optimal policy that maximizes the benefits of policyholders. Lakonishok, Shleifer and Vishney (1992) argue that the governance of DB pension schemes suffers from two layers of agency costs, namely the selection of fund managers by pension trustees and the investment decisions of fund managers. In an attempt to reduce agency costs, pension plan members in the UK have been granted the right to select and appoint trustees since April 1997. The regulation requires that one-third of pension trustees should be nominated by plan members. In the case of schemes with fewer than 100 beneficiaries, at least one member of the trustee board is required to be a representative of plan beneficiaries. Under a statutory consultation procedure, plan members can also grant the right of selection and approval of member-nominated trustees.

The negative impact of having a high proportion of insider trustees managing UK occupational pension schemes has also been noted by Cocco and Volphin (2007). They find that UK insider trustees are more likely to serve the interests of sponsoring companies rather than the sole benefits of policyholders. Results from their instrumental variable regressions robustly show that pension schemes of highly leveraged firms tend to have large proportions of equity investment. The main objective of this investment strategy, from the viewpoint of insider trustees, is to transfer the investment risk from sponsoring firms to pension members because riskier asset allocations by pension schemes might reduce the probability of large future pension contributions. Further evidence of agency problems in the governance of pension schemes is the fact that firms with a large dividend pay-out policy tend to pay low contributions to their pension schemes (Webb, 2007). This evidence has also been confirmed by Cocco and Volphin (2007) in the case of UK occupational pension schemes. Agency problems are not limited only to private pension plans: asset allocations of public pension schemes have also suffered from similar agency problems. Governments or public agencies may use pension assets for other purposes, such as investment in local projects which do not necessarily generate appropriate returns to policyholders.

Principally, there are two main types of moral hazard behaviour arising from these agency problems in corporate DB pension schemes, namely the risk-shifting incentive and the tax arbitrage opportunity. The presence of a pension guaranteed fund, such as the UK Pension Protection Fund (established in 2004) and the US Pension Benefit Guaranty Corporation (established in 1974), creates moral hazard incentives for fund managers at extremely weak funding levels. As pointed out in Sharpe (1976) and Treynor (1977), pension liabilities are similar to the other debt liabilities of a company in that shareholders are only responsible for funding the scheme up to the maximum remaining resource of the company. This limited liability suggests that it is optimal, from the shareholders' perspective, to make large risky equity investments when pension schemes are underfunded. On the one hand, this strategy can significantly reduce the likelihood of large future contributions if equity returns turn out to be significantly positive. On the other hand, if returns are adversely negative, shareholders are not liable to pay any pension benefits in excess of the companies' remaining assets. In addition, the higher volatility of pension assets from large equity investment not only raises expected returns of pension assets but also increases the expected returns on the equity of the companies' shareholders. This is because any excess pension assets over the full actuarial costs of pension liabilities will remain with the firm and will be either paid back to shareholders or invested in other projects to increase the firm's expected earnings.

If there are any outstanding pension obligations, a pension insurance programme is required to support any unsettled benefit payments. It can therefore be argued that a pension guaranteed fund sell a put option to sponsoring firms by offering them an option to sell pension schemes at the full actuarial costs of pension liabilities to the pension guaranteed fund when the companies are insolvent. Since sponsoring firms have a long position in the option, its value will be greater when pension schemes' assets become riskier. According to Harrison and Sharpe (1983), the optimal asset allocation of occupational DB plans would be 100 per cent investment in equities after they incorporate the value of the put option held by sponsoring firms in the optimization model. If there is no insurance service provided by a pension guaranteed fund, this moral hazard incentive still exists since shareholders are still not liable to pay any remaining pension obligations in the case of bankruptcy.

Although Lucas and Zeldes (2006) and Rauh (2006) find no significant effect of this risk-shifting incentive on the pension asset allocations of US firms, they argue that the actual proportions of equity investment are still higher than the optimal theoretical level. This empirical evidence suggests that there may be some degrees of risk-shifting incentives within US sponsoring firms. In the UK, the risk-shifting incentive tends to be stronger than in the US because there are no statutory rules for UK pension schemes to make mandatory pension contributions if the solvency status of the schemes is underfunded. Extra voluntary contributions to reduce funding deficits of UK pension schemes only arise following consultation with actuaries. The only mechanism to limit the risk-shifting incentive of UK fund managers is through an increase in insurance premiums paid to the Pension Protection Fund when the plan's funding status is worsening. However, the levels of annual pension levies that UK firms will have to pay to the Pension Protection Fund are not directly dependent on the degree of riskiness of pension assets. Therefore, sponsoring firms can significantly increase the riskiness of pension assets without incurring higher regulatory costs.

Another way for sponsoring companies to opportunistically reap benefits from pension schemes is to engage in tax arbitrage opportunities (Bodie et al., 1987; Frank, 2002). This is achieved by leveraging the firms and diverting the proceeds to pension schemes for investment in fixed-income securities. The net financial risk of the firms will not be increased even though firms' debt will increase from such leveraging; instead, they can benefit from corporate tax savings. These savings stem from reduced corporate tax payments created by the debt tax shield from the leveraging and the tax-exempted returns from pension assets. Due to the tax privilege of pension assets, Black (1980) and Tepper (1981) argue that overfunded pension plans should invest a large proportion in fixed-income securities[23] in order to maximize shareholders' value. However, this tax arbitrage investment strategy has a negative effect on the seniority of bondholders. Even though pension claims have lower seniority than senior debts in the case of bankruptcy[24], pension beneficiaries are effectively more senior than bondholders because the proceeds from such bond

[23] Dammon, Spatt and Zhang (2005) further argue that this proposition by Tepper (1981) and Black (1980) can also be applied to the investment policies of DC plans because periodic returns from DC accounts are untaxed until the assets are withdrawn at the date of retirement.
[24] According to the UK bankruptcy court, liabilities of pension schemes are considered as the same seniority of trade credits. They are junior to tax liabilities, the salaries of current employees, and the obligations of secured lenders. Even though pension promises can be viewed as deferred pay, in the case of UK bankruptcy courts they are not explicitly considered as back pay.

issuances have already been paid to the schemes to directly support pension obligations.

Empirical evidence in support of this tax arbitrage incentive is mixed. For example, Petersen (1996) finds that although firms with greater tax payments tend to increase pension asset allocations in bonds, the statistical significance is, in fact, nil due to large standard errors in the estimates. His results are consistent with the findings from Bodie et al. (1987), who identify an insignificant relationship between corporate tax rates and the bond investments of DB schemes. In contrast, Frank (2002) shows a significant positive correlation between the proportion of DB assets allocated to bonds and the level of firms' tax benefits for US firms. In the case of UK corporate DB schemes, this tax saving incentive may be significantly limited because UK firms are free to carry losses back and forth to reduce tax payments in certain periods. The opportunity to do this may explain why Cocco and Volpin (2007) do not find any strong evidence in support of this theoretical prediction.

7.3.3 Changes in pension regulations and accounting standards

It has been argued that changes in pension regulations and accounting standards have had a substantial influence on the asset allocations of occupational pension schemes. For instance, Blake (2001) states that the minimum funding requirement (MFR) and limits on overfunding[25] incentivize UK pension trustees to reduce the variation of pension assets. The International Accounting Standard Board (IASB) has been working on developing changes to the existing pension accounting standards. Historically, pension accounting has mainly been based on the "book value" accounting method. Actuaries and pension trustees have a high degree of flexibility in choosing actuarial assumptions such as expected returns on pension assets, discount rates and mortality rates. Sponsoring companies can also smooth the costs of pension provisions in the company's balance sheet by amortizing any unrecognized actuarial gains or losses. Because existing accounting standards do not

[25] In the UK, there is no tax subsidy on overfunding contributions because the Internal Revenue Service does not want pension contributions to be larger than necessary. However, this limit on overfunding increases the risk of pension schemes being underfunded if financial markets experience a sharp plunge.

tend to reveal the real economic costs of pension schemes, authorities and regulators have been attempting to increase the transparency of pension accounting by introducing the “market value” accounting method on all pension-related items that will be recognized in financial statements.

This change in the accounting standard encourages fund managers to reduce their investment in equities and increase their investment in fixed-income securities. Because this shift in the asset allocation of pension funds results from the attempt to reduce accounting volatility and funding risks, this implies that the asset allocation may not be solely determined by a desire to achieve efficient investment which effectively balances and hedges the risk of pension liabilities. Fund managers, investment advisors and consultants are, therefore, concerned that pension funds may not be able to generate sufficiently high returns to meet pension obligations. The extreme sensitivity of pension accounting to the volatility of market prices may also encourage fund managers to focus excessively on short-term price variations rather than on paying attention to long-term investment outcomes. Instead of choosing appropriate individual securities that provide superior risk-return trade-offs in the long-term, fund managers may be pressurized to choose securities with high short-term expected returns.

Furthermore, accounting manipulation has also been shown to influence the asset allocation of poorly-governed DB pension schemes. Generally speaking, a large pension deficit is not preferable from the viewpoint of plan sponsors because it can lead to additional contributions. This would result in reduced corporate future cash flows and lowered future remuneration and share prices. As Bergstresser, Desai & Rauh (2006) point out, firms may increase investments in risky assets in order to maximize short-term earnings, something which is made possible because a higher proportion of equity investment allows a higher expected asset return assumption to be used in the actuarial estimate of the schemes’ funding status. This manipulation will significantly reduce pension deficits (Gold, 2005). The incentive for managers to opportunistically manipulate actuarial assumptions may also be increased if remunerations are largely associated with the level of share prices. This is because a reported funding position of pension schemes in the financial statement is one of the main factors that investors use to price the value of equity. For example, based on the estimation by Grant, Grant and Ortega (2007), the market value of equity for S&P100 firms should be, on average, reduced by US$2.2 billion if the amortization in pension actuarial gains (losses) were terminated and the actual pension funding status were clearly stated on the balance sheet rather than in the footnotes.

7.3.4 Investment beliefs about the benefits of investments in equities, bonds, and other alternative asset classes

During the 1970s, most UK pension trustees strongly believed that equity investment could provide superior long-term returns that outweighed short-term volatility, and could outperform bond investment returns. For immature, long-duration DB schemes in particular, fund managers tend to invest significantly in equity in an attempt to reduce future contributions. In addition, equity investment is often considered as a way to hedge against long-term inflation. Because the expected net profits of firms appear to increase with the growth of wages and prices in the long run, the nominal market value of equity should at least rise in the long-term to reflect inflationary increases. Equity is also seen as having a longer duration than fixed-income securities. Unlike bonds that have fixed maturity periods, some financial analysts argue that a stream of dividend cash flowing from equity investment has no maturity. This characteristic of dividend streams may be appropriate to support the long-term payments of pension benefits. Due to these strong beliefs about the benefits of equity investment, UK pension assets largely consisted of equities during the 1980s and 1990s (c. 60-70 per cent of total pension assets). With those advantages of equities over bonds in mind, fund managers tend to oppose the implementation of the "market value" accounting approach by arguing that the variation in the prices of equities in the short-term does not reflect the potential high long-term returns.

However, because pension obligations have similar forms of cash flow to fixed-income instruments, some analysts argue that pension assets should be concentrated in government bonds or corporate bonds so that the returns from bond investment would match pension benefits perfectly. Where interest rates are stable over time, long-term fixed-nominal liabilities can principally be hedged either by rolling over the investment in short-term bills or by directly investing in long-term nominal bonds. However, in reality, interest rates vary arbitrarily over time; therefore, investment in short-term bills cannot be used to hedge long-term nominal liabilities. In such circumstances the duration of bond and pension liabilities must be as similar as possible in order to effectively hedge against future changes in inflation and long-term interest rates. The variation in the value of pension assets will, therefore, move closely with the changes in the present value of pension liabilities. Some economists also argue that the large proportion of bond investment for pension schemes is a preferable outcome from the shareholders' point of view because it can reduce shareholders' monitoring costs and the possibility that internal cash windfalls will be misallocated (Jensen & Meckling, 1976). Based on this line of reasoning, bond investments may be more appropriate than equity investments.

Furthermore, it has often been noted that sponsoring companies should not increase the risk of their main businesses by investing a large proportion of pension assets in equities. Even though equities may provide superior long-term returns to bonds, the short-term volatility of equity investment can increase the risk of unexpected pension deficits. The unexpected extra contributions to fund pension schemes can greatly reduce the amount of cash for companies to invest or expand their main operations. Some scholars also argue that shareholders are not willing to take any extra risks with the equity investments of pension schemes. If shareholders wish to be exposed to such risks, they can easily increase the equity allocation in their own investment portfolio. This line of reasoning is based on the suggestion by Modigliani and Miller (1958) which state that shareholders' risk exposure will be similar both when holding equities directly in their personal portfolios and when holding equities indirectly through either companies' pension schemes or their direct investments. Even though in practice there are frictional costs that can invalidate this proposition, such as investors' limited information, the lack of economies of scales in transaction fees, and limited access to certain markets, it is still not optimal for DB schemes to provide such investment opportunities to shareholders because there are many other institutional investors that offer this service on a stand-alone basis with greater transparency.

The asset allocation of Boots’ DB pension scheme provides a good example that supports the arguments favouring bond investment. In 2001, it allocated 100 per cent of its fund assets into fixed-income securities. Recently, however, the company started to consider allocating a certain proportion of its assets into other kinds of financial assets because it is impossible for the fund to find fixed-income securities that efficiently match its 35-year duration of pension liabilities. Pennacchi and Rastad (2011) also show that the liability immunizing strategy is an optimal investment policy for public pension plans because this strategy provides tax savings for governments and avoids the possibility of large surpluses being generated, which could be difficult to share among taxpayers and plan members. However, a large investment of more than 80 per cent of pension assets in government bonds may effectively transform funded public pension schemes into PAYG plans since returns from investment in government bonds that support pension benefits of the funded schemes rely directly on government taxation.

Aside from the main financial asset classes of bonds and stocks, some pension fund managers are currently considering whether they should add alternative financial assets to their portfolios, such as private equity, funds of hedge funds, commodities, infrastructure projects, equities in emerging markets, derivatives, commercial loans, and microfinance products. The main advantage of expanding pension investment in these alternative assets is the diversification of risk. Asset returns for these asset classes do not exhibit a strong correlation with returns of traditional bonds and equities. Kimmis, Gottschalk, Armendariz and Griffith-Jones (2002) show that the correlation of asset returns within developed countries between 1985 and 2002 was around 0.53 while at 0.2, the correlation between developed and emerging countries was much lower. Therefore, when pension schemes include emerging market financial assets in their portfolio, the portfolio frontier will normally shift upward with higher expected returns for a given level of risk. Even though the correlation of asset returns between emerging and developed markets has been gradually increasing in recent decades as a result of global financial integration, the correlation coefficient is still in a low range because international trade cycles are generally imperfectly correlated. The Global Financial Stability Report (2003) also notes that assets in emerging countries are much cheaper than those in developed countries when measured by the price-to-earning ratio or the price-to-book ratios. Investing internationally would provide pension funds opportunities that are unavailable in the home country.

In general, pension funds can have exposure to infrastructure projects via investment in listed utility firms or through investment in specialised private equity funds. Therefore, very few UK pension schemes directly invest in infrastructure projects or form partnerships with unlisted infrastructure companies. A survey conducted by Mercer, a consultancy firm, shows that only 0.7 per cent of UK pension schemes invest directly in infrastructure projects. The proportion of asset allocations in this asset class ranges from only 1 per cent to 2 per cent. This level of investment is very low compared to the total value of UK infrastructure projects[26].

In the case of derivatives contracts, UK pension funds normally use these instruments as a hedging tool so as to avoid adopting a naked speculative position. For example, the put option of a market index may be used as a means of portfolio insurance. However, futures contracts have not widely been used by UK pension funds because pension trustees tend not to have a clear understanding about how futures contracts function, and they often view these contracts as “gambling” instruments. The investment of pension schemes in warrants and options is also constrained for the same reason. However, forward rate agreements (FRAs) appear to be prevalent in UK pension funds because they are used to hedge the currency risk. Interest rate swaps have also become increasingly attractive to fund managers who desire to increase the duration of pension assets with some form of inflation hedging. Capelleveen, Kat and Kocken (2004) construct a quantitative model to derive an optimal option portfolio for DB pension schemes. They show that options provide an efficient way to reduce the risk of substantial equity holdings. Although risk and return trade-offs of hedge funds increasingly attract many pension funds, Global Financial Stability Report (2004) notes that an actual aggregate amount of pension investment in the funds of hedge funds is still low, at less than 10 per cent of

[26] The capital value of all Private Finance Initiatives (PFIs) and Public Private Partnerships (PPPs) for infrastructure projects in the UK was more than £60 billion by 2007.

total assets. In sum, the investment of UK pension schemes in these alternative asset classes is currently low, at around 5 to 10 per cent.

7.3.5 The characteristics of pension liabilities

Another key factor that tends to determine how pension funds allocate their assets is the characteristics of pension liabilities. Liabilities of DB schemes are principally linked with future labour earnings such as final salary schemes or average salary schemes. Some companies also offer pension benefits that are indexed to inflation. Therefore, pension fund liabilities are highly uncertain in terms of both timing and the absolute amount, implying that sponsoring companies are exposed to the risk of nominal and real changes in the level of labour earnings. Because pension liabilities are usually denominated in real terms, it is necessary for pension assets to be invested in financial assets that can generate positive real returns and provide a hedge against an increase in inflation. A direct financial asset that serves this function is an inflation-protected government bond. A significant proportion of equity and real estate investments can only provide a partial hedge against inflation. As argued in Bodie (1976), equity investment is not a reliable financial instrument for inflation hedging because long-term real returns of equities are not actually less risky than the short-term volatility of nominal returns. The belief amongst investment practitioners that stocks can hedge inflation stems from the perception that nominal stock prices tend to move proportionally with inflation. However, many economists have shown that stock returns are not significantly correlated with inflation in the long-term.

Rather than providing a hedge against inflation, there is ample evidence which shows that equity investments can be used to hedge against an increase in labour wages in the long-run. Even though wage growth and equity returns appear to have no significant correlation in the short run, as Goetzmann (2005) has found for the case of annual returns, the long-run positive significant correlations between these two variables have been identified by many researchers (e.g. Benzoni, Collin-Dufresne & Goldstein, 2007; Cardinale, 2004). The main reason for these insignificant short-term correlations is that the volatility of equity returns in the short run is far higher than the volatility of labour earnings. The strong positive correlations between consumption growth and dividend growth in the medium and long term, as shown in Bansal and Yaron (2005) and Hansen, Heaton, and Li (2005), also shed some light that returns from equity investments (capital gains and dividends) can compensate for an increase in labour earnings. Giles (2004) presents evidence that the growth of the present value of future profits is strongly correlated (more than 80 per cent) with the growth of future salaries. Consequently, he argues that profit-linked securities such as equities are one of the main assets that can efficiently hedge an increase in labour wages. Geanakoplos and Zeldes (2010) also argue that the long-term correlation between real wage growth and equity returns is due to the mean reversion characteristic of these two variables.

With regards to this strong relationship between labour earnings and equity returns, Lucas and Zeldes (2006) show that the optimal investment strategy of DB pension schemes containing a high proportion of young active workers should include a significant fraction of stock investments, so as to hedge against the evolution of salary-linked pension liabilities. They find that the optimal share of equity investment will dynamically decline as the average age of plan members increases. This is true even when it is assumed that future wages will decline proportionally to the increasing value of current pension accruals, as proposed by Bulow (1982)[27]. Sundersan and Zapatero (1997) also provide an optimization framework to derive pension investment policies from the model which links the variations in wage growth with the levels of pension benefits. As sponsoring firms attempt to equate the expected value of employee compensations from current wages and pension benefits to the expected marginal productivity of workers, they find that the optimal proportions of equity investment increases with wage elasticity. In other words, the greater the labour earning risk is, the higher the equity allocation will be in the replicating portfolio, in order to match the variation of pension liabilities. Because labour-earning risks will be largely resolved when workers approach retirement, the equity allocations of pension assets should then decline. Peskin (1997) also supports this view, showing that large equity allocation is optimal for immature public

[27] Bulow (1982) proposes that the combined compensation of current wages and current accrued pension benefits should equal the marginal product of labour. Therefore, future real wages should decline to offset the increasing value of pension accruals.

pension funds. However, Smith (1998) argues that although equity returns and labour earnings are strongly correlated, growth of earnings per share will not necessarily be strongly associated with the growth of wages per employee. Heaton and Lucas (2001) also find that permanent wage shocks and equity returns are positively correlated at only 0.2 per cent.

Apart from the inflation and wage-related aspect of pension liabilities, the portfolio distributions of pension funds also tend to be influenced by the degree of maturity. There are two main measures commonly used to represent the maturity of pension liabilities, namely the ratio of retired to active members and the duration of pension liabilities (an average time used to discount future pension obligations). When a fund matures with a large proportion of pension benefits expected to fall due in a short period of time, the certainty of investment returns become an important feature. Bond investments that can generate risk-free cashflow appear to be more appropriate in this situation. As a consequence, a lifecycle investment strategy that shifts the allocation of assets from equities into bonds as fund members age has often been proposed by both investment advisors and economists. For instance, Blake (1999) proposes that pension funds with very long-dated pension liabilities should generally invest in equities because the duration of dividend streams are long and, in the long run, equity tends to generate better risk-adjusted returns than bonds. He also shows that the optimal portfolio distribution for pension funds with a high fraction of retired members is a liability-immunizing portfolio that consists largely of conventional bonds and inflation-link bonds. Alestalo and Puttonen (2006) also document that Finnish DB pension schemes reduce equity exposures and increase fixed-income exposures as the age structure of policyholders exhibit a more mature age profile. Gerber and Weber (2007) present evidence that investments in real estates and equities of Swiss DB schemes are negatively correlated with the increasing fraction of retired members, while the proportion of investments in short-term money markets and other liquid assets increases. A reduction in real estate investment may result from the fact that this investment cannot be liquidated instantly when pension funds require cashflow to pay pension promises. In sum, these findings tend to indicate the considerable influence of the members' age structure on the strategic investment policies of DB pension schemes. Due to this causality, pension funds not only have to maximize the risk-adjusted returns of their assets, they must also manage the duration of pension assets in order to comply with the constantly changing maturity structure of pension liabilities.

Overall, a decline in the proportion of equity investment as the maturity of pension obligations increases does not stem from the fact that the investment horizons have been reduced. On the contrary, it is because the benefits of equities in hedging the risks of labour earnings have declined significantly. This lifecycle investment of pension assets is also consistent with the theoretical derivation of household portfolios shown in Bodie et al. (1992), Gomes and Michaelides (2005), and Cocco et al. (2005), who incorporate labour income risks into the model. Moreover, DB pension schemes need more liquidity when the duration of pension obligations is shortened. Investment in fixed-income securities can provide safe and sure periodic streams of returns to support large pension accruals. Therefore, the shift from equities into bonds does not actually contradict the investment hypothesis proposed by Samuelson (1965) and Merton (1969), who argue that investment horizons should be independent of optimal asset allocations.

7.3.6 Implementation of the asset-liability model (ALM)

Because of the need to balance the returns of pension assets with the cash outflows of pension obligations, pension fund managers have increasingly employed the asset-liability optimization technique. According to the Society of Actuaries, the ALM is defined as “the ongoing process of formulating, implementing, monitoring and revising strategies related to assets and liabilities in an attempt to achieve financial objectives for a given set of tolerances and constraints”. This technique is sometimes known as ‘solvency risk management’ or ‘portfolio insurance’ (Leibowitz, 1986; Kritzman, 1988; Bodie, 1991). It extends the Markowitz asset-only optimization framework by quantitatively including the variations of pension liabilities in the model in order to derive optimal asset allocations. According to the traditional Markowitz mean-variance framework, the optimal asset allocation is derived to maximize risk-adjusted returns. The risk measure in this framework is often represented by the ratio of the standard deviations of asset returns to the degree of risk aversion of individuals. This means that the Markowitz optimization framework only considers asset-side risks without taking into account any pension liability variations. Therefore, it may not be rational to use this strategy as the main investment paradigm for pension schemes where the main objective is to generate adequate returns to meet pension obligations rather than to generate superior investment returns.

