Retirees' Financial Choices in Periods of Calm and Crisis: Australian Account Based Pension Evidence

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Abstract

Using Account-based Pension evidence, this thesis investigated retirees' drawdown and investment behaviours within Australia's Defined-Contribution scheme. First, existing drawdown literature was extended through the documentation of, (a) a new gender gap phenomenon, whereby women appeared increasingly more likely to drawdown at the legislated minimum drawdown rates than men, and (b) gender differences in the adoption of the temporary minimum drawdown rates introduced during crises, whereby women appeared more likely to adopt the temporary minimum drawdown rates than men. Second, to the best of the Authors knowledge, this thesis presented the first empirical investigation of retirees' investment behaviours within a Defined-Contribution scheme. More specifically, this thesis documented, (a) retirees' account opening equity allocations, (b) retirees' propensities to revisit and change their account opening equity allocations, and (c) how these behaviours were moderated by crisis periods as well as characteristics such as age, wealth, and gender.

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I would also like to acknowledge the large Australian wealth management company that providing the data analysed in this thesis. Without their involvement, this thesis would not have been possible.

To my family and friends, apologies for going missing for a year, I am looking forward to seeing you again soon.

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Chapter One: Introduction

In the wake of demographic and economic change, global retirement schemes are transitioning from Defined-Benefit to Defined-Contribution. As a result, ordinary retirees are becoming increasing responsible for choosing how to invest and drawdown their accumulated assets. Once a decision reserved for experienced professionals, for retirees, this likely represents a complex and multi-faceted decision that is difficult to solve. Further, during periods of crisis, this difficulty is likely amplified by financial uncertainty, and in the case of Australia, policy changes.

Despite the significance of Defined-Contribution assets – US$22 trillion globally – and the growing portion of individuals soon to retire, it is surprising that there has been little empirical investigation of retirees' investment and drawdown behaviours within these new Defined-Contribution schemes. Hence, using Australian Account-based Pension evidence, this thesis aims to extend empirical literature examining retirees' drawdown behaviors and establish a new empirical literature examining retirees' investment behaviors within Defined-Contribution schemes.

Before doing so, however, this thesis provides the reader with essential context through answering some key questions, namely: "What are Defined-Benefit and Defined-Contribution schemes?", "What are Account-based Pensions?", "Why Australia?", and most importantly "Why should anyone care?". In this light, *Chapter 1* begins by discussing the evolution of global retirement schemes, followed by a description of Australian Account-based Pensions, and concludes with the research proposition and significance of this thesis.

1.1 Transition from Defined-Benefit to Defined-Contribution

The development and taxonomy of global retirement schemes

Samuelson (1987) asserted that in the century prior to 1937, the United States was the richest country on earth, yet the bulk of its retirees relied on charity in retirement. Similarly, in nineteenth century Great Britain, Hannah and Leslie (1986) reported that although the traditional consumption smoothing life-cycle model described the behaviour of professional classes well, hunger and other needs pressing on low-income workers led them to discount the value of their future consumption to the point that little retirement provision resulted. Globally, these conditions were common and motivated the development of organised retirement regimes (Bateman, Kingston et al. 2001).

Historically, the taxonomy of global retirement regimes has consisted of three tiers (OECD 2019). The first tier comprised publicly funded welfare schemes that guaranteed retirement incomes independent of retirees' past earnings. The second tier comprised forced saving schemes that generated retirement incomes dependent on retirees' past earnings. The third tier comprised voluntary savings, where retirement incomes were dependent on retirees' own voluntary provisions. The first tier was designed to protect retirees from absolute poverty (consumption below a minimum subsistence level), through guaranteeing minimum standards of living in retirement. Whereas the second and third tiers were designed to protect retirees from relative poverty (a fall in consumption following retirement), through contributing to consumption smoothing, and therefore standards of living, between working life and retirement (OECD 2001).