In relation to the ALM framework, it can be seen that pension schemes take a long position on the fund’s assets and a short position on the fund’s liabilities. As a result, the key risk measure that should be considered is either the funding ratio between the value of pension assets and liabilities (Daykin, Pentikainen and Pesonen 1991) or the difference between those two values (Mulvey & Vladimirou, 1992). Instead of maximizing asset returns for a given level of asset risks, the ALM attempts to derive asset allocations that maximize asset returns while minimizing the probability of the plan’s underfunding. Many pension schemes have increasingly been implementing the ALM in recent years. A survey by Greenwich Associates showed that around 30 per cent of US pension schemes had employed the ALM by the end of 1990 (Blake, 1992). An overview of the advantages of the ALM can be found in Leibowitz, Kogelman and Bader (1994).

Principally, the ALM technique has led to a system of optimal asset allocation which is different from the traditional Markowitz mean-variance framework. Some financial assets that may be perceived as high risk in the mean-variance framework may be considered risk-free when considered in relation to the movement of liabilities. As Sharpe and Tint (1990) shows, the optimal asset allocation from the ALM deviates significantly from the mean-variance framework. Moore (2004) further notes that pension asset allocation composed of two-thirds equities and one-third bonds exhibits a volatility of around 12.5 per cent in the mean-variance framework but a significantly higher 17 per cent in the ALM framework. He finds that an increase in the volatility within the ALM of around 60 per cent is due to the duration mismatch.

There are two main investment strategies for the ALM; an immunization strategy (Redington, 1952) and a portfolio insurance strategy (Leland & Rubinstein, 1988). The immunization strategy is a type of investment that eliminates funding risks by investing in financial assets that generate sufficient cashflow to meet the fund's obligations in each period. According to this immunization perspective, pension assets will consist mainly of a bond portfolio which has been constructed to match perfectly with the projected fund's liabilities in terms of cashflow, interest rates, and duration. In contrast to this strategy, the portfolio insurance strategy refers to an investment that attempts to maximize the upside potential of assets while limiting the downside risk at a certain level. This limited downside can only be achieved at the cost of eliminating some upside potential. The limit on the upside does not necessarily cause significant concern because any superior returns generated by the fund's assets cannot be realized and distributed to shareholders of sponsoring companies without incurring substantial tax charges. Therefore, it is more beneficial for pension schemes to reduce the risk of insolvency than to maximize surpluses. In recent years, the ALM technique has been further extended from a static modelling into a continuous dynamic framework which includes intertemporal hedging elements (Zenios & Siemba, 2006; Detemple & Rindisbacher, 2008).

A range of literature attempts to derive the optimal asset allocation from the perspective of the ALM. Peskin (1997) proves that pension funds will always be fully funded when investing in financial assets where the market value perfectly co-varies with the movement of pension liabilities based on the assumption of the complete market. However, because the capital market is not actually complete, it is impossible to find any asset classes that move perfectly in tandem with pension liabilities. After computing a covariance matrix between the annual changes of pension liabilities and asset returns, Chun, Ciochetti and Shilling (2000) show that well-funded pension schemes should optimally allocate a high proportion of pension assets to financial instruments that have a low correlation with liabilities because these funds can bear high mismatch risk whereas poorly-funded plans should invest predominantly in assets that have high correlations with liabilities, so that the costs of future contributions are reduced. An interesting ALM framework has also been developed by Sundaresan and Zapatero (1997), who derive dynamic asset allocations that can hedge against the surplus risk in the same way as delta hedging in an option portfolio. The “delta” in their framework represents the scheme’s funding ratio. They find that pension asset allocations will optimally move toward an immunization strategy when the funding ratio approaches one. In addition, Campbell and Viceira (2005) show that an easy way to incorporate pension liabilities into the mean-variance framework is to change the objective function of the optimization problem from risk-adjusted returns to pension plan surplus at various points in the future. A more rigorous approach may include a specification of the marginal costs of underfunding which may be varied according to the different states of the world. For example, the marginal costs of shortfalls during the time when the plan sponsors currently experience financial distress may be higher than in other periods.

Cepelleveen et al. (2003) also use the ALM framework to derive an optimal investment policy that includes options portfolios. They argue that the ALM framework is essential for the derivation because the scheme’s funding status, the average maturities of pension liabilities, and the indexation of pension obligations are all important elements that significantly influence the optimal options strategy. Nevertheless, one main concern about the use of derivatives is the fact that derivatives markets are not sufficiently deep to absorb pension fund investment. Another way for pension funds to efficiently achieve a portfolio insurance strategy is to dynamically use money market instruments and repo markets. For example, pension funds may replace risky assets with cash or an immunized fixed income portfolio when the value of risky assets declines below a given trigger point, thereby reducing the risk of further shortfalls, before swiftly switching back to risky assets as soon as their value rebounds from their lowest point, so as to gain additional returns. This portfolio insurance strategy is often called a contingent immunization strategy. The switching of investments between financial assets with high and low duration can also be used to make the duration of aggregate pension assets continuously match the duration of liabilities.

Instead of constructing a funding risk measure as the main objective variable within the ALM framework, another appropriate strategy is to separate total pension liabilities into a liability index of active and retired members. In terms of value and timing, the liability index of retired members has no uncertainty. Therefore, a proper bond portfolio that could perfectly hedge against this portion of pension liabilities can easily be formulated. This portion of the investment in bonds is passive in that the bonds are held until maturity. In contrast, the liability index of active members is more uncertain and involves several risk factors, including inflation risks, labour earning risks and mortality risks. As a consequence, the hedging of this component of pension liabilities requires a quantitative process to derive dynamic asset allocations that could match or outperform liabilities. The combination of these two different investment strategies is often called a Dedication and Immunization strategy.

However, since the ALM requires an analysis of the historical time-series data of financial asset returns, some alternative asset classes that have limited availability to historical data such as private equity funds, infrastructure projects, or financial assets in some emerging countries, may be discouraged (Myners, 2001). Moreover, a full actuarial valuation of pension liabilities is often conducted on a triennial basis. Therefore, fund managers have a tendency to inaccurately estimate the impact of the variation of pension liabilities within the scheme funding status during the period between the actuarial revaluations. Due to the difficulty in recalculating the value of pension liabilities, they may focus only on the performances of pension assets when making investment decisions.

7.4 The datasets used in this analysis

This section describes the main datasets and the pension accounting standard that UK firms are obliged to use when disclosing information about their occupational pension schemes in their annual reports. The research in this chapter is based mainly on the two main datasets that provide information about the asset allocation of UK pension schemes, namely the MQ5 survey data from the ONS and the annual reports of firms listed on the main market of the London Stock Exchange. The MQ5 survey data comprises the UK official pension statistics, acquired from a sample covering around 340 pension schemes in the UK. The number of pension plans included in this dataset is more than the PPF database because the MQ5 survey data does not exclude the schemes of local authorities and public corporations. Because this dataset has been updated annually since 1962, changes in the asset allocation of superannuation and self-administered pension funds can be analysed over a long period of time. The main statistics obtained from the MQ5 survey data include the market value of aggregate pension portfolios invested in a variety of financial asset classes, the aggregate dollar amount of net asset purchases, and the aggregate amount of pension contributions and pension benefit payments at the end of each year. However, this dataset only provides a rough picture of the potential relationship between demographic structures and the investment behaviour of pension schemes because the number of observations is too low for the analysis to yield robust results. As a consequence, the other main dataset used in this analysis is taken from corporate DB pension schemes of firms listed in the FTSE100 index between 2006 and 2011.

In the UK, firms listed on the financial markets are required to disclose information about their occupational pension provisions in their annual report. The first pension accounting standard in the UK was the SSAP24, which was established in 1988. However, the SSAP24 has been criticized on the grounds that it provides an excessive degree of flexibility to firms when they recognize pension costs on their balance sheet. The disclosure requirements of the SSAP24 could not ensure clear explanations for all aspects of DB pension schemes. Therefore, this accounting standard was replaced by the FRS17 in June 2003. This new accounting standard is mainly based on the international accounting standard IAS19. They are very similar in many ways, with the only exception being that the FRS17 explicitly specifies the yield on AA-rated corporate bonds which have similar maturities to those of pension obligations as the discount rate used to price pension obligations. In contrast, the IAS19 only states that the discount rates are required to comply with the yields on high quality corporate bonds. If the corporate bond market is proved to be insufficiently deep, yields of government bonds can be used instead.

Although the FRS17 was initially implemented in June 2003, in 2005 only 25 per cent of firms in the FTSE100 and 19 per cent of firms in the FTSE250 fully complied with the standard (O’Brien et al., 2009). UK firms were required to make the FRS17 disclosure from January 2005 onwards because this was the first period when all listed firms in the EU were required to adopt the IAS19. In order to obtain reliable information about occupational pension schemes that can be meaningfully compared, the research in this chapter only includes a sample of firms in the FTSE100 in the period 2006-2011. All firms that were members of the FTSE100 index in the sample period are included in the sample, even though some of the companies may have been excluded from the index in certain years. The sample does not include firms which do not provide DB pension schemes to their employees, firms which do not provide reliable information about their DB pension schemes, and firms which have been unlisted from the market due to acquisition or bankruptcy. The remaining number of unique firms included in this analysis is therefore 106. For the firms that publish their financial statements in currencies other than the GBP, the dollar amounts of each financial item will be converted to the GBP by using currency rates at the end of their respective financial year[28]. The large sample size of this panel data can provide sufficient degrees of freedom for a panel regression analysis in order to yield reliable statistical estimates. Another key benefit of this panel data is that the time period of the sample used in this analysis (2006-2011) does not cover a period where there was any significant change in accounting standards or pension regulations. Therefore, the influence of accounting and regulatory frameworks on the investment behaviour of pension schemes can be controlled for.

Under the FRS17, detailed information about actuarial assumptions and the realization of all pension-related expenses and income of occupational pension schemes must be disclosed in the footnotes of the financial statements. In terms of the accuracy of the measurement, the main pension data of concern is the value of pension liabilities because the market value of pension liabilities is unavailable. In accounting terms, these liabilities can principally be measured by three main standards: vested, accumulated, or projected benefit obligation. Both the Vested Benefit Obligation (VBO) and the Accumulated Benefit Obligation (ABO) represent an immediate terminated value of pension liabilities accrued from past employment

[28] The financial year for FTSE100 firms may be different. For example, the financial year of Amec PLC (AMEC) ends in December, while the financial year of Associated British Foods PLC (AFB) ends in September.

contracts. The only real difference between the VBO and the ABO is that the latter includes all accrued pension benefits regardless of the vested condition. Although these two measures tend to comply with other accounting terms because they only represent accrued benefits from previous financial years, they may not accurately represent the actual value of pension obligations that firms will have to incur in the future. Because the VBO and ABO do not take into account the effect of future wage growth or inflation, these two measures do not consider pension schemes as on-going entities. Therefore, the Projected Benefit Obligation (PBO) is used as the main liability measure of the FRS17 accounting standard.

The PBO considers increases in future compensation at the time of employees' retirement. In order to make this liability measure compatible with other accounting numbers, projected salary levels are used with the current length of employment tenure rather than with a projection of the expected future periods of employment. As a result, the PBO measure recognized in the previous year will be accumulated by an additional unit of pension entitlements in the current financial year. These additional pension entitlements are referred to as "Current service costs". If there are any amendments to the benefit formula of the schemes which lead to additional costs (or gains) in previous financial years, companies will have to recognize these additional items on a straight-line basis until they are completely vested as "Past Service Costs". Any curtailments or settlements of schemes during the financial year are recognized separately as a "Curtailment/Settlement Item"[29].

The PBO measure normally includes some measurement errors because it is calculated from a range of actuarial assumptions such as future wage growth, future inflation and policyholder life expectancy. Misestimation in these assumptions can undermine the reliability of this measure. However, Barth (1991), using econometric models to study the appropriateness of different pension assets and obligation measures, shows that the market value measures of pension assets and the PBO measures disclosed in the footnotes of financial statement are more reliable and relevant for investors' valuation than the numbers recognized in the balance sheet,

[29] The curtailment refers to an amendment that involves a reduction in the number of plan beneficiaries whereas the settlement refers to the elimination of certain legal obligations.

which tend to be distorted by the amortization rules of unrecognized actuarial gains (losses)[30]. Barth (1991) further finds that the PBO measure calculated by using both salary progression rates and a productivity component exhibits significantly less measurement error than the ABO measure. This result is consistent with the view that investors consider not only results of past transactions but also future expected wage growth and inflation as one of the main company's current pension liabilities. The appropriateness of the PBO measure in estimating pension obligations has also been supported by Lucas and Zeldes (2006), Peng (2008) and Munnell et al. (2010). Therefore, rather than using the value of pension assets and liabilities recognized in the company's balance sheet, this paper manually acquires the market value of plan assets, the PBO measures and all other relevant pension accounting measures disclosed in the footnotes as the main variables representing the characteristics of DB pension plans.

With regards to the value of pension assets, the marked-to-market valuation is the main valuation technique of the FRS17. Where there are no market prices available for certain financial assets, a discounted cash flow methodology can be used to obtain the fair value of those assets. The portfolio distribution of pension schemes is also disclosed in the financial statement footnotes. Companies normally classify financial asset classes into five main categories, namely equities, bonds (including corporate bonds and GILTs), real estate, cash (including short-term money market instruments), and others (including derivatives, annuity contracts and other alternative asset classes).

7.5 An analysis to examine the dynamics of DB pension schemes' asset allocation

This section will provide analysis which explains the movement of pension portfolio weights. Principally, asset allocation is directly affected by two main components.

[30] Companies do not have to immediately recognize actuarial gains (losses) accrued during the current financial year. They can amortize these unrecognized gains (losses) over other periods, a mechanism known as the corridor approach. According to this approach, plan sponsors can decide to recognize only a portion of actuarial gains or losses that exceeds the 10 per cent corridor of the asset and liability value in the previous period. The amortization period is equal to the expected average employment length of active employees.

The first component relates to the volatility of asset prices. The relative price changes among different asset classes can change the percentage proportions of investment in certain financial assets even though fund managers may not actively reallocate their investments. For example, when the prices of equities appreciate and the prices of bonds depreciate in a certain period, the investment proportion in equities will automatically increase while the investment proportion in bonds will decline. The impact of this price variation on portfolio weights is often referred to as the ‘passive component’ or ‘free float factor’. The second component that affects investment proportions is the deterministic shift in the asset allocation executed by fund managers. The investment proportion in equity can be reduced by actively selling stocks. This active reallocation of investment proportions to different asset classes normally results from a desire to change the long-term strategic investment policies of the fund. This impact on the evolution of portfolio weights is often referred to as the ‘active component’.

Equation 7.1 mathematically illustrates how those two components influence the holding value of a certain financial asset. The subscription i refers to each financial asset in a portfolio. The subscription t refers to a time period. The parameter h_i is the holding value, $r_{i,t}$ is the rate of returns, and $NI_{i,t}$ is the rate of net investment of a certain financial asset.

$$h_{i,t+1} = h_{i,t} \times \left(1 + r_{i,t} + NI_{i,t}\right) \qquad \text{———— (7.1)}$$

Given this relationship, it is possible that portfolio weights of pension schemes observed in each period could be greatly influenced by the free float component. There is considerable empirical evidence showing that changes in the asset allocations of pension schemes tend to be significantly influenced by asset price variations. For instance, Rauh (2009) finds that the proportions of US pension assets invested in bonds and equities are significantly correlated with short-term lagged investment returns. This implies that an increase in equity weights and a decline in bond weights are a result of short-term high equity returns rather than changes in the strategic investment policies of pension schemes. Bikker, Broeders and De Dreu (2007) also show that the portfolio distributions of Dutch pension funds seem to follow the lagged performance of the stock market. They estimate that Dutch pension funds only rebalance[31] around 39 per cent of their investments, leaving the remaining 61 per cent to be free floated. They also discover that the rebalancing activities of Dutch pension schemes depend on the sign and size of equity returns. For positive equity returns, pension funds increase their rebalancing activities as the size of the returns rises. In contrast, pension funds' rebalancing activity decreases with the size of negative equity returns. This implies that pension funds are less likely to unwind large losses which might have stemmed from investment mistakes.

The lack of short-term pension fund rebalancing in many countries may reflect some frictional costs, such as high transaction fees, behavioural biases from inertia (Thaler, 1980; Samuelson & Zeckhauser, 1988), inattention (Duffie & Sun, 1990), and inappropriate incentive, which is created by a performance evaluation procedure that pressures fund managers to focus on short-term investments. Because of the economy of scales in transaction costs, small DB plans also tend to have a limited degree of short-term rebalancing when compared to large plans. However, some studies find that pension funds actually do attempt to rebalance their investments in the long-term. For example, Weller and Wenger (2009), who analyse the investment behaviour of US public pension plans from 1993 to 2005, find that pension fund managers adjust their investments regularly in order to comply with the long-term strategic investment policy.

In the case of UK pension funds, Blake et al. (1999) show that monthly, short-term changes in asset allocations tend to follow relative short-term performances in different asset classes, even though UK pension funds attempt to partially rebalance their portfolios by allocating new cash flows into asset classes that perform relatively more poorly than others. If this condition holds for the annual changes in portfolio weights of UK pension schemes, it will not be possible to use the annual portfolio weights observed in the dataset to analyse how the shift in the demographic structure

[31] A rebalancing strategy refers to a trading strategy that attempts to keep the proportion of investment in certain asset classes equal to the long-term strategic asset allocation of the schemes. This investment style is sometimes called negative-feedback trading because it entails the selling of assets that experience relatively positive returns and the purchase of other assets that experience relatively negative returns.

of pension members influences the strategic asset allocation of pension schemes. Any significant relationships found from the regression analysis will stem from a contemporaneous relationship, which does not indicate causality. As a consequence, the analysis in this section attempts to prove that the annual changes in the portfolio weights of DB pension schemes in the UK are caused predominantly by the active reallocation intention of fund managers to move strategic investment policies over different periods rather than being influenced by price variation among different asset classes.

7.5.1 Empirical evidence relating to the asset allocation behaviour of UK pension schemes based on the MQ5 survey data

As can be seen from Figures 7.1 and 7.2, the aggregate market value of UK pension schemes invested in GILTs and UK equities tends to move in tandem with the index benchmark. Figure 7.1 uses the 10-year GILTs total-return index to represent the price movement of GILTs' holdings, while Figure 7.2 uses the FTSE-All Share total-return index to represent the movement of UK equities. The main reason for using the total-return index is that this index includes investment returns from dividends and reinvestments. Figures 7.1 and 7.2 seem to suggest that changes in the value of pension holdings may be significantly influenced by the free float component.

Figure 7.1 The market value of UK pension funds' GILTs holdings and the 10-year GILT TR Index

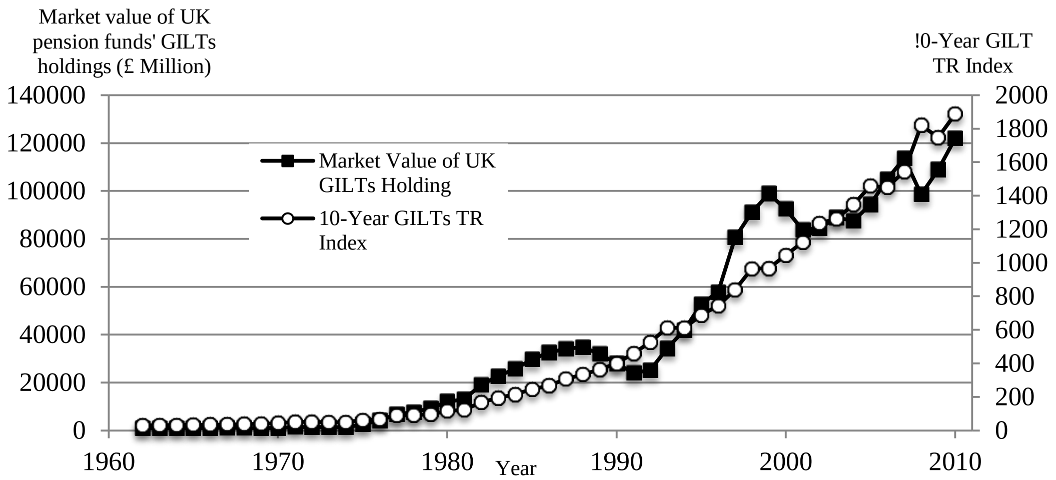
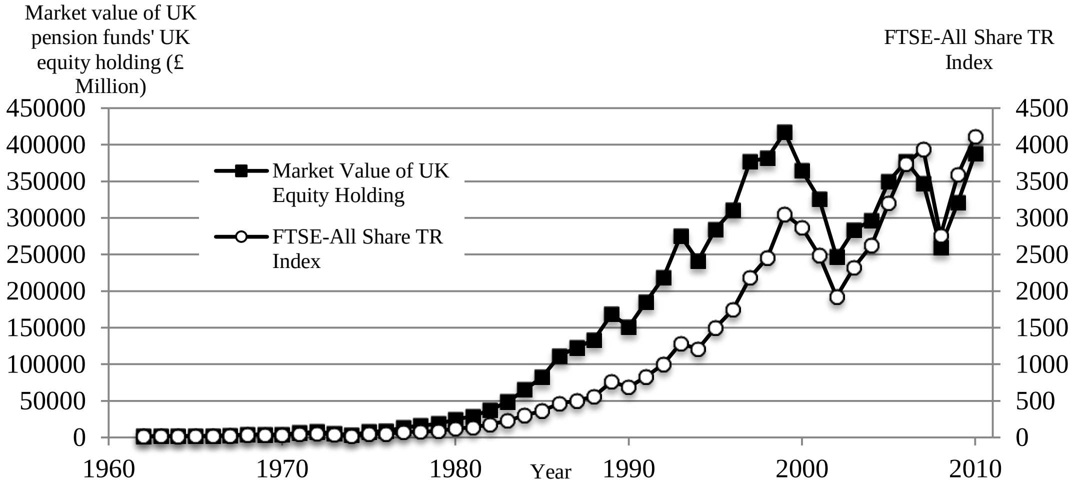


Figure 7.2 The market value of UK pension funds' equity holdings and the FTSE-All Share TR Index



However, Figures 7.3 and 7.4, which depict changes in the aggregate proportions of asset allocations and the evolution of pension schemes' net investments in GILTs and equities, appear to indicate that active trading behaviour has a high degree of influence on aggregate portfolio weights. It can be seen that the positive net investments in UK GILTs between 1976 and 1984 are related to an increase in the portfolio weights of UK GILTs. The negative net investment from the GILTs market between 1987 to 1991 also led to a gradual decline in the investment proportions in GILTs, dropping from approximately 20 per cent to 7 per cent. The large aggregate cash outflows from the UK equity market since 1993 have also led to a reduction in the proportion of equity investments, from approximately 60 per cent in 1995 to only 30 per cent in 2010.

Figure 7.3 The net investment in UK GILTs and the investment proportions of UK pension schemes in GILTs

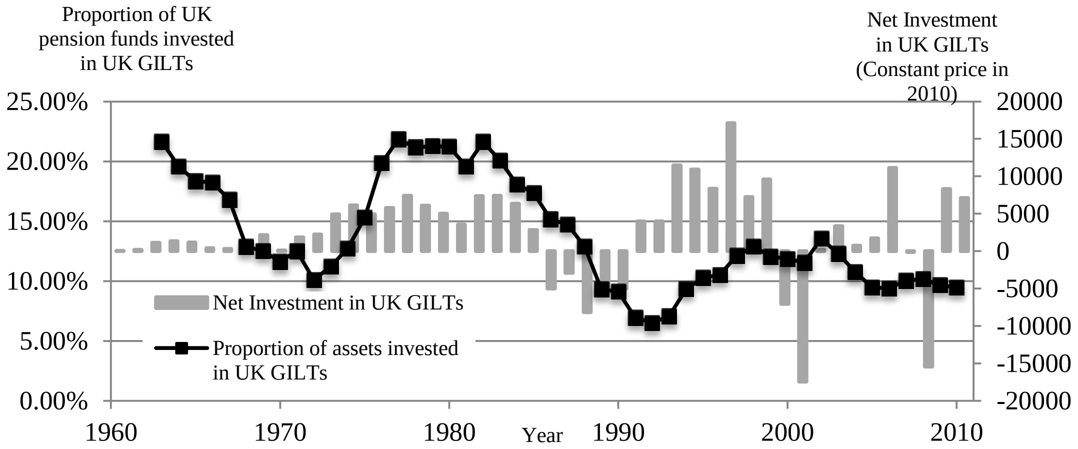
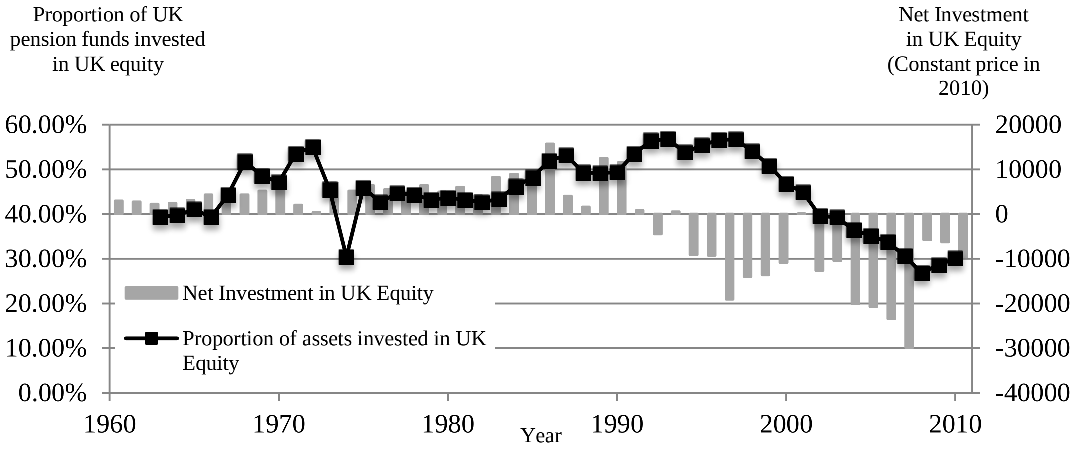


Figure 7.4 The net investment in UK equities and the investment proportions of UK pension schemes in equities



In order to test which components have a higher impact on the aggregate portfolio weights of UK pension schemes, a simple decomposition of Equation 7.1 is necessary. According to the relation in Equation 7.1, it can be rewritten as

$$\frac{h_{i,t+1}}{(A_{t+1})\cdot(A_t)} = \left[\frac{h_{i,t}}{(A_{t+1})\cdot(A_t)}\right] \times \left[1 + r_{i,t} + NI_{i,t}\right]$$

$$\frac{w_{i,t+1}}{A_t} = \left[\frac{w_{i,t}}{A_{t+1}}\right] \times \left[1 + r_{i,t} + NI_{i,t}\right]$$

where A_t is the total value of pension assets and $w_{i,t}$ is the portfolio weight of a certain financial asset. Therefore, the percentage changes in the portfolio weights between each period can be derived as

$$\frac{w_{i,t+1} - w_{i,t}}{w_{i,t}} = \frac{A_t \cdot \left(1 + r_{i,t} + NI_{i,t}\right) - A_{t+1}}{A_{t+1}}$$

$$= \frac{A_t \cdot \left(1 + r_{i,t} + NI_{i,t}\right) - A_t \cdot (1 + r_t + NI_t)}{A_t \cdot (1 + r_t + NI_t)}$$

$$= \left[\frac{r_{i,t} - r_t}{1 + r_t + NI_t}\right] + \left[\frac{NI_{i,t} - NI_t}{1 + r_t + NI_t}\right] \qquad \text{\_\_\_\_\_(7.2)}$$

where r_t and NI_t refer to the rate of returns and the net investment of all assets in the portfolio respectively. From the decomposition in Equation 7.2, the first term of the right hand side represents the impact of the price variation on the percentage changes in portfolio weights while the second term represents the impact of the deterministic portfolio shift. This decomposition makes it possible to estimate the magnitude of the impact of each factor on portfolio weights for each period.

Figure 7.5 illustrates the impact on the investment proportions in GILTs while Figure 7.6 illustrates the impact on equity weights. As can be seen, the impact of the deterministic portfolio shift dominates changes in GILT weights in the periods 1969-1977 and 1987-2001. In other years, fund managers have tended to allow the portfolio weights to move passively with the price variation of GILTs. In the case of equity investment, portfolio weights tend to be largely influenced by the relative returns of equities rather than by strategic net investments. Although this evidence tends to suggest that the portfolio weights of UK pension schemes may mostly be caused by differential returns across different asset classes, the results shown in Table 7.1 appear to indicate a high degree of rebalancing activities, on an annual basis, among UK pension schemes.

Figure 7.5 The impact of relative returns and net investments on the GILT weights of UK pension schemes

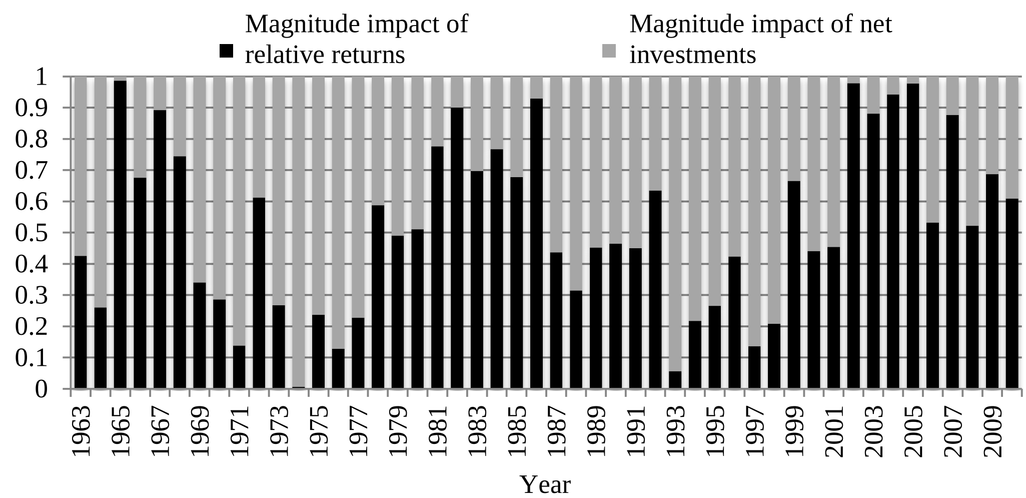


Figure 7.6 The impact of relative returns and net investments on the equity weights of UK pension schemes

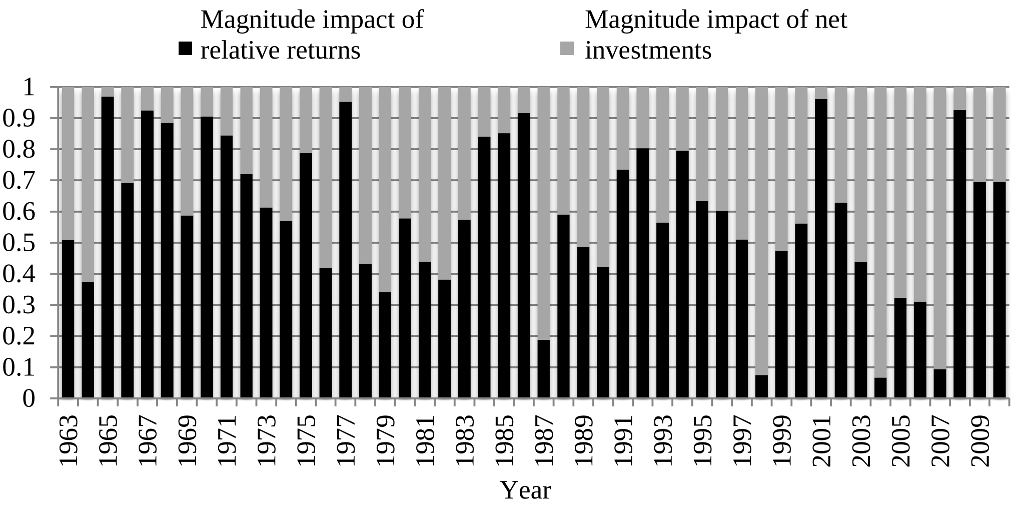


Table 7.1 shows that the mean changes in the portfolio weights of equity investment over the past 48 years are due equally to the mean changes in equity returns and net investment. The mean changes in the portfolio weights of GILTs investment seems to result from the changes in the relative returns of GILTs. However, these estimates of the mean changes of portfolio weights may be confused by the large movement of asset prices in particular years, such as the financial crises of the 1970s and 2008. Although the relative returns of equities dominated the changes in equity weights for 32 years of the period, as opposed to the 16 years that net investment did so, net investments in the equity market went in the opposite direction of equity returns for 16 years out of the 32 years that the relative returns of equities dominate the changes. This evidence indicates that pension fund managers attempted to rebalance portfolio weights when the prices of equities move significantly in either a positive or negative direction. This annual rebalancing strategy is an attempt to adjust portfolio allocations back to their strategic long-term asset weights. There is also a high degree of rebalancing with regards to GILT investments. Therefore, it can be argued that the portfolio weights observed at the end of each year tend to be the weights that comply with the strategic investment policies of the schemes. This result is also consistent with Blake et al. (1999), whose year-on-year cross-sectional analysis shows that UK pension schemes attempt to partly stabilize their asset allocations when relative asset returns of certain asset classes cause the portfolio distributions to deviate from the strategic allocations.

Table 7.1 Statistical results from the simple decomposition of the dynamic of portfolio weights (based on the MQ5 Survey data)

	Equity investments	GILT investments
Total average changes in the percentage of portfolio weight	0.21%	-1.23%
Due to average changes in asset returns	2.50%	-3.19%
Due to average changes in net investments	-2.28%	1.97%
Number of years that		
Net investments dominate changes in portfolio weights	16 (33%)	24 (50%)
Asset returns dominate changes in portfolio weights	32 (67%)	24 (50%)
For the years that asset returns dominate the changes in portfolio weights:		
Number of years that net investments follow the same direction as asset returns:	16 (50%)	7 (30%)
Number of years that net investments go in the opposite direction to asset returns:	16 (50%)	17 (70%)

7.5.2 Empirical evidence related to the asset allocation behaviour of DB occupational pension schemes based on the data from the company accounts of firms in the FTSE100

The previous section provides an analysis of the MQ5 survey data. However, it can only provide evidence on the aggregate movement of the portfolio weights of all UK pension schemes in each year. In order to analyse the investment behaviour of each individual DB pension scheme, the panel dataset from the company accounts of firms in the FTSE100 is used. This panel data enables the examination of the cross-sectional variation in the annual percentage changes of portfolio weights.

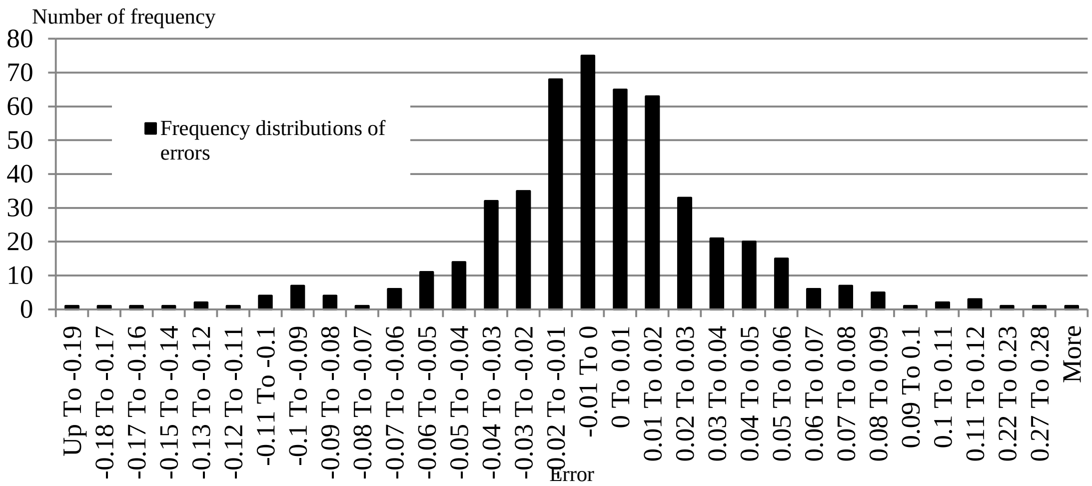
The most important information that cannot be obtained from the footnotes of financial statements is the actual returns of each financial asset that DB occupational pension schemes hold. Although listed UK firms are required to disclose information regarding asset allocations of their DB pension schemes in each financial asset class, they are not required to separately publish the estimates of actual returns generated by each of their asset holdings. According to the FRS17, listed UK firms are only required to disclose the actual returns of total pension assets over the financial year.

These figures can be obtained from the summation of the actuarial gains (losses) on the asset side of the schemes accrued in a particular financial year and the amount of expected return assumptions made by the firms. Principally, actual returns include interest, dividends, capital gains and other returns from pension assets less any costs relating to the fund management, such as management fees, transaction costs and taxes.

In order to approximately estimate the actual returns of each financial asset, benchmark indices are used as proxies for the returns that DB occupational pension schemes receive each period. In the case of equity holdings, the movement of the FTSE-All Share TR index is used. With respect to the actual returns of bond holdings, the movement of the indexed-link GILTs TR index, the GILTs TR indices with different maturities (under 5 years, 5-10 years, 10-15 years, and over 15 years), and the iBOXX GBP corporate bond TR index are used. For real-estate investment, the returns of the FTSE All UK property TR index are used as a proxy for actual returns. The movement of the UK Treasury bill TR index is used for the returns of cash holdings. The nominal return index is not used as a proxy for actual returns because it only includes returns from capital gains, which is just one element of investment returns. The use of this set of external indices as a proxy for actual returns of pension asset holdings should not post significant biases in the estimates because the performances of UK pension schemes have been shown to be highly correlated with the returns of market benchmark indices. For instance, Tonks (2005) presents statistical comparisons between the performance of UK pension schemes and the variation of market benchmark indices. Based on the quarterly return data from WM Company, he finds that the cross-sectional average return of all UK pension funds was 4.32 per cent, which was closely similar to the returns of the FTSE-All Share index at 4.38 per cent. He also shows that the time-series correlation between the quarterly returns of the FTSE-All share index and those of pension schemes is significantly high, at 0.995. Blake et al. (2002), who provide statistical estimates of the cross-sectional monthly return distributions of UK pension schemes, also show that the difference in the actual equity returns of pension schemes between the 5th and 95th percentiles is just less than 400 basis points. Actual returns of most UK pension funds tend to be tightly packed around the mean. In addition, Blake et al. (2002) find that the median fund manager generates investment returns that are just 10 to 15 basis points away from the returns of the benchmark index. The alpha estimates of abnormal performance (based on the Christopherson-Ferson-Glassman model) are both economically and statistically negligible.

The variation of the errors between the returns of all pension assets calculated by these indices and the actual return estimates of all pension assets as disclosed in financial statement footnotes is illustrated in Figure 7.7. It can be seen that the performances of most DB occupational pension schemes closely cluster around the returns of the benchmark indices. Very few pension schemes generate investment performances that deviated significantly from the benchmark, a result which is consistent with Blake and Timmermann (2002). Nevertheless, the number of DB schemes that is included in the sample for this analysis will be truncated at 2 percentage point errors in either direction. This truncation is an attempt to reduce the biases from the analysis. The final number of observations is 202 over the 5-year periods.

Figure 7.7 The distribution of observations based on the errors between the total pension asset returns calculated from the benchmark indices and the actual returns as disclosed in financial statement footnotes



Tables 7.2 and 7.3 provide results from the simple decomposition of Equation 7.2 on the annual percentage changes of pension portfolio weights. Table 7.2 shows that the impact of relative returns on equities significantly dominates the variation in equity weights in 2008 only. This result is unsurprising because of the financial crisis

during this period. In other years, the deterministic shift in net investments executed by pension fund managers tended to dominate the changes in the proportion of equity investment. The correlations between the annual changes in equity weights and the annual net investments are high, at around 80-90 per cent. For the years that equity returns dominate the changes in equity weights, the direction of net investments appears to be in the opposite direction to equity returns. This evidence is an indication of the rebalancing activities performed by the majority of pension fund managers. Table 7.3, which shows the evolution of portfolio weights in the bond investment, also provides the same results. Annual changes in the proportion of bond investments tend to be caused largely by the active investment decisions of fund managers, rather than by the differential returns among different asset classes.

Table 7.2 Statistical results from the simple decomposition of the dynamic of equity weights (based on the panel data of firms listed in the FTSE100)

	2007	2008	2009	2010	2011
Number of firms	54	54	44	57	62
Total average changes in the percentage of equity weights	-6.99%	-12.71%	-2.08%	2.69%	-7.03%
due to average changes in asset returns	1.57%	-12.78%	1.65%	5.48%	-2.85%
due to average changes in net investments	-8.57%	0.15%	-3.69%	-2.48%	-4.26%
Correlation between changes in the equity weights and					
changes due to asset returns	0.3076	0.2865	0.4863	0.0541	0.1317
changes due to net investments	0.9801	0.8256	0.5416	0.9819	0.8589
Number of firms where					
net investments dominate the changes in equity weights	44 (81.48%)	7 (12.96%)	15 (34.09%)	32 (56.14%)	30 (48.39%)
asset returns dominate the changes in equity weights	10 (18.52%)	47 (87.04%)	29 (65.91%)	25 (43.86%)	32 (51.61%)
For firms where asset returns dominate the changes in equity weights,					
number of firms in which net investments follow the same direction as asset returns:	5 (50.00%)	22 (46.81%)	9 (31.03%)	8 (32.00%)	21 (65.63%)
number of firms in which net investments go in the opposite direction to asset returns:	5 (50.00%)	25 (53.19%)	20 (68.97%)	17 (68.00%)	11 (34.37%)

Table 7.3 Statistical results from the simple decomposition of the dynamic of bond weights (based on the panel data of firms listed in the FTSE100)

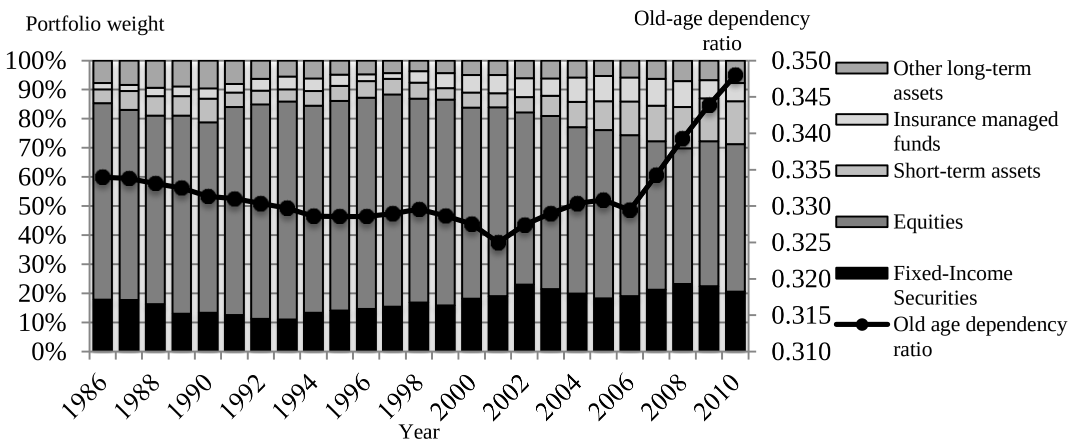
	2007	2008	2009	2010	2011
Number of firms	54	54	44	57	62
Total average changes in the percentage of bond weights	14.25%	13.55%	4.59%	2.70%	6.15%
due to average changes in asset returns	-2.77%	17.10%	0.78%	-4.91%	4.49%
due to average changes in net investments	17.00%	-3.18%	3.66%	7.60%	1.62%
Correlation between changes in the bond weights and					
changes due to asset returns	0.1874	0.2584	0.6131	0.1349	0.2282
changes due to net investments	0.9926	0.8894	0.5435	0.9506	0.9030
Number of firms where					
net investments dominate the changes in equity weights	47 (87.04%)	17 (31.48%)	17 (38.64%)	34 (59.65%)	33 (53.23%)
asset returns dominate the changes in equity weights	7 (12.96%)	37 (68.52%)	27 (61.36%)	23 (40.35%)	29 (46.77%)
For firms where asset returns dominate the changes in bond weights,					
number of firms in which net investments follow the same direction as asset returns:	4 (57.14%)	15 (40.54%)	9 (33.33%)	7 (30.43%)	11 (37.93%)
number of firms in which net investments go in the opposite direction to asset returns:	3 (42.86%)	22 (59.46%)	18 (66.67%)	16 (69.57%)	18 (62.07%)

The annual rebalancing activities of pension fund managers described in this section reflect the “calendar rebalancing strategy”. As shown by Blake et al. (2002), even though the monthly changes in the portfolio weights of UK pension schemes tend to be influenced largely by differential returns among different financial asset classes, the findings from this analysis provide further insights that UK pension fund managers attempt to readjust the portfolio allocation annually in order to make it comply with the long-term strategic weights. This evidence implies that the annual changes in the asset allocation of DB occupational pension schemes obtained from the company accounts of FTSE100 firms should represent the strategic shifts of long-term investment strategies rather than passive changes resulting from the free float component. Therefore, asset allocations observed at the end of each financial year can be used to robustly test the extent to which the investment policies of DB pension schemes are influenced by the shift in the demographic structure of pension members. A panel regression analysis will be presented in the next section in order to test this causality.

7.6 An analysis to examine the relationship between the investment principles of DB occupational pension schemes and the demographic structure of plan members

In this section, a panel data regression is conducted to statistically estimate the investment behaviour of DB occupational pension schemes. The main factor that this analysis attempts to investigate is the impact of the shift in demographic structures of plan members on the portfolio distributions of pension schemes. A rough illustration of the relationship between the pension schemes' portfolio distribution and the dynamics of the old-age dependency ratio can be seen in Figure 7.8. The sharp rise in the old-age dependency ratio appears to be related with a decline in the equity weights of UK pension assets. Investment in short-term assets and fixed-income securities has gradually increased since the 2000s. Therefore, if demographic patterns do actually have a significant relationship with the investment proportions in equities or bonds, this result will provide additional evidence which supports the proposed hypothesis that the significant relationship between the demographic variables and the financial market observed since the 1960s may be caused by the investment behaviour of pension funds.

Figure 7.8 Asset allocations of UK pension schemes and the old-age dependency ratio



With regards to the investment strategy of corporate DB pension funds, some researchers argue that a number of firm-specific factors, such as the level of the firm's credit ratings, the level of the firm's debt-to-equity ratio, and the cyclicality of the firm's cash flows, may influence the portfolio distributions of pension assets. For example, Petersen (1996) finds that profitable firms with high certain cash flows tend to have a significantly larger proportion of pension assets invested in equities. In contrast, firms with greater cyclicality in earnings tend to have a lower proportion of stock investment. These results are consistent with both Froot, Scharfstein and Stein (1993) and Lucas and Zeldes (2006). Rauh (2009), however, finds that US firms tend not to adjust the pension portfolio allocation in order to comply with the characteristic of cash flows generated by their operating assets.

In the case of firms that have a tendency to experience financial distress, it is argued that pension assets should not consist of a high proportion of equity because these firms should seek to reduce the probability of financial distress in order to increase shareholder value (Mayers & Smith (1982); Smith & Stulz (1985)). Rauh (2006) finds that the pension asset allocation of US firms with low credit ratings tend to have low equity weights and high bond weights. This empirical result may stem from the fact that credit rating agencies tend to prefer an immunizing strategy: the more closely pension assets can match pension liabilities, the higher the likelihood that rating agencies will increase credit ratings assigned to sponsoring firms. A theoretical model constructed by Almeida, Campello, and Weisnach (2011) also shows that the risk-shifting incentive will be limited in the underfunded pension schemes of firms that have a strong likelihood of survival. Results from those research papers imply that the risk management to limit the probability of financial distress tends to dominate the risk-shifting incentives suggested by Sharpe (1976) and Treynor (1977). However, contradicting these results, Cocco and Volphin (2007) find that the DB pension schemes of highly leveraged UK firms are more likely to allocate higher proportions of pension assets in risky assets. The high degree of risk-shifting behaviour among UK firms may be owing to the fact that they are not required to pay mandatory contributions when pension schemes are underfunded. British firms are required to fully fund pension schemes only when they plan to close all DB pension liabilities. This legislation was first implemented by the Labour government in 2003.

Given the mixed results found by many researchers, the effect of corporate decisions on corporate pension policies appears to be an empirical issue rather than a causal relationship. Since this chapter attempts to investigate the influence of the variation in the schemes' characteristic on the portfolio distributions of corporate DB pension schemes, the explanatory variables included in the panel regression analysis are the demographic structure of pension members, the size of pension schemes as measured by the present value of pension obligation, and the solvency status of the schemes as measured by the ratio of pension assets to pension liabilities. The main dataset for this analysis has been manually obtained from financial statement footnotes of FTSE100 firms. This analysis will include only those firms that provide funded DB occupational pension schemes. Any unfunded liabilities offered by firms to their employees will be subtracted from the measure of total pension obligations. Since UK firms are not required to disclose the age structure of their employees, a proxy for this estimate will be constructed. The following section will discuss the maturity measure used in this paper which is used as a proxy for the demographic pattern of policyholders. It will also show the appropriateness of this measure to accurately represent the old-age dependency ratio.

7.6.1 The maturity measure of pension liabilities used as a proxy for the demographic patterns of policyholders

A range of measures can be used to represent the movement of the age structure of pension members. Most researchers tend to use the ratio of pension benefits within a particular financial year to the present value of total pension obligations. The reason for this is that a higher proportion of retired members relative to the fraction of active members will be associated with the higher portion of pension benefit payments relative to the total liabilities, which include the pension obligations of both active and retired policyholders. However, since this measure incorporates the present value of pension liabilities, using this measure to compare different firms may not yield meaningful results because calculating the present value of pension obligations requires a number of actuarial assumptions. Sponsoring firms can subjectively decide the level of inflation rates, discount rates, mortality rates, and rates of increase in salaries and pension payments. Marginal differences in these actuarial assumptions can lead to a significant difference in the present value of pension obligations. For instance, Gohdes and Baach (2004) show that a marginal variation of discount rates of just 1 per cent could change the reported value of pension obligations by as much as 15 per cent. Bozewicz (2004) argues that this level of sensitivity is too low, suggesting that the sensitivity of pension liabilities on discount rates should be around 12 per cent for each 0.5 per cent variation in the discount rates. A recent study by Record (2006) on UK public sector pension schemes also finds that the value of pension liabilities varies by 18 per cent per 1 percentage point change in the discount rate. Therefore, the differences in the maturity measure in different firms can be the result of using different actuarial assumptions, even though the real economic value of pension obligations is similar.

Other researchers may use the sensitivity of the discount rate assumption as the measure of the maturity of pension liabilities. This is because the longer the duration of pension obligations, the higher the sensitivity of pension obligations to changes in the discount rate assumption will be. Theoretically, the duration is dependent on the ratio of retired to active members. However, listed UK firms are not obliged to disclose the sensitivity analyses of their pension obligations. Therefore, if this maturity measure is used in this analysis, the number of observations in the regression analysis will greatly be reduced.

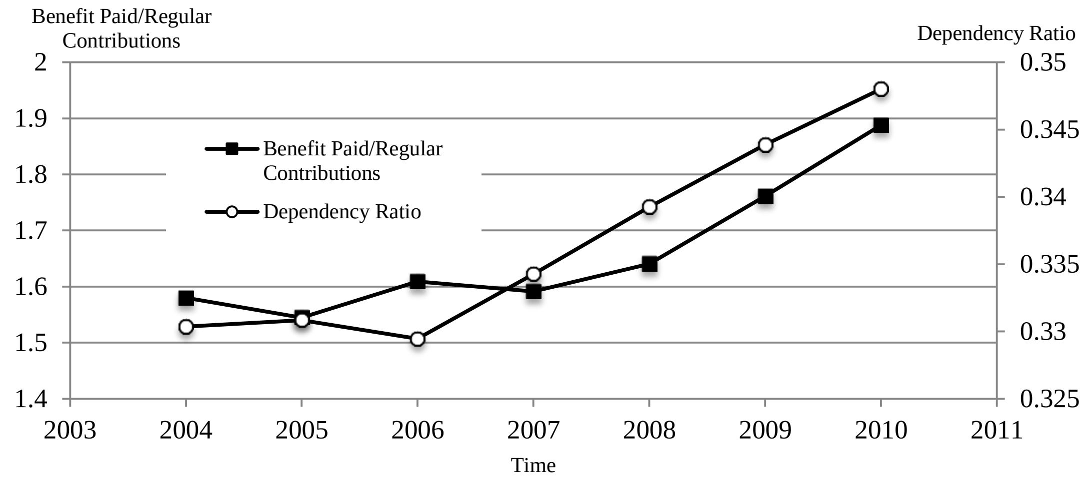
This paper argues that a more appropriate maturity measure, which could act as a proxy for the demographic pattern of pension members, is the ratio between the amount of pension benefit payments and the amount of regular contributions. Equation 7.3 shows the mathematical function of the pension benefit payments and the proportion of retired members, while Equation 7.4 illustrates the relationship between the amount of regular contributions and the proportion of active members.

$$Pension\ Benefit\ Payments = \sum_{i=1}^{n}[accrual\ rate_i \times tenure\ length_i \times final\ salary_i] \qquad (7.3)$$

$$Regular\ contributions = \sum_{i=1}^{m}[Employer\_C_i \times Salary_i + Employee\_C_i \times Salary_i] \qquad (7.4)$$

"Employer_C_i" and *"Employee_C_i"* are, respectively, the contribution rates made by employers and employees; *"n"* represents the total number of retired members and *"m"* the total number of active members. Because the total value of pension benefit payments and regular contributions shown in Equation 7.3 and 7.4 are largely dependent on the summation factors of *"m"* and *"n"*, the movement of the ratio between the pension benefit payments and the regular contributions should approximately mirror the movement of the old-age dependency ratio. Figure 7.9 shows the comovement of this maturity measure and the old-age dependency ratio based on the data from the MQ5 survey.

Figure 7.9 The ratio of pension benefit payments to regular contributions and the old-age dependency ratio



Even though more than 50 per cent of the FTSE100 firms included in this analysis have closed their defined-benefit pension schemes to new employees, they are still required to pay regular and extra contributions into the schemes. The amount of contributions used in the calculation needs to be regular contributions which exclude any voluntary extra contributions for deficit reductions. This is because large additional contributions paid during certain periods are not directly related to the proportion of either active or retired members. Typically, information regarding the schedule of extra contributions to reduce pension deficits is normally disclosed in the section that explains the official triennial actuarial valuation made by qualified actuaries. For firms that do not incur pension deficits after the triennial actuarial valuation, the reported pension contributions will normally include only regular contributions. However, not all firms report the total amount of extra contributions in their company accounts. Therefore, the sample used in this analysis will only include those firms which clearly provide estimates of regular contributions in the footnotes.

7.6.2 Results from the panel data regression analysis

Table 7.4 shows the descriptive statistics of the variables included in the panel data regression. The average number of firms included in the sample is around 80 for each financial year. It can be seen that the standard deviation of pension assets and pension liabilities is high, reflecting the fact that the size of pension schemes of some firms is relatively larger than the average size of most schemes. For instance, in 2011 the value of the pension assets of Royal Dutch Shell and British Telecom was around £40,000 and £37,000 million respectively. Because of these outliers in the estimate of the size of pension schemes, a log transformation of pension liabilities is used in order to distribute the data points more uniformly. The maturity measure that is used in this analysis also needs to be log-transformed because the ratio between pension benefit payments and the amount of regular contributions can vary from a very low value to a very high level. The gradual rise in the mean of the maturity measure between 2006 and 2011 represents a rising old-age dependency ratio in the UK. Table 7.4 shows that pension schemes of FTSE100 firms are mostly underfunded. Over the past six years, the solvency ratios measured by the ratio between the value of pension assets and liabilities was around 0.95.

Table 7.4 Descriptive statistics of the variables used in the panel regression

	2006	2007	2008	2009	2010	2011
Pension characteristics						
Pension asset (£ Million)	3,439.34 (6,566.33)	3,632.74 (7,022.30)	3,298.23 (6,205.59)	3,410.12 (6,400.02)	3,964.18 (7,351.37)	4,402.87 (7,903.32)
Pension liability (£ Million)	3,690.18 (6,712.11)	3,596.15 (6,620.95)	3,468.99 (6,395.19)	3,892.28 (7,098.45)	4,342.46 (8,007.64)	4,626.47 (8,237.59)
Ln[Pension liabilities]	6.97 (1.74)	7.00 (1.63)	6.94 (1.68)	7.05 (1.65)	7.20 (1.62)	7.26 (1.62)
Benefit paid/ regular contribution	1.51 (1.29)	2.45 (6.93)	2.84 (7.32)	3.39 (11.94)	3.77 (12.38)	4.67 (13.46)
Ln[Benefit paid/ regular contribution]	-0.006 (1.043)	0.177 (1.070)	0.409 (0.979)	0.413 (1.033)	0.556 (1.036)	0.713 (1.075)
Solvency ratio	0.902 (0.106)	0.980 (0.111)	0.949 (0.131)	0.875 (0.111)	0.906 (0.113)	0.955 (0.130)
Pension asset allocation						
Equities	58.90% (14.79%)	53.27% (15.23%)	46.80% (15.90%)	44.53% (16.21%)	43.37% (15.89%)	39.36% (16.22%)
Fixed-Income securities	32.14% (14.25%)	36.90% (15.29%)	41.17% (16.14%)	41.85% (16.92%)	42.25% (16.33%)	45.10% (17.72%)
Properties	3.61% (4.04%)	3.84% (4.14%)	3.69% (3.82%)	3.21% (3.37%)	3.52% (3.55%)	3.35% (3.60%)
Annuity contracts	0.15% (1.01%)	0.62% (4.26%)	0.99% (6.21%)	2.46% (12.00%)	1.80% (10.29%)	2.35% (10.21%)
Others	5.21% (5.62%)	5.43% (5.53%)	7.35% (8.92%)	7.95% (8.65%)	9.06% (11.03%)	9.84% (11.96%)
Total unique firms	78	80	82	86	85	82

Note: Standard deviations are shown in parentheses.

Regarding the asset allocation of pension schemes, nearly two-thirds of pension assets were invested in equities in 2006. This level of equity weights among UK pension funds is similar to the proportion of equity investment of pension funds in the US, the Netherlands, and Canada. These empirical observations are generally prevalent in markets which are regulated predominantly by the Prudent Person Rules rather than the Quantitative Restriction Rules. The ubiquity of the equity weights at around two-thirds arises from the belief among investment advisors that in the long run returns from stocks outperform bonds. In the UK, the equity weight at around 55-60 per cent is often considered as a “conservative” strategy, while equity allocation at more than 75 per cent is perceived as an “aggressive” strategy. However, equity weights have gradually declined, from approximately 60 per cent in 2006 to approximately 40 per cent in 2011. Corporate DB pension schemes appear to have increased their investment in fixed-income securities, annuity policies and other asset classes, cash and short-term money market instruments. The proportion of real estate investment has tended to stay constant at around 3.6 per cent.

The relationship between the maturity measure and the portfolio distribution of pension schemes is shown in Table 7.5. The table depicts the relation between the decile of the maturity measure and asset weights from a pooled sample including observations from 2006 to 2011. It can be seen that pension schemes with a young age structure tend to have a large asset allocation in equities. Pension assets of those schemes whose maturity measure is at the 10th decile have equity weights at nearly 60 per cent compared to 36 per cent of the schemes in the top decile. The low equity allocations of plans in the top decile are accompanied by high allocations to fixed-income securities, annuity contracts and short-term money market instruments. The results from Table 7.5 provide strong evidence which supports the influence of the age structures of plan members on the investment policies of pension schemes. However, these results are not robust enough to claim causality between those two factors because other factors may confound the results. For example, the funding status of schemes has also been shown to significantly affect the asset allocations of pension schemes (Rauh, 2009). As a consequence, a panel regression is conducted in order to control for factors other than the maturity measure.

Table 7.5 The decile of the maturity measure and portfolio weights

Percentile	Sample size	Average percentage of portfolio weights				
		Equity	Bond	Property	Annuity	Cash
10th	50	59.46% (18.88%)	28.45% (15.03%)	2.75% (3.68%)	0.00% (0.00%)	9.45% (10.56%)
20th	49	58.01% (14.30%)	30.50% (11.98%)	3.40% (3.74%)	0.49% (1.93%)	7.61% (8.61%)
30th	50	50.97% (18.30%)	36.94% (16.57%)	3.33% (3.53%)	0.40% (1.18%)	8.37% (9.95%)
40th	49	49.25% (15.93%)	40.88% (14.98%)	2.76% (3.30%)	0.05% (0.36%)	7.06% (9.13%)
50th	50	45.04% (14.87%)	44.88% (16.15%)	3.77% (3.67%)	0.41% (2.89%)	5.89% (6.06%)
60th	49	47.10% (14.68%)	40.97% (13.16%)	3.81% (3.30%)	1.98% (11.99%)	6.12% (7.80%)
70th	50	45.10% (15.95%)	42.82% (15.17%)	3.70% (3.23%)	0.39% (2.73%)	7.99% (6.73%)
80th	49	41.04% (14.76%)	49.26% (15.46%)	4.57% (4.37%)	0.00% (0.00%)	5.12% (5.01%)
90th	50	42.01% (13.44%)	40.07% (17.83%)	5.08% (4.34%)	4.47% (14.23%)	8.37% (11.90%)
100th	49	35.95% (14.69%)	45.48% (18.34%)	2.28% (3.51%)	6.07% (17.64%)	10.21% (13.82%)

Note: Standard deviations are shown in parentheses.

Tables 7.6 to Table 7.10 show the regression results from the three main statistical techniques of the panel regression analysis, namely pooled regression, the random-effect and the fixed-effect analysis. The estimates of the pooled regression are similar to the OLS estimates. However, this technique does not control for some unobserved effects in the sample. The main advantage of analysing the panel data is the ability to control for some unobserved heterogeneous factors that are specific to each firm. The fixed-effect and random-effect estimation are statistical techniques which incorporate these unobserved factors into the derivation of standard errors. The random-effect method assumes that the unobserved factors have zero correlation with the observed explanatory variables while the fixed-effect procedure allows for arbitrary correlation between the unobserved components and the observed explanatory variables.

Results from Table 7.6 show that the maturity measure has a significantly negative relationship with equity weights at the 95 per cent confidence level. This result is consistent with Rauh (2009) who finds that the percentage of active employees in the corporate DB schemes of US firms is positively correlated with the degree of risk taking. The large equity allocations of DB pension schemes with immature pension obligations are consistent with the hypothesis that equity investments are used as a hedging tool against an increase in future pension benefits which are directly linked with real wages (Sundaresan & Zapatero, 1997). The reduction in equity allocations as the degree of maturity increases also suggests that UK firms consider the variations of the PBO rather than the ABO to be the main criteria influencing strategic investment policy. Because the PBO requires a forward estimate of future labour wages of policyholders at retirement, the proportion of equity investment, which is considered as a way to hedge labour earning risks, is normally reduced when most policyholders approach retirement. In addition, as noted by Blake (1998), if the main goal of pension assets is to hedge against the ABO measure, pension asset allocations will largely consist of bonds in order to achieve perfect duration matching. Pension fund managers do not need to consider any risks related to changes in future real wages or future inflation.

Table 7.6 Regression results of the relationship between equity weights and explanatory variables

Dependent variable: Portfolio weight in equities			
Explanatory variables	Pooled Regression	Random Effect Model	Fixed Effect Model
Maturity Measure $= Ln\left(\frac{Benefit\ paid}{Regular\ contribution}\right)$	-0.0622** (0.0068)	-0.0636** (0.0085)	-0.0581** (0.0101)
Solvency Status $= \left[\frac{Pension\ asset}{Pension\ liability}\right]$	-0.2527** (0.0555)	-0.1017 (0.0541)	-0.0827 (0.0582)
Size of pension scheme $= Ln(Pension\ liability)$	-0.0052 (0.0043)	-0.0111 (0.0083)	-0.0930** (0.0253)
Constant	0.7790** (0.0591)	0.6762** (0.0784)	1.2398** (0.1921)
Number of Observations	493	493	493
Number of firms	-	86	86
Average number of observations per firms	-	5.7	5.7
Adjusted R-squared	0.2179	0.2080	0.1025

Note: ** indicates the statistically significant different from zero (2-tailed p-value) at alpha = 0.05; Standard errors are shown in parentheses.

The allocations to fixed-income securities, annuity contracts, and short-term assets show an inverse response to the dynamic of the age structure of policyholders. Regression results from Tables 7.7, 7.8 and 7.9 illustrate that the maturity measure has a significant positive influence on allocation to those asset classes, reflecting the fact that pension schemes need more certain cash flows and additional liquidity when a large percentage of pension members approaches retirement. In addition, the liabilities of retired members are quite certain in terms of both their absolute value and their timing. Therefore, fund managers are able to invest in bonds and annuity contracts that can generate cash flows similar to the payments of pension benefits.

Table 7.7 Regression results of the relationship between bond weights and explanatory variables

Dependent variable: Portfolio weight in bonds			
Explanatory variables	Pooled Regression	Random Effect Model	Fixed Effect Model
Maturity Measure $= Ln\left(\frac{Benefit\ paid}{Regular\ contribution}\right)$	0.0401** (0.0071)	0.0260** 0.0081	0.0183** (0.0092)
Solvency Status $= \left[\frac{Pension\ asset}{Pension\ liability}\right]$	0.2559** (0.0580)	0.0651 (0.0506)	0.0406 (0.0534)
Size of pension scheme $= Ln(Pension\ liability)$	0.0028 (0.0045)	0.0120 (0.0090)	0.0594** (0.0232)
Constant	0.1221** (0.0617)	0.2418** (0.0808)	-0.0669 (0.1764)
Number of Observations	493	493	493
Number of firms	-	86	86
Average number of observations per firms	-	5.7	5.7
Adjusted R-squared	0.1147	0.0909	0.0325

Note: ** indicates the statistically significant different from zero (2-tailed p-value) at alpha = 0.05; Standard errors are shown in parentheses.

Table 7.8 Regression results of the relationship between annuity weights and explanatory variables

Dependent variable: Portfolio weight in annuity contracts			
Explanatory variables	Pooled Regression	Random Effect Model	Fixed Effect Model
Maturity Measure $= Ln\left(\frac{Benefit\ paid}{Regular\ contribution}\right)$	0.01553** (0.0037)	0.0147** (0.0046)	0.0134** (0.0052)
Solvency Status $= \left[\frac{Pension\ asset}{Pension\ liability}\right]$	0.0061 (0.0306)	-0.0278 (0.0284)	-0.0356 (0.0302)
Size of pension scheme $= Ln(Pension\ liability)$	-0.0068** (0.0024)	-0.0078 (0.0052)	-0.0122 (0.0131)
Constant	0.0488 (0.0325)	0.0906 (0.0465)	0.1269 (0.0998)
Number of Observations	493	493	493
Number of firms	-	86	86
Average number of observations per firms	-	5.7	5.7
Adjusted R-squared	0.0334	0.0361	0.0271

Note: ** indicates the statistically significant different from zero (2-tailed p-value) at alpha = 0.05; Standard errors are shown in parentheses.

Table 7.9 Regression results of the relationship between portfolio weights in other financial assets and explanatory variables

Dependent variable: Portfolio weight in others			
Explanatory variables	Pooled Regression	Random Effect Model	Fixed Effect Model
Maturity Measure $= Ln\left(\frac{Benefit\ paid}{Regular\ contribution}\right)$	0.0098** (0.0041)	0.0205** (0.0054)	0.0277** (0.0068)
Solvency Status $= \left[\frac{Pension\ asset}{Pension\ liability}\right]$	-0.0021 (0.0337)	0.0233 (0.0354)	0.0500 (0.0395)
Size of pension scheme $= Ln(Pension\ liability)$	-0.0004 (0.0026)	-0.0004 (0.0048)	0.0347** (0.0172)
Constant	0.0749** (0.0359)	0.0470 (0.0475)	-0.2311 (0.1305)
Number of Observations	493	493	493
Number of firms	-	86	86
Average number of observations per firms	-	5.7	5.7
Adjusted R-squared	0.0065	0.0122	0.0050

Note: ** indicates the statistically significant different from zero (2-tailed p-value) at alpha = 0.05; Standard errors are shown in parentheses.

The insignificant relationship between the maturity measure and the allocation to real estate shown in Table 7.10 may result from the fact that this asset class has a low investment risk but a high liquidity risk. Pension schemes tend not to reduce their allocation to real estate because the periodic returns from the investment in these assets are quite certain, and can be used to support pension benefit payments. However, the low liquidity of real estate investment prohibits pension funds from increasing the allocation to this asset class. With regard to the impact of other pension-related factors, such as the solvency status and the size of the schemes, there tends to be no significant influence on pension asset allocations to all asset classes.

Table 7.10 Regression results of the relationship between portfolio weights in real estates and explanatory variables

Dependent variable: Portfolio weight in properties			
Explanatory variables	Pooled Regression	Random Effect Model	Fixed Effect Model
Maturity Measure $= Ln\left(\frac{Benefit\ paid}{Regular\ contribution}\right)$	-0.0034** (0.0016)	-0.0019 (0.0015)	-0.0015 (0.0017)
Solvency Status $= \left[\frac{Pension\ asset}{Pension\ liability}\right]$	-0.0078 (0.0127)	0.0234** (0.0094)	0.0281** (0.0098)
Size of pension scheme $= Ln(Pension\ liability)$	0.0097** (0.0010)	0.0088** (0.0019)	0.0096** (0.0043)
Constant	-0.0239 (0.0135)	-0.0472** (0.0166)	-0.0580 (0.0325)
Number of Observations	493	493	493
Number of firms	-	86	86
Average number of observations per firms	-	5.7	5.7
Adjusted R-squared	0.1579	0.1497	0.1466

Note: ** indicates the statistically significant different from zero (2-tailed p-value) at alpha = 0.05; Standard errors are shown in parentheses.

7.7 Concluding remarks

This chapter provides an analysis of the investment behaviour of DB occupational pension schemes. The annual percentage changes in the asset allocation of UK pension schemes tend to be largely influenced by the deterministic shift of long-term strategic investment policies. Even though fund managers may allow portfolio weights to deviate from strategic investment strategies monthly or even quarterly, on an annual basis they will attempt to reduce the degree of deviation and rebalance the portfolio weights so as to make the portfolio distributions comply with long-term strategic investment policies.

This chapter also finds that the age structure of policyholders is the main factor influencing the portfolio allocation of DB occupational pension schemes. Fund managers appear to significantly reduce allocations to equities while the proportion of investments in fixed-income securities, annuity contracts and short-term money market instruments significantly increases. The benefits of equity investment as a hedging instrument against an increase in real wages and inflation are reduced significantly when a large proportion of pension members approaches retirement because the salary levels of those retired members have been resolved. Although the pension obligations of retired members may still contain high inflation risks if the benefit payments are indexed to inflation rates, fund managers appear to allocate a large proportion of pension assets to inflation-protected government bonds. The investment in this asset class not only provides an inflation-hedging benefit but also offers fund managers the opportunity to adjust the duration of pension assets to perfectly match the liability index of retired members, which tends to have a short period of duration.

In addition, this chapter discovers little evidence of significant under or outperformance of DB occupational pension assets relative to the performance of the market benchmark indices. This evidence appears to indicate a strong herding behaviour among UK pension fund managers. Because pension trustees normally evaluate the performance of fund managers via a peer group benchmark, asset allocations of most UK pension funds tend to cluster around the industry norm.

Although the investment selections over individual securities may be different, the herding behaviour tends to determine portfolio weights across broad financial asset classes. A reliance on industry consensus means that most UK pension funds follow the same investment strategy in response to changes in the characteristics of pension liabilities. Since this chapter finds that the dynamic of the age structure of policyholders significantly influences the proportion of pension funds’ investments in bonds and equities, the movement of fund outflows from the equity market and fund inflows to the bond market is expected to be substantial in subsequent decades. This could lead to pension funds having a significant effect on the movement of financial asset prices and returns as the aggregate demographic structure shifts toward the higher old-age dependency ratio.

Chapter 8: Discussion and conclusion

8.1 Introduction

The purpose of this chapter is to summarise the main findings of this thesis and to discuss their theoretical and policy implications. Results from the research in chapters 5, 6, and 7 have shed some light on the impact on financial asset prices and returns by the investment decisions of pension schemes. Since the long-term strategic asset allocation of pension schemes seems to be significantly influenced by the age structure of their policyholders, it suggests that the variation in security prices may not wholly be driven by changes in fundamentals. Some extents of the movement in asset prices may be significantly affected by the dynamic of demographic structures. This implies that the shift away from DB pension schemes to DC plans may not be a sustainable solution for the problems posed by the population ageing. Even though the solvency problems and financial burdens of traditional unfunded PAYG schemes and funded occupational DB plans may be solved by the transformation to the funded DC pension account, the expected terminal retirement wealth of the next generation through the saving in DC pension plans may still be severely affected by the population ageing which is expected to reduce investment returns from the price appreciations of financial assets. Findings from this thesis suggest that the expensiveness of financial assets in terms of the price-to-earning ratios may decline during the period of the sharp rise in the old-age dependency ratios. The summary of the whole thesis and the assessment of the results found in this thesis will be illustrated in section 8.2. Limitations of the research methodologies conducted in this thesis will also be discussed.

The impact of pension schemes' asset allocation on financial asset prices implied by the findings in this thesis also suggests that the demand curve function of financial assets may be downward sloping rather than horizontal, as suggested by the Efficient Market Hypothesis (EMH). According to the traditional asset-pricing framework, prices of financial assets should always be equal to their fundamental value regardless of any short-term large trading volumes that can cause asset prices to temporarily deviate from their intrinsic value. Nevertheless, a number of literature has shown that the supply of and demand for financial assets can affect asset prices. For example, an increase in the supply of government bonds appears to significantly reduce bond prices. The movement of stock dividend yields also tends to forecast expected investment returns more accurately than expected dividend growth rates. This evidence indicates that an increase in equity prices does not always reflect an improvement in fundamentals but appears to be a result of excess demands for equities. Discussion on the theoretical aspect of the price pressure impact from large fund flows will be shown in section 8.3. The purpose of this discussion is to show that it is highly likely that the asset reallocation of pension schemes can have a significant influence on the movement of financial asset prices and returns.

Moreover, it has been argued that demographic transition not only has an impact on financial markets through changes in the supply and demand of pension schemes, but also on the growth rate of the national economy as a whole. The ageing of the workforce, the reduction in labour productivity, the decrease in the size of the workforce, and the decline in aggregate saving rates and demands for investments can greatly diminish the rate of returns to capital. This implies that population ageing can affect the fundamental values of financial asset prices, thereby leading to a change in the risk and return trade-offs to financial assets over the coming decades. As such, section 8.4 will also discuss the extent of the impact of demographic transition on the fundamental values of financial asset prices.

Considering that population ageing may significantly affect the long-term growth rate of the economy, policy makers may consider implementing certain economic policies in order to mitigate its impact. Therefore, the actual movement of asset prices or the rates of return to capital over the coming decades may not be as severely affected as the theoretical models suggest. Changes in public pension systems from PAYG to a nation-wide DC account may partly mitigate the selling pressure of mature DB pension schemes. The governments may decide to increase the supply of long-term government bonds and inflation-protected bonds in order to absorb the demands by pension schemes. Alternative securities such as longevity bonds or GDP-linked bonds may also be introduced. In addition, policies that encourage the labour participation rates of old and female workers may help to reduce the shortage in labour supply and to smooth decumulation of pension assets by baby-boomers. Other solutions to tackle ageing include increasing international capital and labour flow which can increase the demand for capital of the rapidly-ageing countries. The discussion on policy implications will be shown in section 8.5. It will be followed by suggestions on future research plans in section 8.6. The chapter will end with a conclusion in section 8.7.

8.2 Summary and assessment of the research in this thesis

Chapter 1 provides an overview of the thesis and outlines the main hypothesis proposed in this thesis. Chapter 2 shows that there has been a continuing trend to replace the defined-benefit structure of pension provisions with the defined-contribution account in both public and private sectors. One of the main driving forces of this transformation is the shift in the demographic structures resulting from an improvement in life expectancy, a decrease in fertility rates, and the retirement of baby-boomers. A sharp increase in the old-age dependency ratio is expected to severely affect the solvency status of unfunded PAYG schemes and funded occupational DB plans. Rather than keeping the basic design of the pension system unchanged, it seems clear that policy makers decide to solve this problem by transforming the whole pension system from a DB structure into a funded DC pension system through the establishment of a ‘National Account’ or some form of privatization. Governments in the US, the UK, Australia, New Zealand and many Latin American countries have been shown to follow this policy implementation. Some countries such as Sweden, Italy and Poland have decided to implement a notional defined contribution (NDC) pension scheme. This shift away from the DB pension system is also prevalent among firms in the private sector. It has been shown that the closure of occupational DB pension schemes has significantly accelerated in many developed countries. Although private firms increasingly provide DC pension accounts to their employees, the coverage rates of pension provisions in the private sector actually decline. This poses some concerns about the retirement wealth of the next generations.

The transformation from DB pension arrangements to DC pension accounts may seems to solve the problem posed by the population ageing at the first glance. However, this thesis argues that there appears to be a strong relationship between demographic transition and financial markets. A shift in demographic patterns may have an influence on the rates of return to capital or on the demand and supply of capital in the market. Therefore, no matter how the pension system is structured, if an underlying relationship between demographic structures and the capital market exists, DC pension plans may not be sustainable since the rate of returns from investments may not be sufficient to maintain an appropriate standard of living during retirement.

In chapter 3, a detailed analysis on the dynamic of demographic transitions over the past 60 years has been shown. Even though the population ageing is a worldwide phenomenon, the timing and rates of the aging may vary between different countries. This chapter shows that the impact of population ageing on the stability of current social and economic structures may be significant particularly in industrialized countries such as the US, the UK, Germany, France, Japan and Italy. This is because these countries have experienced significant improvements in healthcare, which greatly lengthen the life expectancy at old ages. The drop in fertility rates among these countries has also been shown to be larger than other developing countries in Asia and Latin America. The proportion of old-age population among developing countries is not expected to increase significantly in the near future. In contrast, according to the demographic projection by the Office for National Statistics, it is projected that the old-age dependency ratios in the UK will sharply increase from approximately 30 per cent in 2009 to nearly 50 per cent by 2040. Because this sharp growth rate in the dependency ratios mainly results from an improvement in longevity of old people rather than a current decline in birth rates, the negative impact on the social and pension system will be immediate.

By comparing the movement of demographic variables and the variation of financial market indicators, chapter 4 provides a rough picture of the potential strong relationship between those two factors since the 1960s. The key demographic variables that are used in the comparison are the fraction of adult population (20-60/65) and the proportion of the prime working-age group (40-60/65). It is widely accepted that saving and consumption behaviour of households within those age ranges may be significantly associated with the strong motive of savings for retirement. It has been shown that the movement of the working-age population has a strong positive correlation with the variation in equity and bond prices particularly after the 1960s. Prior to this period, there were no strong relationships in either direction. The expensiveness of equities in terms of the price-to-earning ratios has just gradually increased after 1960s. Instead of fluctuating over a long-term constant level, dividend yields appear to consistently decline over the past 30 years. This thesis argues that this evidence may result from the emergence of institutional investors since the 1960s which sharply increases household participation rates in the financial markets. It has been shown that there was a sharp increase in the amount of fund inflows into occupational pension schemes during 1970s and 1980s. This has led pension schemes to be one of the largest institutional investors in the financial markets. Because of the large size of UK pension schemes, asset allocation of these funds which may be largely influenced by the lifecycle saving and dissaving motive of households may have a significant effect on asset prices and returns. However, the graphical illustrations shown in chapter 4 do not provide robust results which either support or reject any underlying mechanisms; instead, they merely show a few trends between different variables. In order to robustly test the proposed hypothesis, three research projects have been conducted.

In chapter 5, the research which attempts to statistically examine the time-series relationship between demographic variables and financial market variables is shown. The aim of this research is to test that the time-series relationship between those two factors during the period after 1960s is statistically significantly different from the time-series relationship prior to this period. The location of this structural break is estimated from the Chow test statistic. Apart from this statistical test, this research also attempts to estimate which age variables have a statistical significant relationship with financial asset prices. One main concern of the time-series regression is the existence of spurious relationship between time-series variables. The unit-root tests have also been conducted in order to prove that all variables in the regression models have no unit root.

The research in chapter 5 has made some contributions to the existing literature in this area. Instead of using annual returns of financial assets which tend to contain high noises, this research uses the 3-year and 5-year returns as the main financial variables. The demographic variables used in the regression models are the n-year percentage changes in the population estimates rather than the direct “level” estimate of the proportions of population as mostly used in previous literatures. The use of the n-year percentage changes provides a direct statistical test for the hypothesis concerning whether changes in demographic structures may lead to changes in asset prices. This research also examines the impact of demographic transitions on the price-to-earning ratios and dividend yields. Instead of using the conventional 12-month trailing estimates, this study calculates these ratios by using the forward 12-month earnings and dividends. This forward measure will provide a more accurate representation of the expensiveness of security prices. Because the use of n-year overlapping returns in the regression models normally leads to estimation biases resulting from the autocorrelation in error terms, the Newey-West standard errors are used to correct this problem.

Results from the Chow test statistic show that a significant structural break in the time-series relationship is 1965. The presence of this structural break can explain why previous studies, which have not taken this structural break into account, do not find a significant relationship between demographic variables and asset prices. After analysing the time-series regression for the period after 1965, changes in the 35-44 age group are shown to have a significantly positive impact on equity prices. This has led to an increase in P/E ratios and a decline in dividend yields. Regarding the impact on the bond market, changes in the 60-64 age group appear to have a significantly negative relationship with the changes in GILT yields. This empirical evidence suggests that equity allocation of household portfolio may be high during the age of 35-44. The reallocation into less-risky financial assets such as government bonds may begin during the age of 60-64.

However, there are some caveats that need to be considered from this research. For example, the transition of demographic structures over the past 50 years has largely been caused by the ageing of one large group of population, namely the baby boom generation. Therefore, it can be considered that the history only contains one important realisation of demographic patterns. This implies that fifty annual observations after 1960s may only represent one main observation of the relationship between demographic structures and the financial market. Moreover, there may be other economic factors such as labour productivity and the ageing of labour workforce that can significantly affect asset prices. Since these variables can also be influenced by demographic transitions, including only demographic variables in the regression models may not post a severe specification bias. Additionally, the strong positive relationship between asset prices and demographic variables only represents the accumulation period of households' lifecycle savings. It does not provide any causal mechanism explaining the relationship. In order to better understand the empirical evidence found in chapter 5 and to robustly test the proposed hypothesis of this thesis, research projects shown in chapter 6 and 7 are required.

The analysis of the lifecycle saving behaviour of British households is shown in chapter 6. In practice, households can participate in the financial market through a range of investment opportunities such as direct investments, investments in unit/ investment trusts, or savings through occupational pension schemes and personal pension plans. Therefore, it is interesting to study the lifecycle saving behaviour of households in each type of saving opportunities. The lifecycle age profile found in this research will be used to compare with the results found in chapter 5 in order to understand the underlying mechanism which explains the significantly positive relationship between the proportion of the 35-44 age group and equity prices. If the age group of peak participations in a certain investment option is similar to the age group found in chapter 5, which has a significant influence on asset prices and returns, it will indicate that the aggregate investment activity of households in a specific investment option (i.e. direct investment, saving in unit/investment trusts, or saving in pension schemes) is the main source of the strong relationship between demographic variables and asset prices.

The main database used in this research is the Family Expenditure Survey data, 1968 to 2007. Although this dataset is not a longitudinal survey, the repeated cross-sectional samples of this dataset can be approximated to represent the saving behaviour of a certain cohort over time. Because of the long history of this dataset on an annual basis, it is possible for the analysis to yield robust results that have been controlled for either the time or cohort effect. The graphical illustrations for the probability of household savings in each type of investment opportunities shown in chapter 6 have been smoothed by the LOWESS smoothing technique. The purpose of this smoothing is to produce more accurate profiles of household lifecycle saving. The logit regression analysis is also conducted to estimate the age profile of household savings while controlling for other household characteristic variables.

The main result found in this research is that the peak in household direct ownership of financial assets occurs at around 60-70. The dissaving rates of this portion of household wealth appear to be slow. This lifecycle saving profile is also similar to the saving behaviour in unit/ investment trusts. These results have led many scholars to conclude that the dissaving rates during the period of the retirement of baby-boomers may not sufficiently large to cause a precipitation in asset prices. However, further analysis of household saving behaviour in pension schemes provides a different picture. The lifecycle age profile for the saving in both occupational and personal pension schemes appears to peak during the age of 40. Interestingly, this age group is the same as the age group that has a significant relationship with asset prices. This result is one of the main contributions to the existing literature in this area. The presence of pension schemes appears to be one of the main mechanisms that guide households to behave according to the lifecycle hypothesis. Without these institutions, it may be difficult for households to individually make rational saving and consumption decisions over different periods of their life. Because of this pension provision, households may perceive their own direct investment in the financial market as a last source for their savings in retirement. This insight can explain why previous literatures do not find consistent results between household saving behaviour and the lifecycle hypothesis.

One main limitation of this research is the impossibility to observe lifecycle household wealth holdings in each type of investment opportunities. The dataset only provides comprehensive information about income and expenditure elements of households. The lifecycle profile of the probability to own financial assets is not always similar to the changes in household wealth over their lifetime. Nevertheless, the probability estimates shown in this chapter may be able to approximately reflect the amount of fund inflows and outflows across financial markets. The period of the large proportion of the 35-44 age group may be associated with large net inflows into the financial markets because most of the population in this age group make saving through pension schemes. Housing assets are not included in the analysis because the probability to own or rent a house does not only depend on the investment aspect. Housing assets also have a feature to provide current consumption for households.

The findings from chapter 5 and 6 tend to suggest that asset allocation of pension schemes may be the main cause of the significant relationship between asset prices and demographic variables. Therefore, the analysis on the investment strategy of pension schemes is necessarily in order to understand the characteristic of asset price behaviour during the period when large proportions of population are retired. The research in chapter 7 presents an investigation that attempts to explicitly examine the causal relation between the investment principles of pension schemes and the demographic structure of policyholders. The main databases for the analysis are the MQ5 survey from the ONS and the information of occupational DB pension schemes disclosed in the footnotes of financial statements of firms listed in the FTSE100. Before analysing the investment strategy of pension schemes, it is necessary to examine whether the observed asset allocation represents the actual long-term strategic asset allocation of the schemes. This analysis is to factor out the possibility that asset allocation may be largely influenced by differential returns across different asset classes rather than by the shift in the strategic investment policy of the funds.

Since firms are not required to disclose sensitive information about the age structure of their employees, a maturity measure is constructed. This thesis argues that the maturity measure computed by the ratio between pension benefits and the amount of regular contributions is an appropriate measure that can approximate the dynamic of the old-age dependency ratios. The ratio between pension benefits and the present value of pension obligation used in most previous studies may contain some biases resulting from the manipulation of the actuarial estimate of pension liabilities. The panel regression technique is conducted to estimate the impact of demographic shifts on pension schemes' asset allocation.

It has been shown that the annual percentage changes in portfolio weights of pension schemes tend to be largely associated with the shift in long-term strategic asset allocation of the funds. Although the short-term variation in portfolio weights is largely influenced by the price movement of different financial asset classes, pension fund managers appear to rebalance the asset allocation of the funds in order to comply with the strategic investment policy at the end of each year. The use of the panel data over the 6-year period from 2006 to 2011 can factor out the impact of the pension regulatory and accounting changes on the asset allocation of pension schemes. The large number of firms in the panel data also provides a high number of degrees of freedom for the comparison between pension schemes with the young and old age structure at a certain period. Regression results show that pension schemes with a high proportion of retired members relative to active members tend to significantly have greater investments in fixed-income securities, annuity contracts and short-term money market instruments. The portfolio weight in equities is shown to have a negative relationship with the aging of policyholders. The benefits of equity investment as a hedging instrument against an increase in real wages and inflation are reduced significantly when a large proportion of pension members approaches retirement. This is because the salary levels of those retired members have been resolved. The results of this research not only support the proposed hypothesis that the presence of pension schemes since the 1960s is the main linking mechanism between demographic transitions and financial markets but also provide insight that the retirement of the baby boom generation over the next 20 years may significantly decrease the price-to-earning ratios of equities and increase the expensiveness of bond prices as most pension schemes in the market reallocate their assets in response to the ageing of their fund members.

In summary, results from the research in this thesis suggest that the asset allocation of pension schemes, which tends to be significantly influenced by the demographic transition of policyholders, may have a significant impact on the movement of asset prices. This hypothesis also implies that financial asset prices may not purely behave according to the efficient market hypothesis. In theory, the demand curve function of asset prices should always be horizontal. Prices of financial assets should not be affected by the size of trading volumes or the excessive demands and supplies. In order to show that asset reallocation of pension schemes can potentially have some significant influence on security prices, a discussion on a range of anomalies in the movement of financial asset prices and some alternative theoretical explanations with regards to those anomalies will be presented in the next section.

8.3 Discussion on the possibility of the effect of pension schemes' asset allocation on financial asset prices and returns

The main fundamental theory in financial asset pricing is the Efficient Market Hypothesis (EMH). It is widely accepted that asset prices will always equal their expected discounted cashflows. Expected investment returns in any period are "fair game", meaning that the current prices of financial assets should reflect existing information. In other words, there should be no risk-free arbitrage opportunities available in the market. Although all investors in the market do not have the same level of information when they make investment decisions, at least one informed investor can make the market efficient. Whenever informed traders find underpriced or overpriced securities, they will either bid up or short sell such respective securities until the prices of the securities reach their fundamental value. This notion also implies that trading orders of irrational investors who are inefficiently informed can only have a short-lived, trivial effect on financial asset prices. Nevertheless, informed traders are required to have no capital constraints when they execute their trading orders, and the financial market should be frictionless so as to allow informed traders to move their capital freely and immediately across different securities.

Because the assumptions regarding the frictionless economy and the abundance of arbitrageurs' capital do not always hold in reality, price discovery from the investment activities of arbitrageurs (informed rational traders) may not occur efficiently. The ability of investors in a particular market to correct the inefficiency of financial asset prices may be limited by capital constraints. A small number of informed traders may not be able to absorb the trading volumes of uninformed investors or the trading orders of large pension schemes which may be executed for reasons other than fundamental considerations, such as the shift in the demographic structure of fund members. Moreover, arbitrageurs tend to have some degree of risk aversion, implying that they may require a certain level of risk premiums (the size of arbitrage opportunities) before they are willing to execute a trade. These conditions have led to the possibility that trading activities of most pension schemes in the market may significantly cause asset prices to deviate from their fundamental value over certain periods of time.

There are many circumstances in the financial market where security prices do not behave in the manner that a fundamental analysis would suggest. For instance, Cochrane (2011) finds that the variation in the dividend yields of common stocks is not associated with the variation in future dividend payments. An increase in equity prices causing a reduction in dividend yields is not normally followed by an increase in dividends in future periods. On the contrary, the movement of dividend yields seems to be a better forecast for expected risk premiums. This evidence contradicts the EMH, which suggests that dividend yields should stay roughly constant over time. Furthermore, Shiller (1979) discovers that the volatility of the yields on long-term fixed-income securities is too large to be explained by the expectation model of the term structure of interest rates. According to the fundamental theory, an increase in the yield curve of fixed-income securities should reflect the fact that investors expect a rise in future interest rates. In reality, however, current high yields of long-term bonds normally provide a signal of abnormal positive returns for long-term bond holdings. In the case of corporate bonds, the volatility of credit spreads[32] tends to reflect changes in the risk premiums rather than changes in the default risk. The evidence of excessively high equity risk premiums observed over the past 40 years is also a puzzle that requires alternative explanations since they are inconsistent with the C-CAPM framework. Even though the CAPM may be able to explain the movement of the mean returns of securities and their "beta" with the market risk premiums, the large size of the premiums is still unjustified. The existence of those anomalies has led Cochrane (2011) to propose a discount rate hypothesis which argues that the main factor determining current market conditions is the "discounted part" that investors use to discount future expected cashflows, rather than the variation in the value of expected cashflows. This "discounted part" can be viewed as discount rates, interest rates, expected returns, or the risk premiums of the investment.

In general, it seems that low expected returns are observed after the "good times" and high expected returns after the "bad times". One of the main reasons for this phenomenon is that during "bad times", consumption, production output, and investment demands tend to be low while unemployment rates tend to be high. The expectation of low growth limits the ability of investors to bear risk. The capital and wealth of investors are also constrained during "bad times". Such a situation can generate a mismatch in the supply of and demand for capital in the market. Since investors take flight to safety and liquidity when the supply of risky assets is large, the discount rates or risk premiums will obviously be driven up. The recent financial crisis of 2007 provides a clear example of this mechanism, with price anomalies and arbitrage opportunities being created in various financial markets. According to this line of reasoning, trading liquidity, supply, demand, and the level of available capital are clearly significant factors that drive the movement of asset prices. Since pension schemes are one of the main institutional investors who provide considerable liquidity in the market, the reallocation of pension assets across different markets will clearly affect the price behaviour of securities to some extent. Section 8.3.1 will present a detailed discussion and empirical support regarding the impact of the

[32] Credit spreads are the differences between corporate bond yields and the yields from risk-free Treasury bonds with similar maturities.

imbalance in demands and supplies on financial asset prices.

Market segmentation is another factor which inhibits market efficiency. Investors tend to participate in those markets which offer the risk and return trade-offs most suitable to them. For example, pension schemes generally favour long-term bonds rather than short-term securities. Additionally, institutional investors are generally structured according to the type of financial assets in which they specialise, implying that there are actually limits on the degree of risk sharing within the pool of investors across different markets. Therefore, it is possible for capital being unable to move costlessly across different markets in order to end any arbitrage opportunities in a specific market. The elimination of those arbitrage opportunities tends to depend mostly on the invention and marketing of market participants in that local market. As a result, market segmentation can create the price pressure effect or the downward-sloping demand curve. Trading volumes that stem from the supply and demand of certain institutional investors may have some effect on security prices. One of the main theoretical frameworks related to market segmentation is the preferred-habitat theory, which was initially used to explain the relative price movement between short-term and long-term fixed-income securities. An explanation of empirical evidence related to this framework will be discussed in section 8.3.2.

8.3.1 The slow-moving of capital to absorb the imbalance in demand and supply of financial assets

There is ample empirical evidence showing that sizeable trading activities of institutional investors can influence the movement of asset prices. The price pressure effect created by these trading volumes conceptually results from the imperfect substitutability across different financial assets in the market (Scholes, 1972). The slow movement of capital to support large trading volumes may be due primarily to impediments such as search costs in finding trading counterparties or costs in managing inventory of market dealers. In order to test for the downward-sloping demand curve of financial assets, it is necessary to control for the informational effect which can alter their fundamental value. As a consequence, most studies in this area normally examine the magnitude of the price pressure effect during the announcements of an event that does not convey any changes in fundamental information. One such event that is mostly used by many researchers is the event of stock additions into stock market indices. The considerations to either added into or deleted from the market index do not generally provide new information about future expected cashflows. On the contrary, when any new stocks are added to the index, professional investors who track the movement of the index benchmark will have to reallocate their portfolios, so as to comply with the new composition of the index. This trading will create excessive demands for added stocks. For instance, analysis by Harris and Gurel (1986) shows that added stocks into the S&P500 index rise significantly after the announcement and effective date. Shleifer (1986) also finds similar results. Kaul, Mehrotra and Morck (2000) estimate that an increase in the demand for stocks that had just been announced to be included in the TSE300 index significantly lead to excess returns for added stocks of around 2.3 per cent.

Chen, Noronha and Singal (2005), who study the price movements of deleted stocks, find that while stock prices experience a sharp drop on the announcement date (on average around 8 per cent) and a further drop between the announcement date and the effective date (6 per cent), after 60 days from the effective date, prices tend to recover fully. In contrast to this complete price reversal, the prices of added stocks on the announcement date do not generally revert back to their pre-announcement levels. Wurgler and Zhuravskaya (2002) also show that the price behaviour of added stocks act in a similar way. The difference in the price reaction between added and deleted stocks may partly be explained by the liquidity level of assets. This is because added stocks normally experience a persistent increase in trading volumes while deleted stocks are not accompanied by a reduction in volume turnovers. Hegde and McDermott (2003) present an empirical analysis about the liquidity effect on added and deleted stocks, finding that prices of added stocks experience higher trading volumes of around 1.6 times than normal, which has led to cumulative abnormal returns as large as 2.3 per cent on the effective date. The certification hypothesis (Jain, 1987; Dhillon & Johnson, 1991), which explains any increase in prices after additions as resulting from the better long-term prospects of added firms, is unconvincing because the evidence of complete price reversals for deleted stocks appears to contradict this hypothesis, which suggests that prices of deleted stocks should not revert back to their pre-announcement levels.

Instead of analysing the event studies shown above, Levin and Wright (2006) use an econometric technique to test the downward-sloping demand curves. By using the transaction data of market makers for stocks in the FTSE100 index, they find that market makers adjust market prices when they observe unexpected changes in the inventory movement of a certain stock. This adjustment in prices as a response to excess demands represents the price elasticity of demand or the slope of the demand curve function for a given stock. They estimate that, on average, an excess demand of around 70 per cent over the normal trading volumes increases stock prices by around 1 per cent. The analysis by Froot, O'Connell and Seasholes (1998) also shows that international portfolio flows across 44 countries have a significantly positive effect on future equity returns. This effect of fund inflows to forecast future returns will be strong especially in emerging markets.

The price pressure effect from the imbalance between demand and supply is not limited only in the equity market. It has also been shown that the variation in government bond yields appears to be significantly affected by order flow imbalances rather than being associated only with changes in macroeconomic circumstances. The estimate by Brandt and Kavajecz (2004) shows that the imbalance between demands and supplies in the US Treasury bond market can explain the daily movement of bond yields by around 26 per cent. They assert that this price pressure impact appears to be persistent particularly during the period of low liquidity. Warnock and Warnock (2006) also find that foreign capital flows to purchase US government bonds have a significant effect on US bond yields.

The supply effect of government bond issuances on the Treasury yield curve has also been found. Reinhart, Sack and Heaton (2000) show that levels of government deficits are positively correlated with the slope of the yield curve. Fleming and Rosenberg (2008) also note that changes in Treasury supply can distort Treasury bond prices since dealers demand higher risk premiums to absorb changes in their inventory. More systematic evidence is demonstrated by Greenwood and Vayanos (2010) who show, based on data between 1952 and 2005, that the relative supply between short-term and long-term bonds is significantly related to the slope of the yield curve. Further evidence showing that demand can affect bond prices is found in Krishnamurthy and Vissing-Jorgensen (2007), who discover a significant negative relationship between credit spreads and the debt-to-GDP ratio, especially for long maturity bonds. They argue that the stronger effect on long-term Treasuries results from low substitutes from corporate bonds in the private sector. Fernald, Keane and Mosser (1994) and Kambhu and Mosser (2001) also find that, during the 1990s, the hedging activities of interest-rate option investors and mortgage traders have some influence on the slope of the yield curve. As bond prices seem to behave according to the downward-sloping demand curve, Baker, Greenwood and Wurgler (2003) show that firms can benefit from the predictability of yield curves by timing the duration as well as the maturity of new bond issuances.

The liquidation effect arising from the large redemptions made by investors in mutual funds is another test for the price pressure impact caused by demand and supply imbalances. These redemptions create a supply shock affecting individual securities held by mutual funds. Coval and Staffard (2007) find that in a sizeable redemption period, stock prices experience negative abnormal returns of around 7.9 per cent. Edmans, Goldstein and Jiang (2012) find that the price pressure effect from large redemptions persists over nearly 12 months. The movement of new capital to reverse this price pressure effect may be slow because other investors are unable to form rational expectations immediately upon seeing the drop in price. Typically, they would interpret the unanticipated liquidation as a signal of an unexpected adverse event, and since the detail of the liquidation is not publicly reported, it would take some time for other market participants to rationalise and identify whether the drop in price is attributable to adverse changes in fundamentals or just the result of an unexpected supply shock (Merton, 1987). Other agents would also be concerned about the asymmetric nature of the information, suspecting that some investors may possess better fundamental information. As a result, traders and market dealers require greater premiums as compensation for this concern (Acharya and Pedersen, 2005). Investors' rationalization will improve only if they receive additional information about future cashflows and details of the liquidation. Over time, prices may gradually recover if either the capital of rational investors is large enough to absorb trading orders of irrational investors or if the large redemptions do not continue steadily over long periods. Duffie, Garleanu and Pedersen (2007) develop a framework to measure the price pressure effect and price reversals of securities caused by the shift in the investors’ preferences in the OTC market. They argue that the magnitude of the price pressure impact and the time period required for the price reversal depends on the rate of locating appropriate counterparties to take on the positions.

Alternative asset pricing models that attempt to incorporate the effect of institutional investors’ trading behaviour on asset prices have been developed by many scholars. The two-period model firstly developed by Brennan (1993) suggests that the investment of institutional investors who passively tracks the performance of the benchmark index will increase stock prices that are added into the index. Cuoco and Kaniel (2011) also find similar results from a continuous-time model. A mathematical model developed by Vayanos and Woolley (2010) shows that fund flows of institutional investors can generate the non-fundamental comovement among securities that are overweighed by the active funds. They also show that the price pressure effect will be large for securities that contain high idiosyncratic risk. Basak and Pavlova (2012) construct an asset pricing model that directly links the proportion of institutional investors in the financial market with asset prices. They show that a rising proportion of institutional investors will increase the prices and volatilities of stocks included in the benchmark index. The net effect of this relationship leads to a reduction in expected returns and sharp ratios.

In particular, the slow movement of capital to absorb excess demands or supplies of a certain financial asset can be greatly amplified during the period of the funding and capital constraints of market players. The mathematical models of this theory have recently been developed by Brunnermeier and Pedersen (2009), Ashcraft, Garleanu and Pedersen (2010), and Duffie (2010). Broadly speaking, liquidity in the market can dry up when market participants face a shortage in capital and funding. The squeeze of arbitrageurs’ capital will make them reluctant to increase their exposure to risk, particularly with regards to investment positions that require high initial margins and large capital. This reluctance to take on positions can greatly reduce the liquidity of securities. As the volatility of asset prices increases and investment positions become more sensitive to hit margin thresholds, the ability of arbitrageurs to initiate a trade will be greatly reduced. Institutional investors may also face a capital shock due to the prospect of large redemptions by fund members (Shleifer and Vishney, 1997), which will further drive down market liquidity. This liquidity spiral will greatly intensify the price pressure effect of large order flows by institutional investors. It can only end if new capital flows into the market to stabilize asset prices and margin requirements. According to the theoretical framework developed by Ashcraft et al. (2010), a decline in interest rates and the haircutting of assets can significantly decrease the costs of new capital and expected returns required by traders. As the squeeze in both the funding and market liquidity lessens, prices of financial assets will gradually recover. This mechanism explains how the slow movement of capital can reduce the degree of the market efficiency.

The capital constraint of market players also leads to commonality in price behaviour across financial asset classes. Security prices will be driven more by trading flows rather than any variation in fundamentals. For instance, Chordia, Roll and Subrahmanyum (2000) show that money flow can explain the majority of coordinated price movement across equity and fixed-income markets. An interesting empirical analysis by Coughenour and Saad (2004) further shows that when NYSE specialist firms encounter low funding and less capital, the prices of stocks they handle exhibit a high degree of comovement in comparison to other stocks. Generally speaking, dealers and specialists are the market participants who provide liquidity and trade immediacy to investors. Their ability to absorb order imbalances significantly diminishes when they have funding constraints. To explain this mechanism, Gromb and Vayanos (2010), Duffie and Strulovici (2011), and Lagos, Rocheteau and Weill (2011) propose alternative asset pricing models to traditional asset pricing theory, each of which finds that the variation in the security risk premiums is significantly distorted when funding liquidity is constrained. This theoretical suggestion has been supported by considerable empirical evidence. Meli (2004) shows that the variation in dealers' capital is strongly correlated with swap spreads. Collin-Dufresne, Goldstein and Martin (2001) also discover a high comovement in credit spreads while Boudoukh, Whitelaw, Richardson and Stanton

(1997) find similar evidence for the price behaviour of mortgage-backed securities. Fleckenstein, Longstaff and Lustig (2010) note that the arbitrage opportunities resulting from the mispricing between TIPS and Treasuries, and between corporate bonds and CDS, strongly comove even though those assets are traded in very different markets. All the empirical research on the commonality of security prices tends to suggest that shocks affecting the availability of capital can drastically reduce market liquidity and increase the degree to which security prices are affected by supply and demand.

According to the literature discussed above, it seems clear that asset allocation of institutional investors can significantly distort asset prices over certain periods of time. The impact of pension schemes' asset allocation on financial asset prices and returns may be highly possible. The presence of pension schemes since the 1960s is one key factor that has led to a substantial increase in market liquidity. When liquidity is diminished as a result of pension schemes unwinding their investment positions, one would expect the prices of such assets to be lower in terms of P/E ratios or market-to-book ratios in order to reflect the higher expected returns required by investors as compensation for taking on large investment positions of pension schemes.

Moreover, the existence of some behavioural biases and cognitive limits may indicate that if pension schemes' trading activities do actually have some influence on asset prices, investors in the market may not be able to recognise this price pressure effect. This results from the fact that the price impact of pension fund flows may be too low for them to be recognised in the short-term. Market players are generally only able to identify noticeable price shocks caused by block trading volumes over a short period of time. However, the marginal price pressure effect from pension schemes' trading activities does not necessarily imply that the effect is negligible in the long-term. This is because the marginal price impact can be accumulated in the long run, thereby leading to a significant long-term influence on asset prices. The inability of market players to identify, on a daily basis, the marginal price impact of pension schemes' trading activities also implies that they may interpret, at the end of each trading day, the marginally distorted prices of assets as equilibrium fundamental prices. For instance, stock prices can be supported at lower bounds by a continued increase in pension funds' equity investments. Since other market players cannot identify that this support in prices is caused by the large purchases of pension schemes, they may interpret these daily price increases as being a market-wide escalation in the valuation, concluding that the high premium valuation embedded in asset prices reflects the long-term forward looking of aggregate investors. Therefore, they will consider an increase in the expensiveness of financial assets (in terms of P/E ratios or EV/EBITDA ratios) as being a new normal level. This line of reasoning may be able to explain why rising equity prices over the past 50 years cannot usually be justified by cash flows in subsequent periods.

8.3.2 Market segmentation and limit on arbitrage

Market segmentation - the limited ability of investors to share financial risks with each other - is another key factor inhibiting the efficiency of the financial market. The capability of arbitrageurs to integrate different markets is limited due both to their degree of risk aversion and to their availability of capital to absorb supply and demand imbalances. Only suitable investors can actively participate in a specific market, implying that prices of financial assets may be predominantly determined by "local" factors such as investors' supply or demand shocks in that particular market. The price behaviour of securities will, therefore, move according to the downward-sloping demand curve rather than the horizontal line. The main theoretical model explaining the behaviour of security prices in terms of market segmentation is the preferred habitat hypothesis, initially proposed by Culbertson (1957), and Modigliani and Sutch, (1967). This hypothesis has been rigorously applied to explain the movement of the term structure of interest rests. In other words, the variation in bond prices tends to exhibit a price pressure effect. The interest rates of fixed-income securities with particular maturities appear to represent the equilibrium prices determined by the supply and demand of economic agents who actively trade in that subset of maturities.

In theory, the underlying mechanism that integrates markets containing bonds with different maturities relies on the trading activities of arbitrageurs. In an ideal world, arbitrageurs are risk neutral, caring only about fundamental risks such as the volatility of short-term interest rates or the movement of future inflation rates. Other non-fundamental risks relating to the possibility of either supply or demand shocks are irrelevant because it is assumed that arbitrageurs have an unlimited availability of capital. As noted in Greenword and Vayanos (2010), if arbitrageurs have a low degree of risk aversion then they will be able to absorb a certain amount of supply or demand shock, but what will be of more concern is the variation in short-term interest rates. The movement of bond prices across different maturities will be more closely related to changes in the market price of short-term interest rate risks because arbitrageurs can partly smooth local demand or supply shocks by executing an arbitrage strategy. For example, if there is a surge in demand for short-term bonds which subsequently leads to a sharp increase in price or a reduction in short-term yields, arbitrageurs will short the short-term bonds and use the proceeds to buy long-term bonds. This activity spreads the local demand shocks across the entire term structure of interest rates and helps to keep the yield curve in sync with the pure expectation hypothesis (Lutz, 1940). However, in reality, arbitrageurs do not perfectly behave like this. Arbitrageurs' high degree of risk aversion implies that bond prices will be more closely related to "local" shocks of excessive demand for a particular segment of maturities.

Greenwood and Vayanos (2008) develops mathematical frameworks which explain the underlying mechanism of the preferred habitat hypothesis, their predictions clearly explaining the actual movement of bond prices. They find that the relative supply differences between short-term and long-term bonds are significantly related to the variation of term spreads[33]. A rising supply of short-term bonds is associated with an increase in short-term interest rates. They also find that the supply effect on bond prices is particularly strong for long-term maturities. After controlling for the Cochrane-Piazzesi (2008) factor[34], the term spread increases by 39 basis points when the relative supply of long-term bonds increases by one standard deviation. Greenwood and Vayanos (2008) explains that this strong price pressure effect on long-term bonds results from the high expected returns required by arbitrageurs to

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[33] The term spread is the interest rate difference between long-term and short-term bonds.

[34] The Cochrane-Piazzesi (2008) factor is the common factor that can explain the price movement of bonds across different maturities.

compensate for high risks in the movement of long-term interest rates and inflation rates. This line of reasoning indicates that market segmentation is caused by the inability of arbitrageurs to move capital costlessly across bonds with different maturities and by the presence of arbitrageurs' risk aversions, which limit their ability to bear risks. Therefore, market segmentation could amplify the price pressure effect that arises from the slow movement of capital, especially during bad times when arbitrageurs face capital constraints and unanticipated forced liquidation.

Pension schemes are institutional investors that have a special interest in a segregated segment of financial assets. Pension funds are particularly active in securities that can provide superior long-term risk and return trade-offs so as to match the variation of their long-term nominal liabilities. As a consequence, it has been shown that the excessive demand for long-term bonds of pension schemes appears to create a price pressure effect on bond prices. This evidence is apparent in the UK bond market. Following the enactment of the 2004 Pension Act, UK pension schemes were strongly incentivised to increase their investment positions in long-term government bonds. According to Greenwood and Vayanos (2010), UK pension schemes had net investments of around £11 billion in index-linked GILTs and GILTs with maturities over 15 years between Q1 2005 and Q4 2006. UK pension funds also readjusted their portfolios by increasing investment positions with a large exposure to the movement of long-term interest rates. The total amount of this readjustment was around £50 billion. The combined amount of money flowing to long-term assets has created a significant negative effect on the yield curve of long-term bonds.

Greenwood and Vayanos (2010) shows that the interest rate spread between bonds maturing in 2035 and 2016 was negative in 2003, and declined further, to as low as -0.68 per cent at the end of 2006, the lowest level observed in their history. Sizeable demands by UK pension schemes for very long-dated GILTs also led to a yield of only 0.48 per cent for bonds maturing in 2055. BIS (2007) also notes that yields on index-linked GILTs significantly dropped to as low as 0.9 per cent and 0.7 per cent for the 30-year and 50-year maturities in 2006 respectively. These levels of yields on long-dated inflation-protected bonds were much lower than those in the Euro and the US market. It is particularly low when compared to the long-term real interest rates of 3 per cent in the UK economy. The large size of this price pressure impact also implies that the price elasticity of pension schemes' demands for long-term bonds tends to be low. This may result from the changes in pension regulations and the funding positions of UK pension schemes which force them to purchase long-term bonds regardless of the prices. Even though there is evidence that arbitrageurs attempt to spread this "local" demand shock to bonds with nearby maturities, the impact of arbitrageurs' trading activities to stabilize the yield curve is relatively low compared to the sizeable money flows of pension schemes. Some pension schemes may also decide to take on some derivative positions such as the use of interest rate swaps in order to avoid the price pressure effect in long-term bonds. However, counterparties of such derivative contracts still have to hedge their positions in the bond markets; thereby leading to some impact on bond prices.

The influence of pension schemes' asset allocation on the price of fixed-income securities is not limited only in the UK bond market. The excessive demands for long-term bonds have also been estimated to exceed the bond supply in the US bond market (Visco, 2005). OECD (2006) estimates that the magnitude of the imbalance in demand and supply of high quality bonds is large across different currency and maturity segments of long-term bonds. Changes in the pension accounting standard and tax regime in Denmark have also led Danish pension schemes to significantly increase long-term bond positions. BIS (2007) documents that this asset allocation largely reduces the interest rate spread between Euro and Danish 10-year government bonds. Distortion in the price of inflation-protected bonds has also been observed in Canada. Reid, Dion, and Christensen (2004) show that the large demand from pension schemes significantly reduce yields on inflation-linked bonds. This has led to the widening in the yield spread between nominal yields and real yields, which cannot be justified by the rational expectation of future inflation.

The effect of market segmentation on asset prices can also be observed in the equity market. It has been shown that the price behaviour of stocks within a market index is different from the price variation of non-index stocks. For instance, Barberis, Shleifer, and Wurgler (2005) find that there appears to be a high comovement among stocks in a market index. When a given stock is deleted from the index, the correlation of its price variation with other stocks in the index significantly declines. Because the subset of investors who actively trades index stocks is different from those who actively buy and sell non-index stocks, the empirical evidence shown above clearly suggests a strong influence of fund flows on asset prices. A recent study by Boyer (2011) also finds similar results in the case of stocks that have been switched from the value index into the growth index.

As discussed above, the presence of frictional costs in the financial market inhibits securities from maintaining their fundamental value. The assumption that the investments of irrational or "less-than-rational" investors has only a trivial short-term effect on security prices appears not to be the case in reality. The evidence of price anomalies in the financial market indicates that the functioning of arbitrageurs' trading activities to absorb the imbalance in the supply and demand of those groups of investors who do not always make trading orders based solely on a consideration about fundamentals are limited. Therefore, the price pressure effect stemming from the asset reallocation of the majority of pension schemes, which can occur at nearly the same time, may have some profound impacts on financial asset prices. However, demographic transitions do not only have an impact on financial asset prices through the trading activities of pension schemes. Shifts in demographic structures can also have a direct fundamental impact on the rates of return to capital and the growth rates of aggregate economy. The next section will discuss this potential impact.

8.4 The direct fundamental impact of demographic transition on asset prices and returns to capital

It is not only on financial asset prices where demographic transition has impacted through changes in the pension schemes' investment strategies. The dynamic of demographic structures can also have a direct fundamental influence on the expected rate of return to capital, thereby determining the price movement of financial assets. A range of aggregate economic factors can be significantly affected by demographic transition. In general, a rising old-age dependency ratio implies that the supply of labour relative to the size of the economically-inactive population will be reduced. The level of aggregate employment and labour productivity are expected to decrease due primarily to the rising average age of the workforce. In addition, the strong relationship between household saving decisions and their lifetime age profiles (as shown in chapter 6) also suggests that aggregate saving rates may decline as a result of population ageing. Both a decline in the percentage of savings to total income and a reduction in the workforce can limit the growth rate of the economy. An increase in the proportion of pensioners, it has been argued, may also lessen the demand for investments since the lack of labour supply and the abundance of capital in the market suggest that labour wages will increase at a relatively higher rate compared to the rate of return to capital. These interactions will eventually lead to a drop in equilibrium real interest rates, real GDP per capita and real consumption per capita.

This section will discuss a range of literature which investigates the impact of demographic transition on aggregate economic indicators. Section 8.4.1 will illustrate research that attempts to estimate the relationship between the demographic pattern and the productivity level of labour. It will also include a discussion about the shift in employment rates and the interaction between the supply of labour, wages and returns to capital. The impact of population ageing on investment demands and aggregate saving rates will be considered at the end of this section. A theoretical model that incorporates all those feedback mechanisms, so as to simulate the partial impact of demographic structure on the aggregate economy, is the overlapping-generational model (OLG). As such, section 8.4.2 will discuss simulation results from a number of different OLG models.

8.4.1 The relationship between demographic transitions and aggregate economic indicators

Within the literature there are a number of studies which identify a significant relationship between age structure and labour productivity. Focusing on the share of the population in each age group, Lindh and Malmberg (1999) conclude that the fraction of the elderly has a significantly negative influence on the growth rate of labour productivity. Feyrer (2007) shows that workers aged between 40 and 49 tend to have a positive significant impact on labour productivity. These findings can explain the rise in the US productivity during the 1990s following the slowdown of the 1970s. He further posits that the variation in the age structure of the workforce explains approximately a quarter of the differences in the productivity level between OECD and low-income countries. According to a panel data analysis across developed and developing countries, Werding (2008) estimates that total factor productivity (TFP)[35] exhibits an inverted u-shape age profile, which is consistent with Feyrer (2007). Bloom, Canning, Fink and Finlay (2007a) also finds that per-capita output is negatively related to the growth of the dependency ratio. A more recent work by Boulhol (2009), which uses the "Perry-weighting" technique to estimate the impact of demographic structures on employment and follows the work of Jorgenson, Gollop and Fraumeni (1986) to estimate the impact on productivity, illustrates that the variation in demographic structures among OECD countries accounts for around 16 percentage points of the gap between the OECD GDP per capita and the level seen in the US, estimating that three-fifths of this demographic impact are due to differences in labour productivity with two-fifths due to employment rates. His results support Beaudry, Collard and Green (2005) who note that economic performances among developed countries during between 1960 and 2002 are strongly related to the age structure of each country.

An increase in the average age of the workforce is not the only factor contributing to a reduction in overall productivity growth. Productivity can also be significantly reduced by the lack of skills amongst newcomers to the labour market (Lamo, Messina & Wasmer, 2006). In addition, changes in the proportion of output can also influence the expected growth rate of future productivity. The production growth rate in the service sector may be higher than the growth rate in the manufacturing sector when the proportion of the elderly is higher. Since the productivity growth rate in the service sector is typically lower than in the manufacturing sector, the overall growth rate in productivity should decline when faced with an ageing population. Although the negative effect of ageing may be limited to between 10 and 20 years, there is still the question of how long the slowdown in productivity and in the whole economy will be.

[35] Total factor productivity measures the impact of technological improvements and efficiency on production outputs after controlling for all inputs.

Furthermore, the ageing of the baby boom generation also implies that the labour supply over the coming decades will be relatively lower than over the past 50 years. McDonald and Kippen (2004) analyse the variation in fertility rates across 16 developed countries, finding that France, Germany, the UK and Italy are expected to experience the lowest growth rate in labour supply over the coming decades. In order to reduce pension budget deficits, the OECD (1998) proposes that an increase in employment rates at older ages is necessary. Some of the effects on the economic growth rate of this shortfall in employment can be found in Turner, Giorno, De Serres and Vourc'h (1998). Their simulation shows that by 2030 the annual economic growth rate will drop to 0.25 per cent in Japan, 1 per cent in European countries and around 1.5 per cent in the US. Boersch-Supan (2003) also shows that the impact of lower productivity on economic growth rates is less significant than the impact of a reduction in labour supply. However, there may be an offsetting factor, caused by a rising proportion of young women in the workforce, engendered by the curtailing of age and sex discrimination in the workplace. This factor can help to reduce the negative impact of population ageing on labour supply and labour productivity (Burniaux, Duval & Jaumotte, 2004). A projection model by Carone et al. (2005) finds that the GDP per capita may decline by less than the fall in the overall GDP growth rate. This simulation, they argue, stems from the offsetting factor of rising female participation rates in most EU countries during the 2010s. Additionally, Cutler, Poterba, Sheiner, Summers and Akerlof (1990) argue that the scarcity in the labour supply will incentivize firms to increase R&D expenditure, which also helps to increase labour productivity.

A further negative effect created by the reduction in the working-age population is that the labour supply will be relatively lower than the capital supply. The implication of this is that labour wages will increase while the returns to capital will decrease as a result of the relatively abundant supply of capital. The returns to capital will fall further if the savings demands of the next generation are higher than the reduction in the labour supply. Moreover, it is expected that there will be fewer investment opportunities when the majority of the population consists of economically-inactive pensioners. As argued in Cutler et al. (1990), the shrinkage in labour supply reduces the quantity of investments needed to maintain the level of the capital to labour ratio. A simulation model by Masson and Tryon (1990) also highlights a negative effect of population ageing on the domestic demand for investments. The clearest example regarding the impact of the shrinkage in labour forces on production output and investment is the economic experience of Japan since the 1970s (Faruqee & Muhleisen, 2003). The population ageing effect will induce firms to reduce production accordingly; as such, the economic growth as well as the rate of returns will be limited. The interaction of all these factors will lead to a long-term decline in equilibrium real interest rates, dividend yields and gilt yields. In their simulated model, Cutler et al. (1990) notes that an increase in the capital to labour ratio would reduce the return to capital from around 6.7 per cent in 1990 to only 3.5 per cent in 2025.

Furthermore, Higgins and Williamson (1997) argue that the dynamic of demographic structures has a different impact on the demand for investments and on the supply of savings. They show that the variation in investment demand appears to be more closely related with the movement of the fraction of children whereas the saving supply tends to be positively related with the fraction of the working-age population. Based on their findings, one would expect that a young-age economy should experience current account deficits. This situation stems from the fact that the high level of domestic investment is mostly financed by foreign capital due to the limited supply of domestic savings. Rapidly ageing nations such as the US and those in Europe have also been projected to become capital importers because the decline in domestic savings occurs at a higher rate than the decline in investment demand (Brooks, 2003). Regarding the impact of demographic structures on the real consumption level, Weil (1997) provides evidence that the drop in fertility rates during the 1960s helped to boost consumption levels after 1970. He projected that the consumption level will decline by 10 per cent between 2010 and 2030, primarily due to population ageing.

The overall impact of population ageing on the aggregate economy has been analysed by several researchers. According to the European Commission (2002), a sharp reduction in the fraction of the working-age population among EU countries is expected to result in the growth rate of GDP per capita to be lower than the US growth rate by around 0.4 per cent over the next 50 years. Carone et al. (2005) further indicates that the impact of the ageing can reduce GDP per capita by approximately 0.2 to 0.3 per cent annually. By using a dynamic intertemporal equilibrium model, Batini, Callen and McKibben (2006) demonstrate that population ageing will result in current account weakening and a sharp decline in productivity growth rates. The impact of demographic transition on both fiscal and monetary stability has been reviewed by BIS (1998) and Davis (2004b) respectively. Bikker (1996) argues that balance-of-payments would be in deficit when population ageing causes a decline in the labour workforce and an increase in dissaving among retirees. Davis (2006) empirically shows that the proportion of the 40-64 age group in OECD countries is positively associated with a surplus in external balances, while the fraction of the population over 65 is related to a deficit. Looking globally, it is expected that countries with faster population ageing will see their current account in deficit relative to other countries.

8.4.2 The Overlapping Generational Model (OLG) as a mathematical framework to examine the causality between demographic transition and the aggregate economy

The main mathematical model that links all the feedback mechanisms between demographic transition and macro-economic factors is the overlapping-generational model (OLG). Following the insights of the lifecycle theory (Modigliani and Brumberg, 1954), Auerbach & Kotlikoff (1987) were amongst the first group of researchers to develop the OLG model. This model has been widely used in the analysis of social security public policy to estimate projections of certain economic variables, such as saving rates and interest rates, in response to the demographic shift. OLG simulations can be used to help policy makers identify whether any alternative adjustments to existing economic policy would lead to sustainable, welfare-enhancing outcomes based on specific assumptions about future demographic distribution.

Broadly speaking, optimal economic decisions can be derived from the OLG model by separating individuals into different age groups. It is assumed that people are forward-looking and have perfect foresight regarding their future employment income and expected returns from savings, and that they make optimal decisions by incorporating these factors into a lifetime utility function. The lifetime wage pattern is normally assumed to have an inverted U-shape profile, thereby reflecting empirical evidence of the peak in real labour income between the ages of 45 and 50[36]. In general, returns from invested capital are based on assumptions about production functions. When an individual reaches retirement, the OLG model assumes that their consumption is financed only through the dissipation of accumulated wealth. Therefore, in order to gain the maximum utility level, consumption should be planned so that, upon the expected date of death, all wealth should have been consumed, so long as there are no bequest motives. Economic activities made by individuals at each age will determine aggregate economic outcomes, which can be achieved by incorporating the proportion of the population at each age over a period of time. Since demographic structures determine saving and investment supply, asset prices and expected returns should be affected by the fundamental impact of the demographic transition.

There has been much literature which has examined the impact of demographic patterns on the capital market, in particular the effect of baby-boomers, through the use of overlapping generational models. A variety of modifications to the basic overlapping generational model have also been proposed. However, the magnitude of the demographic impact on capital markets using these different models varies. Abel (2001; 2003) relaxes the assumption about the fixed supply of capital by allowing it to vary. He models the dynamic movement of capital prices by a stationary autoregressive process, thereby implying that capital prices have a long-term unconditional mean. He discovers that an increase followed by a sharp decline in fertility rates leads to a decline in the rate of return from invested capital when compared to a steady state economy with constant birth rates. Therefore, the baby boom generation would experience lower investment returns than other generations because during the period when baby-boomers are saving (i.e. when they are in the labour market), the price of capital will be high. Abel (2001) also finds that results

[36] As argued in Lazear (1979), the lifetime hump-shape wage profile can increase productivity levels and prevent shirking. The wage levels are normally below the marginal rate of productivity at the beginning of the employment and above it as retirement approaches.

from the overlapping generational model both with and without the bequest motive are similar.

Instead of making assumptions about changes in fertility rates, other researchers have calibrated these changes with actual experiences. Yoo (1994b) develops an overlapping generational model by dividing an individual lifetime into 55 consecutive ages, assuming 45 years of work. After calibrating this individual lifetime with actual demographic patterns, he finds that baby boom cohorts experience less attractive returns than other cohorts. Moreover, he finds that results are sensitive to the assumption about the supply of capital. Asset prices are estimated to increase by 35 per cent compared to the benchmark case (the stable population growth assumption) in the case of fixed supply of capital. Under this model, with a variable supply of capital, the baby boom effect on asset prices is diminished to around 15 per cent.

Unlike Yoo (1994b), Brooks (2002) assumes four stages in the lifecycle: youth, young workers, old workers, and retirees. He also investigates the impact of demographic shift on different asset classes, such as riskless bonds and risky equities. His model is calibrated using the empirical evidence that older people tend to prefer holding riskless bonds as opposed to risky assets. Based on his overlapping generational model, equity risk premiums increase when baby-boomers age. For risk-free return, he finds that returns reduce by approximately 50 basis points, following calibration of US demographic evolution. This simulation stems from the shift in household portfolios from equity investments towards bonds when they reach retirement as a way of reducing the consumption risk. Moreover, this model also shows that the equity risk premium will decline when baby-boomers are in the working-age range but rise when this cohort reaches retirement. However, according to Brooks’ (2002) model, the estimated magnitude of the impact is too low to cause an asset meltdown scenario.

Geanakoplos et al. (2004) not only incorporate the actual age profile but also post World War II U.S. income patterns in an overlapping generational model. They also investigate other factors that may affect lifetime household saving behaviour, such as social security provision, bequest motives and wage shocks. Their main finding is that demographic shock generates a swing in asset values. Although actual historical swings between the highs and lows of the S&P index are greater than can be explained solely by demographic shocks, the movement of price-to-earning ratios corresponds fairly closely with the variation in the medium to young ratio. After including business cyclicality, the swing of equity prices simulated by the model appears to more closely match the actual movement. Based on their models, price-to-earning ratios are expected to decline, falling to around 5-16 times earnings over the next twenty years. Moreover, their model also shows a “favoured cohort effect”, where the cohort with a larger proportion appears to experience worse investment performances than other smaller cohorts. To illustrate this point, when a large cohort moves into the middle age, they will bid up the prices of equities, leading to probable low rates of return in the future. In contrast, a small cohort could purchase equity at low prices as a result of the large supply by the large old-age cohorts. Another negative effect on large cohorts is the low wages they can earn during the middle ages. These relatively low wages stem from a high competition in the labour market (Easterlin, McDonald & Macunovich 1990). Murphy, Plant and Welch (1988) calculate that large cohorts will receive labour wages around 10 per cent below the average size cohort.

Rather than assuming a fixed assumption on technical progress, Miles (1999) finds that the shape of technical progress is a significant factor determining the estimated impact of demographic structures on the capital market. He also shows that while pension reforms which include the reduction of replacement rates can increase aggregate saving rates, the equilibrium real interest rates will be lower than the baseline case, due primarily to the higher capital to labour ratio. After calibrating the OLG model with UK data, Miles (1999) projects that by 2060 the capital to labour ratio will rise by 12 per cent if the replacement rate is reduced to 20 per cent of average earnings.

Instead of focusing on the demographic transition from a young to old age structure, Donaldson and Maddaloni (2002) extends Constantinides, Donaldson and Mehra’s (2002) OLG model to examine the partial effect of the growth rate of the overall population on the capital market. Their key finding is that equity risk premiums are negatively related to population growth rate. They argue that this simulation is caused by an increase in aggregate wages, which are paid to a larger workforce. These labour costs will reduce dividend payments to equity holders.

The literature noted above mostly uses OLG models to study the impact of demographic transition on the rate of returns for broad financial assets such as bonds and equities. Given that other specific asset classes are not separately investigated, Cerny, Miles and Schmidt (2006) attempt to explicitly incorporate housing assets and a PAYG pension system into the OLG model, so as to estimate the interaction between pension reforms and housing demands. Having calibrated the model with the UK economy, they find that the less-generous public pension is directly related to an increase in housing demand, which by 2050 may drive up house prices by 8.5 per cent. If there is an increase in the minimum retirement age to receive a public pension, it is likely that saving rates will fall because there will be less time for households to consume their accumulated assets during retirement. Based on these results, it may be difficult to achieve the *pareto* efficient outcome. Even though a decline in the generosity of the pension system may enhance the welfare of current middle-aged cohorts, current elderly cohorts will lose out as a result of not having the opportunity to accumulate sufficient assets when they were younger.

However, the OLG has five major limitations which need to be considered. The first is the reliability of assumed functions regarding utility functions. A variety of utility functions have been developed to represent the actual utility evaluations of households. The constant relative risk aversion (CRAR) utility function may be too simple to adequately reflect human economic behaviour. Other classes, such as the Hyperbolic Absolute Risk Aversion (HARA) utility function, or the sophisticated Epstein-Zin utility function, both of which have been developed to separate the effects of time preference and substitution elasticity, can also be used. Assumptions regarding the appropriate level of parameters used in the utility function, such as the risk aversion coefficient or the rate of substitution, are rather subjective. Other factors that may constrain individual’s decisions about consumption and saving are not normally included in the model as a result of the complexity of numerical problems.

The second drawback of an overlapping generational model is the assumption regarding the supply of capital. If it is assumed that there is fixed supply of capital, the magnitude of the impact of demographic shock on asset returns will be unrealistically amplified. Typically, an increase in the price of capital also has an influence on the growth rate of new capital to the market. In theory, if the adjustment cost of new capital is assumed to be zero, the total capital stock in the market will vary such that the capital is always priced at its reproduction cost. In other words, the supply curve of capital will be perfectly horizontal, reflecting the fact that the capital supply can always be adjusted optimally to the changes in investment demand. This idealistic situation will blunt the impact of demographic shock on the price of financial assets which have contingent claims on physical capital. However, because in reality an adjustment cost will be incurred from changes in the capital stock, demographic transition may have some effect on the capital market. Research by Lim and Weil (2003) shows that variation in the supply of capital will affect the impact of demographic shock on asset prices. By adjusting the installation costs of capital, they prove that high installation costs mean that demographic transition has a significant influence on asset prices. They also note that rational households will be less able to smooth their lifetime consumption because they will have to accumulate capital at expensive prices due to high frictional costs in the capital supply. Abel (2001) also finds that the magnitude of changes in asset prices caused by demographic shock is sensitive to the assumption of the supply of capital.

The third issue relates to the assumption surrounding economic boundaries. In a world where the economy is closed, there would be no international capital and labour flows. This assumption makes the impact of the baby boom effect on the domestic capital market more severe than it is in practice. Since demographic changes in different countries do not take place at the same time or to the same magnitude, there will be labour and capital flows to countries which are less adversely affected by demographic shocks relative to the domestic market. Such a situation will attenuate the impact of the baby boom effect on the capital market.

Through globalization and international financial integration across capital markets, asset prices and returns in a given market will be influenced by demographic patterns throughout the world rather than just according to the patterns of one particular country. In a perfectly open economic system without trade barriers, the level of domestic demand does not depend solely on the country's own saving supply but rather on the total supply of savings worldwide. Consequently, it may be misleading to assume that in a closed economy interest rates are exogenously determined. A country with a larger economy relative to the world should have a greater impact on world equilibrium real interest rates.

Recent empirical analyses on the major effects of international capital flows, as undertaken by Boersch-Supan, Ludwig and Winter (2006), show how pension reforms and demographic changes have impacted on the return to capital in an open economy framework. They show that using the closed economy assumption, the rates of return to capital in Germany will decline by 0.5 per cent between 2012 and 2026. The declining rate of return to capital is reduced to 0.3 per cent if the OLG model allows for international capital flows within the EU region, and to only 0.1 per cent if the capital is allowed to move freely across the OECD area. Boersch-Supan and Ludwig (2009) also develop multi-country OLG models that consider the interaction of labour and capital markets between the US, European countries and Asian nations. They find that with a funded pension system, the impact of demographic transition on returns to productive assets is higher than with a PAYG system. Other multi-region OLG models include the simulation by Juillard et al. (2000), who derive a three-region OLG model which represents the dynamic international capital flow between Europe, Japan and North America, and that of Attanasio and Violante (2000), who construct an OLG model of two open economies consisting of the North American and Latin American region. Brooks (2006) argues that a country which has an old-age structure will become a capital importer relative to a young country; therefore, the impact of ageing on the returns of domestic capital will be partially mitigated. However, his study does not endogenously consider the effect of ageing on technological progress and labour supply decisions. Brooks' (2006) argument is consistent with that of Siegel (2006), who points out that ageing countries will have to sell foreign assets in exchange for goods and services.

One main concern of all these analyses pertaining to an open economy is the inaccuracy of their calibration with historical capital flow patterns. Additionally, multi-region OLG models are still far from complete because certain economic variables, such as exchange rates and global real interest rates, are exogenously assumed (Boersch-supan et al., 2003; Fehr et al., 2003). This implies that simulation results regarding spillover effects across different countries may not accurately represent the actual global general equilibrium. Recent OLG models that endogenously derive global interest rates include Saarenheime (2005) and Merette and Georges (2010). Saarenheime (2005) shows that the rate of decline in global interest rates will be high if the generosity of public pension systems remains at the current level. Meanwhile, Merette and Georges (2010) illustrates that old countries will earn some intertemporal gain from international trade with young countries.

The fourth issue focuses on the assumption used in the production function. Most of the research in this area assumes Cobb-Douglas Production functions, which contain certain deteriorating rates of capital values. The main variable that links the utilization of capital with rates of returns is the labour productivity parameter. Since demographic changes have resulted in a higher average age of the workforce, there is a lack of robust knowledge about the impact on the dynamic of productivity. In an OLG model, the productivity rate is generally assumed to be constant at a particular level. Cutler et al. (1990) finds that if there is a strong relationship between productivity and demographic patterns, the impact of demographic transition on the capital market through other mechanisms may be blunted. As discussed in the previous section, Werding (2008) and Feyrer (2007) point out that there is an inverted U-shape relationship between age and total factor productivity (TFP), finding that highest labour productivity occurs with workers aged between 40 and 49.

The fifth limitation is related to the assumption pertaining to rationality in individuals' decision making. Based on the OLG's concept of optimal derivation, it is assumed that investors are capable of predicting their own future labour income and investment returns. However, in reality this 'forward-looking' assumption is difficult to observe because the problem is too complex and involves the estimation of various variables in the long-term. These variables include labour income, investment returns, and survival probability. If actual behaviour is biased and irrational, aggregate demands for capital by the population may often be different from modelled simulations. In addition, if the assumption regarding perfect foresight on the future impact of demographic transition on the capital market is correct, current asset prices should already reflect any adjustment stemming from this impact. If market participants foresee that the retirement of the baby boom generation will cause asset prices to fall, they will begin short-selling assets at current market prices in advance of the expected price fall so as to reap maximum profits. There will also be lower current demand for these assets because investors foresee that prices will fall following the retirement of baby boom generation. This situation creates pressure for asset prices to fall immediately; therefore, there will be no price adjustments at the time baby-boomers retire. However, DellaVigna and Pollet (2005) suggest that demographic effects occurring more than six years in the future have a low impact on current market prices, implying that individuals do not have perfect forward-looking characteristics about future outcomes.

An accurate, unbiased simulation resulting from the derivation of the OLG is difficult to achieve because the model requires a variety of simplified assumptions regarding the economy and household decision-making. For example, there is yet to be any widely-accepted view as to whether any particular utility function represents the actual behaviour of households. If we add further constraints representing more realistic assumptions into the OLG model, such as borrowing costs, the variable supply of capital and the presence of international capital flow and bequest motives, complex computational routines are typically required in the derivations of the model. When combining all these conditions together, it is generally impossible to derive a closed-form solution of the problem, and numerical techniques may be required so as to identify the model’s equilibrium paths.

Moreover, the key significant assumption underlying the OLG is the inverted u-shape age pattern of household financial asset ownership. In other words, it is assumed that individuals without a bequest motive acquire assets as they save during their working lives, and then start to decumulate these assets when they retire. However, as has been shown by several pieces of research on household survey data, it seems clear that economists do not agree on the rate of decumulation by the elderly in retirement. Issues such as bequest motives and precautionary savings may create a slow dissaving rate. As shown in Chapter 6, the dissaving behaviour of British households' direct investments is not high during retirement. On the contrary, the dissaving rate is fairly low and begins only after the age of 65. The presence of pension schemes seems to be the main mechanism that reinforces the lifetime saving behaviour of households to comply with the lifecycle hypothesis. British households significantly reduce their savings through pension schemes as they approach retirement. Therefore, researchers who focus on how the OLG model is constructed may be interested to incorporate the lifetime saving behaviour of households through pension schemes into the model as this may generate more accurate representations of actual saving behaviour.

8.5 Policy implication to attenuate the impact of population ageing on the financial market

The impact of pension schemes' asset allocation on financial asset prices over the next 30 years can be partly mitigated by the implementation of some policies. These policies may include the transformation of the funding structure of nation-wide pension provisions, the encouragement of the workforce participation by women and older workers, the introduction of new financial securities to support excessive demands by pension schemes, and the reduction in the economic costs of international capital and labour flows. As shown in chapter 2, there has recently been a strong trend away from DB-type pension schemes to DC-type funded plans or hybrid schemes in both public and private sectors in many developed and developing countries alike. This transition suggests that the relative amount of money managed by DC pension plans will gradually increase while the importance of DB pension schemes in the financial market will gradually decline over time. Since there are no explicit pension liabilities that DC pension plans are required to meet, asset allocation of these plans may not be significantly related to the dynamic movement of the age structure of plan members. As DC plans increasingly become the main pension schemes in the market, the strong linkage between demographic patterns and aggregate pension asset allocation observed over the past 50 years might gradually diminish. A detailed discussion on the asset allocation of DC plans will be shown in section 8.5.1, highlighting the fact that the shift away from DB to DC schemes does not necessarily reduce the extent of the relationship between pension asset allocation and demographic structures.

Governments may also consider increasing the supply of long-dated fixed-income securities or introducing a new type of financial assets that can serve the needs of mature DB pension schemes. This policy can help mitigate the price pressure impact of pension schemes' asset allocation on long-term bonds. Section 8.5.2 will discuss a range of options for this policy. Longer life expectancy, coupled with a reduction in morbidity, suggests that the expected reduction in labour supply may be resolved by increasing statutory retirement ages or incentivising old people to work longer. Similarly, increasing female participation in the labour market can help mitigate the problems created by the shrinkage in labour supply. Policies which could increase employment rates of women and older people will be discussed in section 8.5.3. Since the magnitude and pace of ageing across different countries are dissimilar, international capital flows can partly support the selling pressure from mature pension schemes in rapidly ageing countries. Moreover, economic policies that facilitate migration can be implemented to tackle the labour scarcity in the domestic market. A discussion on international capital and labour flows is presented in section 8.5.4. Investing in R&D and human capital, thus boosting labour productivity, and offshoring the production process to countries with an abundant supply of labour are further ways to stimulate economic growth. The prospect of these particular economic policies will be discussed in section 8.5.5.

8.5.1 Discussion on the asset allocation of DC pension accounts

According to the way in which DC pension plans are constructed, DC fund managers do not have to meet any obligations relating to either the amount of pension benefits or the terminal accumulated value of the plans. Therefore, the asset allocation of DC pension plans may not have a direct relationship to the age structure of their plan members. Theoretically, the optimal asset allocation of DC plans should be dependent on plan members' degree of risk aversion. Individuals who are highly risk tolerant will prefer a higher proportion of investment in risky assets so as to increase the likelihood of a high terminal value of their DC accounts. If the degree of risk aversion does not increase as individuals age, the large equity investment of DC plans may still be an optimal strategy, even though plan members may be approaching retirement. This implies that the selling pressure of risky assets from DB pension schemes with mature liabilities may be partly absorbed through investments by DC pension schemes that have aggressive investment strategies. However, much research finds that individuals' degrees of risk aversion tend to exhibit a lifecycle profile. For instance, Rubin and Paul (1979), Riley and Chow (1992) and Bekshi and Chen (1994) all show that old people are less likely to take risks compared to the young. By using psychometric questionnaires, Hallahan, Faff and McKenzie (2004) also discover that although the degree of risk tolerance increases with household income, it actually declines with age. Moreover, other risk factors such as labour income and human capital tend to be associated with age. Therefore, after incorporating these risk factors into the derivation, the majority of researchers find that the optimal investment proportion in risky assets decreases with age (Bodie et al., 1992; Gomes and Michaelides (2005); Cocco et al., 2005).

Although DC plans do not have any explicit obligations, it is still sub-optimal for DC fund managers not to consider the expectation of terminal wealth or the amount of annuity purchases when planning their asset allocation. Haberman and Vigna's (2002) derivation shows that the optimal asset allocation of DC plans is significantly related to the age structure of their plan members where the objective function of the derivation is to maximise the ratio between expected terminal wealth and the quantity of annuity purchases. Cairns, Blake and Dowd (2006b), who use the ratio of target wealth to the level of final salary as an objective function for optimization, illustrates that DC plan members can maximise their retirement wealth if they follow stochastic lifestyle investment strategies[37]. Although these stochastic lifestyle strategies do not explicitly specify a certain deterministic pattern between equity

[37] Stochastic lifestyle strategies refer to investment policies that numerically consider dynamic variations of various risk factors such as changes in individuals' attitude toward risk or time-varied correlations between salary and asset returns.

allocations and age variables (or the period of time until retirement), these strategies still involve the dynamic movement from investment in equities (risky assets) to bonds (low-risk assets) as DC plan members approach retirement. The optimal asset allocation derived by Yang and Huang (2009) also shows that the investment proportion in short-term money market instruments should increase when DC plan members reach retirement in order to reduce liquidity risk. An analysis of welfare gains from the lifecycle investment strategies of DC plans can be found in Poterba et al. (2006), Gomes, Kotlikoff and Viceira (2008), and Basu and Drew (2009). Those gains come mainly from the reduction in the volatility of terminal wealth, which greatly reduces the risk of severe negative impacts during market downturns. Expected utility levels from lifecycle investment strategies are normally highest when compared to other strategies that fix the investment allocation over the lifecycle of households.

Empirical surveys of the asset allocation of DC plans generally show that their actual allocation has a strong relationship with the age structure of plan members. VanDerhei, Galer, Quick and Rea (1999), which examines investment strategies of around 18 per cent of the membership of US 401(k) plans, find that the asset allocation of old employees appears to largely consist of fixed-income securities and guaranteed investment contracts such as annuities. Broadbent et al. (2006) also shows that asset allocations of DB and DC plans in Australia, the US and Canada tend to be similar. One of the main differences in the investment behaviour of these two plans is that DB plans seem to invest directly in securities while DC plans are more likely to hold equities or bonds through mutual funds. A survey by Greenwich Associates (2006) illustrates that approximately 55 per cent of US 401(K) sponsors have already offered lifecycle investment funds to their employees, and that around 27 per cent of the sponsors plan to offer this lifecycle investment strategy in the future. This reflects the fact that the lifecycle investment policy is normally offered as a default investment option of DC plans. Because Choi et al. (2006) finds that more than 50 per cent of employees tend to choose a default option, the lifecycle investment strategy is expected to be a norm for the asset allocation of DC plans.

The picture for the UK market seems similar. As shown in Byrne, Blake, Cairns and Dowd (2007), since April 2005, due to changes in UK pension legislation, it has been a requirement that the default options of UK plans have some form of lifecycle asset allocation. They also find that DC plan members who have high levels of financial literacy are more likely to invest in equity-like instruments. However, the types of financial asset which DC plans can invest in tend to be limited due to the liquidity requirements of some plan members who may want to shift their asset allocations in certain periods. This implies that DC pension plans tend to have low allocation in alternative asset classes such as private equity funds and hedge funds (Myners, 2001). Although a survey by Watson Wyatt (2005) shows that around 80 per cent of UK DC plan sponsors offer more than five separate investment policies, UK plan members tend to be relatively inactive in changing their asset allocation. Byrne et al. (2007) find that only 4.7 per cent of UK DC plan members in their sample actively make changes in asset allocation within a 12-month time frame. Bridgeland (2002) also reports that in excess of 80 per cent of DC plan members in the UK are more likely to accept the default option offered by their plan sponsors. One of the main causes of the lockup in default investment options is the behavioural bias of DC plan members. Analyses of this bias can be found in Byrne (2004), Gomes and Michaelides (2005), and Choi et al. (2006).

8.5.2 Policies to mitigate the price pressure impact on long-term bonds

As previously discussed in section 8.3, the asset allocation of pension schemes tends to have a significant price pressure effect on long-term fixed-income securities. The impact observed during 2004-2005 appears to reflect just the beginning of the shift in pension schemes' investment strategies. As shown in chapter 7, the ageing of policyholders appears to significantly encourage pension fund managers to increase investment positions in fixed-income securities. Therefore, the sharp increase in the old-age dependency ratios over the next 30 years may lead to a much more sizeable allocation of pension assets to high-quality bonds with some features of indexation. Due to the limited supply of inflation-protected bonds and very long-mature government bonds, the price pressure impact is expected to be large. In order to mitigate this situation, the governments may consider increasing the supply of long-dated inflation-indexed and nominal bonds. It has been shown by many economists (Reinhart et al., 2000; Fleming & Rosenberg, 2008; Krishnamurthy & Vissing-Jorgensen, 2007) that this policy can be used to absorb the excessive demands of institutional investors, thereby restoring the fundamental value of asset prices and maintaining the stability of the whole financial market.

Moreover, the governments may consider introducing new types of financial assets that attract the investment from pension schemes. The issuance of these new securities can reduce the demands by pension schemes for traditional long-term government bonds. For example, Blake and Burrows (2001) suggest that the government is an appropriate entity to issue survivor bonds. These bonds are considered as an ideal instrument for pension schemes and insurance companies to hedge against an unexpected increase in longevity of policyholders. The coupon payments of these bonds will be directly related to the fractions of populations surviving to certain ages. The maturity period of the bonds is not fixed depending on the last year that a certain birth cohort survives. Consequently, investors in these bonds will receive higher coupon payments if the aggregate estimate of mortality improvements unexpectedly rises. DB pension schemes will be able to closely match the performance of their assets with the variation of their liabilities. Blake and Burrows (2001) further argue that the governments are in a better position than private sectors to take on mortality risks and provide attractive default-free yields on survivor bonds. This is because mortality risks can be distributed across different generations. Although longevity risks cannot be completely diversified away, the low risk of default by the governments largely reduce the costs of issuing these bonds. Typically, the high costs of issuing survivor bonds by the private sectors have led to the non-existence of these bonds in a large scale. The only available mortality-linked securities in the private sectors are longevity bonds issued by Swiss Re in December 2003 and by BNP Paribas in November 2004. However, Dowd (2003) argues that this argument may not necessarily hold if the costs of government interventions are taken into account. Brown and Orszag (2006) also estimates that the costs of issuing longevity-linked securities by private sectors can largely be reduced if the governments eliminate asymmetric information problems arising from adverse selections. This can be done through the mandatory annuitization for all retirees.

Apart from inflation-indexed bonds, the governments may issue GDP-linked bonds. This new type of government bonds was initially proposed by Shiller (1993). The coupon payments of these bonds will be directly indexed to the growth rate of GDP. By including a cap on the maximum yields during the period of high GDP growth rates, yields on the bonds during recession periods can also be bounded at zero. It has been considered that pension schemes may be the main institutional investors in GDP-linked bonds. Pension fund managers may invest in these bonds in order to receive equity-like returns but at a much lower level of volatility. Pension schemes can also avoid credit risks of corporate bonds and high idiosyncratic risks of a given individual stock. Because liabilities of DB pension schemes depend on the growth rate of labour earnings, the investment in GDP-linked bonds can also be used to partially hedge this risk. This results from the fact that labour wage and GDP growth rates tend to be highly correlated. Kamstra and Shiller (2008) note that this new debt instrument also provides diversification benefits and optimal risk exposures for retirees. This helps to protect retirees against poor standard of living during the period of high inflation. They also estimate that the cost of issuing GDP-indexed bonds is just around 150 basis points higher than the cost of issuing traditional fixed-coupon bonds. By the use of overlapping generational models, Kruger and Kubler (2006) derive that the policy implementation analogous to the issuance of GDP-indexed bonds can improve *pareto* efficiency. The asset-pricing model for these bonds is analysed in Krus, Meitner and Schroder (2005).

In addition to the benefits of mitigating the price pressure effect of pension schemes on long-term bonds, issuing GDP-linked bonds can also help the governments to manage their budget deficits. This is because during the years of low growth, debt payments will also be reduced which help to stabilize the debt-to-GDP ratio. Robalino and Bodor (2007) also show that GDP-indexed bonds can be used to reduce the costs of the state earning-related pension benefits. Up till now, countries that have issued debt instruments similar to GDP-indexed bonds are Bulgaria, Costa Rica, Bosnia, Singapore and Argentina (Kamstra & Shiller, 2008). Developed countries with highly liquid financial markets may coordinate to provide solutions for technical issues and to specify a set of standards for the development of GDP-indexed bonds.

8.5.3 Economic policies to promote employment rates among female and older workers

Recently, the "compression of morbidity" among the elderly in the majority of developed countries has emerged (Fogel, 1997; Costa, 1998). This phenomenon is attributed mainly to medical breakthroughs which have greatly reduced age-specific diseases and disabilities. Anti-ageing medical treatments have resulted in people living longer and healthier lives. Mathers et al. (2001) argue that the adjusted measure of life expectancy, weighted by individuals' lifetime health status, seems to move in tandem with the conventional measure of period life expectancy in many developed countries. The health-adjusted dependency ratio[38] proposed by Sanderson and Scherbov (2010) also appears to increase at a much slower rate than the conventional old-age dependency ratio. These results suggest that the longer life expectancy of the elderly stems mostly from the fact that the impact of major health problems is diminishing. Therefore, it is possible for older people to extend their age of retirement so that they might continue to apply their knowledge and skills within the economy. According to Bloom et al. (2007b), this extension has been theoretically proven to be an optimal response to rising healthy life expectancies.

Regarding the minimum statutory retirement age, there is still considerable room for extension. Based on the findings by Bloom et al. (2010), the average increase in the minimum retirement age of 43 selected countries over the period 1965-2005 was only 6 months, whereas life expectancy rose by approximately 9 years. They also show that the cross-correlation between the male retirement age and the increase in life expectancy was low at around 37 per cent. In terms of the actual average retirement age, the European Commission (2010) shows an increase of around 1.1 years (from 59.9 in 2001 to 61.4 in 2008) across the EU-27 countries. In the UK, the

[38] This health-adjusted dependency ratio, proposed by Sanderson and Scherbov (2001), is calculated by dividing the proportion of the population with a life expectancy of less than 15 years by the proportion of population older than 20 with a life expectancy of more than 15 years.

state pension age will be raised to 66 by 2020 and to 67 by 2028 (DWP, 2013). However, a change in the minimum legal retirement age is not the only economic policy that can promote an increase in employment rates of people aged over 50.

Reform of the public pension system is another policy which can efficiently increase the supply of older workers by reducing the incentive of early retirement. As shown in Gruber and Wise (1999), the current public pension systems of most developed countries seem to encourage old workers to retire early. Tax policies could be adjusted to provide better comparative benefits to those workers who prolong their working lives. Human capital investment that focuses specifically on on-going training and skills development of older workers in new areas such as information technology could also be applied to promote equality in the workplace and to improve the productivity of the whole organization (Chan, Phillips and Fong, 2003). In addition, age discrimination against the retention of older employees will have to be diminished (Leeson, 2006). Allocating older employees to positions where burdens are lower and flexibility is greater is another appropriate mechanism for increasing the efficiency of employment in old-age. A good example of a private company which has kept on older workers in but maintained their level of labour productivity is BMW. Loch, Sting, Bauer and Mauermann (2010) show that BMW are significantly increasing the efficiency of older workers by improving the ergonomics of using assembly machines, providing more flexibility through job rotation, and offering a comprehensive health care system.

Regarding the participation of women in the workforce, there has been a continuing increase in female employment rates over the last 50 years. The main factor which has caused this increase has been the reduction in the average number of children per woman. Bloom et al. (2009) analyse the movement of fertility rates and participation by women in the workforce. They simulate that in a scenario of low-fertility rates, the rising participation rates of women in the workforce can help the economy grow by around 0.27 per cent, despite the fact that the economy will be negatively affected by population ageing over the next 40 years.

Statistical evidence from House of Lords (2003) shows that labour participation rates of older women in the UK increased from 61 per cent in 1997 to 66 per cent in 2003. One of the main reasons for this increase was the sharp rise in the rates of employment of successive female cohorts, whose participation in the labour market has grown steadily since the 1960s. Joshi (1986, 2002) shows that, after controlling for interruption time for birth and childcare, the average working time of British women born in 1910 was 60 per cent lower than that of men, while women born after 1958 worked for roughly the same amount of time as men. She further finds that women born in 1910, on average, returned to the labour market after 13 years of giving birth whereas for those born in 1970, around 50 per cent returned to employment within a year. The increased participation rates of successive female cohorts in the workforce can be seen across most developed countries (Psacharopoulos & Tzannatos, 1989).

Although there has been a significant increase in the female workforce over the last 50 years, overall female participation rates are still lower than those for males. As a result, there is some room for expansion in female employment rates. Economic policies which could promote higher female labour participation rates include legislation against sex discrimination in the workplace and the implementation of a comprehensive childcare system. The implementation of policies which improve educational opportunity and attainment for women would also, very probably, generate higher labour participation rates among young women. As shown in Fitzgerald (2005), women who graduate at a high school level are more likely to enter the labour market than those with lower educational levels. However, rising female participation rates in the labour market may pose some challenges to the social welfare system since there would seem to be a conflict with childbearing and fertility rates. Therefore, policy makers may also need to consider the balance between the workforce and demands for the family.

8.5.4 International capital and labour flows which can mitigate the impact of population ageing on domestic markets

Since demographic transitions do not occur at the same period or to the same magnitude in every country, capital and labour may flow from countries that are severely affected by population ageing to countries which experience a less negative impact. In theory, it is expected that capital will flow from ageing countries with a high capital to labour ratio to younger countries in order to earn higher expected rates of return to capital (Blanchet and Kessler, 1992; Higgins, 1998). Households in rapidly ageing economies can receive higher returns from international investments, though some portions of those returns may compensate for higher risk premiums. Capital outflows from ageing countries can also partly reduce the negative impact of population ageing on the returns to capital in domestic markets. Over the past 50 years, flows of capital across different financial markets have been increasingly facilitated by the liberalization and integration of financial markets. Transactional as well as informational costs related to investment in emerging markets have been greatly reduced. Although the globalization of financial markets is expected to increase over the coming decades, this does not necessarily imply that there will be sizeable international capital flows which would significantly limit the negative impact of population ageing.

It has often been argued that international capital flows are the main cause of the high volatility of asset prices and exchange rates in emerging markets. Since international capital flows typically concentrate on secondary markets rather than direct investment in physical assets, the benefits of sustained economic expansion in developing countries is generally limited. In contrast, financial markets in developing economies will be greatly exposed to the risk of instability and financial crises due to such unexpected pro-cyclical flows of foreign capital. Therefore, the majority of governments in both developed and developing countries tend to impose certain measures to control the size and timing of international capital flows, thereby minimising the systemic risk of the global financial system and retaining some financial resources for the development of their domestic economies.

Pension schemes in the majority of developed countries face strict constraints when it comes to international portfolio investments, with quantitative portfolio limits and tax regulations often being imposed. For example, pension schemes in Canada have a 30 per cent limit on international investment; Italian and German pension funds are also subject to a 20 per cent limit. Quantitative limits on foreign investment are even more stringent in developing countries, with most hovering between 5 and 10 per cent. Even though the regulation for portfolio controls of pension schemes in the UK and the US is based on the prudent person rule without quantitative limits, the actual proportions of foreign investment are normally low, at around 23 per cent and 11 per cent respectively (IMF, 2005b). The actual allocations of foreign investments of pension schemes in countries with quantitative limits also appear to be far below the maximum thresholds (7% in Germany, 15% in Canada, and 2.5% in Hungary). This evidence reflects the home bias of the investment behaviour of most institutional investors (French & Poterba, 1991; Kang & Stultz, 1997; Huberman, 2001). Investors tend to prefer domestic assets to foreign investments. Currency risks, liquidity risks, extra transaction costs relating to the registration and currency commissions, concerns on the scarcity of information, and low-quality disclosure standards in emerging markets are among the main causes of this home bias. The presence of this home bias will therefore limit the extent of mitigating effects of international capital flows on the returns to capital and the price pressure impact in rapidly ageing economies.

Migration, or international labour flow, is generally considered as another solution to tackle the scarcity of labour supplies in ageing economies. Theoretically, labour flows of young workers from developing economies can smooth age patterns, reduce dependency ratios, maintain the level of labour supplies, and limit the growth rate of labour wages in the domestic labour market. However, in order to significantly reduce the expected sharp growth rate of dependency ratios, the proportion of working-age immigrants needs to be fairly high. According to the UN (2007), over the next 50 years net migration inflow to European countries needs to be approximately 2.9 immigrants per annum in order to completely offset the negative impact of population ageing on labour supply. The required magnitude of migration is large compared to the average actual level, which between 1995 and 2000 was around 1 million per year. In the specific case of the UK, Blake (2003b) provides estimates of how many future immigrants are needed to stabilise the government's pension budget. Using reasonable assumptions on the real growth rates of wages and pension benefits, he shows that from 2010 onwards the UK economy requires net inflows of around 500,000 migrants per year. This number is more than double the average number of net UK immigrants who arrived in 2001 and 2002. Based on these calculations, it can be clearly seen that any economic policies that encourage such massive migration inflows would be unfeasible from both a political and social perspective.

Although international migration cannot entirely solve the problems posed by demographic transition, economic policies that facilitate the flow of reasonable numbers of working-age migrants can still partly reduce the negative pressure of population ageing on the domestic labour market. The key issues which policy makers need to pay attention to are the social pressures which migration poses to recipient countries. Inevitably, migration is often associated with social unrest, inequality and discrimination in the workplace, and culture shocks. These social problems may be overcome by ensuring that foreign workers are provided with fair benefits from the social security system and appropriate wage levels from their employers. In order to maintain their productivity, employers should also be incentivised to provide adequate training and fair treatment to immigrants which meet minimum labour standards. Unless those social concerns related to migration are dealt with effectively, international labour flow cannot be an optimal response to the challenges caused by population ageing.

8.5.5 Capital investment to increase labour productivity and offshoring production processes to countries with a large supply of labour

Labour productivity is another key factor that can enhance economic growth despite shrinkage in the supply of labour. The development of new knowledge and innovations in workflow can increase the efficiency of production processes. Investments in physical capital, human capital and R&D projects can significantly contribute to high growth rates in labour productivity. Rising labour wages, resulting from a rise in the capital to labour ratio in ageing countries, will automatically put pressure on employers to invest in new technology which could reduce the need for costly labour inputs. Governments can also improve future growth rates in labour productivity by maintaining a reasonable amount of spending in the educational system, thereby increasing the proportion of highly educated workers. As argued in Lee and Mason (2010), population ageing may create less socioeconomic problems if the shrinkage in the labour workforce is associated with a decline in the proportion of unproductive workers and a rise in the proportion of younger, more productive workers. Apart from investment in R&D and human capital, UN (2006) argues that investments in infrastructure projects are an equally important factor to enhance productivity. This is because appropriate infrastructure projects can efficiently reduce supply chain costs.

In the UK, Young (2002) shows that a constant growth rate of labour productivity in the long-term can significantly reduce the negative impact of population ageing. It estimates that if labour productivity can grow consistently at an annual rate of 1.75 per cent across all age groups, the simulation implies that the supply of productive workers will be double in 2050 when compared to the levels observed in 2000. When the simulation model incorporates an assumption of 10 per cent growth per decade in capital stocks, the real income per capita in 2050 is projected to be twice as high as in 2000. However, this optimistic simulation may contain some bias because no consensus exists as to how demographic transition will affect the rate of productivity growth (Disney, Haskel and Heden, 2000). It is reasonable to assume that advancements and new innovations will require some degree of creativity from young workers. Because the decline in fertility rates has significantly reduced the proportion of young workers relative to old, the aggregate growth rate of new scientific discoveries may be slow, which will subsequently lead to lower growth rates in labour productivity.

Instead of allowing an impracticably massive migration inflow, the manufacturing sectors of rapidly ageing countries may go offshore to countries with lower ageing rates which therefore have an abundant supply of labour. As Freeman (2006) argues, foreign direct investment (FDI) in developing countries can enhance the production capacity constraints posed by the shrinkage in labour supply. This outsourcing of the production process has been increasingly productive over time, due primarily to the rapid advancement of information and communication technologies (ICT), which has enabled more cost-efficient means of monitoring and managing workers and production processes at offshore locations. Forrester Research (2002) estimates that US industries with high intensity in the use of ICT may move nearly 3.3 million jobs abroad by 2015.

Although offshoring appears to be a plausible means by which to maintain and enhance production capacity, it does not really solve the other economic problems caused by the sharp increase in dependency ratios. Public pension systems will still encounter budgetary issues because of the lower tax yield from the domestic working-age populations. A large transfer of the manufacturing sector to foreign countries may also impact on international trade balances and domestic employment rates. Therefore, economic policies that promote offshoring should also pay careful consideration to other economic effects.

8.6 Directions for future research

Results from the research in chapter 5, 6 and 7 suggest that pension schemes' asset allocation may have a significant effect on asset prices and returns. Therefore, one direction for future work is to investigate the magnitude of the price pressure impact caused by pension schemes' trading volumes. This analysis is necessary for an accurate simulation of the risk and return characteristic of financial asset prices over the next 50 years. One of the main concerns of the research in this area is the ability to factor out the effect of changes in fundamentals on security prices. The decisions to buy, to sell or to hold a certain financial asset of institutional investors may be largely influenced by changes in its underlying fundamentals. However, the empirical result found in chapter 7 which shows the strong influence of demographic transition on asset allocation of pension schemes suggest that it may be possible to estimate the proportion of the demand for and supply of financial assets that are only determined by the shift in demographic structures. Because this portion of pension schemes' asset allocation is based solely on reasons other than fundamental considerations, the market price adjustment resulting from these information-free trading orders can be considered as the magnitude of the price pressure effect.

In addition, the empirical analysis shown in this thesis is based only on the UK experience. The significant impact of the 35-44 age group on equity prices found in this thesis may not be generalizable to explain the relationship between demographic patterns and asset prices in other countries. The relative growth rates of funded pension schemes vary significantly across different countries reflecting different historical paths in the development of social welfare. If the proposed hypothesis of this thesis holds in an international context, it should be expected that financial asset prices in countries that have a high proportion of funded occupational pension schemes such as the US, Switzerland, the Netherlands, Canada and Australia may have a similar significant relationship with the movement of demographic structures as shown in this thesis. In contrast, the price behaviour of financial assets in countries whose pension provisions are heavily relied on unfunded PAYG schemes and in countries whose private pension funds are relatively underdeveloped should be insignificantly correlated with the dynamic of demographic patterns. In order to test this question, international comparative studies may be conducted.

Lastly, the empirical findings reported in chapter 6 show that the lifecycle saving profiles of households through different investment opportunities are significantly different among each other. The presence of pension schemes appears to be the main mechanism that guides households to behave according to the lifecycle hypothesis. This arises from the fact that pension schemes act like professional advisors who make optimal lifecycle saving decisions for households. The existence of household saving through either occupational pension schemes or personal pension plans also appears to influence the saving behaviour of households' direct investments in the financial market. Therefore, future research that attempts to test the lifecycle saving behaviour of households or to estimate the aggregate dissaving rates during the retirement period may have to take into account the lifetime accumulation and decumulation of household wealth through pension schemes. Moreover, researchers that attempt to use the OLG model to investigate the impact of population ageing on the rates of return to capital may also be interested to incorporate the investment behaviour of pension schemes into the model as this may represent the actual lifetime risk exposure of households to the financial markets.

8.7 Concluding remarks

This thesis proves that the strong correlation between demographic patterns and financial asset prices since the 1960s was caused largely by the shifts in the institutional structure of the financial market, namely the emergence of pension schemes. The sharp growth rate of the pension fund sector relative to other institutional investors implies that any substantial reallocation of pension fund investments across various financial asset classes could significantly influence the stability of the financial market. Because demographic transition occurs gradually in the long-term, the investment activities of pension schemes may have a long-run impact on the movement of financial asset prices.

This thesis has shown that the 35-44 age group, who significantly affect the movement of equity prices (as shown in chapter 5), is the same as the age group that have highest participation rates in occupational pension schemes and personal pension plans (as shown in chapter 6). These results provide evidence that the relatively large saving rates of households via investments in pension schemes by this age group appear to create upward pressure on equity prices, thereby leading to an increase in the expensiveness of equities as measured by P/E ratios or dividend yields. Empirical evidence in chapter 6 also shows that the lifecycle behaviour of direct household investment in the financial market does not tend to follow the patterns suggested by the lifecycle hypothesis. Therefore, it can be argued that pension schemes act like professional advisors who make optimal lifecycle saving decisions for households. Without these institutions, it would be difficult for households to individually make rational saving and consumption decisions in different periods of their life. The insight gleaned from this research may explain why some of the results of previous research do not show consistency between household saving decisions and the lifecycle hypothesis.

The results found in chapter 7 also prove that the asset allocation of DB pension schemes is significantly influenced by the age structure of their plan members. Therefore, the retirement of baby-boomers can result in the majority of DB pension schemes reallocating significant quantities of their assets from risky equity investment into low-risk fixed-income instruments and annuity contracts. However, the market meltdown scenario is not predicted to occur because pension schemes' investment strategies should be gradually adjusted over the long-term in response to the slow-moving nature of demographic patterns. Even though the trading volumes of each pension scheme may be too small to cause the price pressure effect on asset prices, where several pension funds reallocate funds during the same period and in the same direction, there can still be a significant effect on asset prices. The marginal effect of pension schemes' investment on asset prices in the short-term may also, over time, be accumulated, thereby leading to a scenario where over the next 20-30 years the expensiveness of equity prices constantly declines while the expensiveness of long-term bond prices continually increases.

This chapter has suggested that it is possible for the sizeable investments of pension schemes to impact on security prices. The slow movement of capital and market segmentation may limit the degree of market efficiency. Aside from the price pressure impact arising from the trading activities of pension schemes, an expected decline in the P/E ratios of equities in the coming decades may also partly be influenced by the direct fundamental impact of population ageing on the expected rates of return to capital. Even so, policy makers have a range of options to mitigate the ageing effect on the aggregate economy and the pension trading effect on asset prices, such as encouraging the labour participation rates of older workers and facilitating international capital and labour flows. The implementation of a nation-wide DC plan can also increase the participation rates of young households in the financial market, which can partly absorb the selling pressure from mature DB pension schemes. Introducing alternative asset classes such as survivor bonds and GDP-indexed bonds can partly reduce excessive demands on traditional long-term bonds. However, the absolute net effect from the interaction between population ageing and mitigating factors on the financial market and aggregate economy is yet to be seen.

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