The transition from Defined-Benefit to Defined-Contribution schemes

Over the first half of the 20th century, global population growth was fast, economies developed quickly, and retirement income regimes were dominated by first-tier welfare

schemes and second-tier Defined-Benefit (**DB**) schemes (OECD 2019). Although differing in how retirement incomes were calculated (whether they were related to earnings), these schemes shared two central features. First, they were funded on a 'pay-as-you-go' basis whereby current retirees' incomes were financed through contributions from the working generation. Second, the institutions providing the schemes were responsible for managing the financial and longevity risks associated with guaranteeing retirees' current and future incomes.

Over the second half of the 20th century, however, as the global population aged and economic growth slowed, the financial sustainability of these 'pay-as-you-go' schemes became uncertain (Dorothée, Aida Caldera et al. 2019). This was because (a) ageing populations meant contributions levied on a shrinking working generation were unlikely to finance incomes to a growing generation of retirees, and (b) slowing economic growth limited the returns on assets and increased the discounted liabilities of 'pay-as-you-go' schemes[1]. Combined, these factors made it difficult for 'pay-as-you-go' schemes to adequately sustain paying members their promised retirement benefits.

As a consequence of this declining sustainability, in the late 20th century, there was a global paradigm shift towards second tier Defined-Contribution (**DC**) schemes (Bateman, Kingston et al. 2001, OECD 2019). The central feature of these new DC schemes was that pre-retirement, members payed fixed (defined) contributions into a personal account, and post-retirement, chose how to invest and withdraw their accumulated assets to generate a retirement income, thus assuming the financial and longevity risks associated with their own retirement.

[1] For a more expansive explanation see Dorothée, R., et al. (2019). "Fiscal challenges and inclusive growth in ageing societies."

For example, Chile in 1981 and Mexico in 1997, replaced their public 'pay-as-you-go' DB schemes with DC schemes. In addition, as a complement to their existing 'pay-as-you-go' DB schemes, Australia, Germany, Estonia, Hungary, Poland, the Slovak Republic and Sweden either introduced mandatory DC schemes or raised the contribution rates that fund them. In the case of Australia, this DC scheme was introduced in 1992 with an initial contribution rate of 3% and by 2020 had seen popularity grow and its contribution rate raised to 9.5% (Australian Taxation Office 2020). Similarly, in countries like the United States, the prevalence of 'pay-as-you-go' DB schemes has also slowly declined in favour of more DC schemes (OECD 2019).

Further accelerating the trend towards DC schemes, has been the susceptibility of institutions managing 'pay-as-you-go' DB schemes to default risk, particularly during periods of financial crises. For example, in the midst of the European Debt Crisis, Greece defaulted on its sovereign debt and its DB scheme cut the retirement incomes of 2.89 million retirees by 70%, forcing 1.5 million into poverty (The National Herald 2017). Similarly, in the aftermath of the Global Financial Crisis, 921,184 Americans witnessed their 'pay-as-you-go' DB providers file 'critical and declining status notices' with the U.S. Department of Labor in order to reduce or suspend paying their retirement incomes (Pension Rights Centre 2020). Last, as a more recent example, in the wake of the coronavirus pandemic, the Bricklayers & Allied Craftsmen Local 7 Pension Fund – projected to be insolvent by 2023 – received approval to cut 441 members retirement incomes by up to 66% (U.S. Department of the Treasury 2020), potentially forcing retired bricklayers below the U.S. federal poverty level.

1.2 Research Motivation

Do retirees have the skills to aptly invest and drawdown their accumulated savings?

To reiterate, because of this global paradigm shift – from 'pay-as-you-go' DB towards DC – the modern retiree now faces greater responsibility for choosing how to invest and withdraw their accumulated assets upon retirement. Therefore, this global paradigm shift has transferred from institutions to retirees, the responsibility of managing financial and longevity risks inherent in generating retirement incomes.

Underlying this global shift in responsibility, is the dominant framework of neoclassical finance (Mitchell and Utkus 2004). It assumes that the modern retiree, to whom the responsibility has been handed, can interpret and weigh information presented, and choices offered, appropriately evaluate and balance these choices, and then make an optimal choice regarding the investment and withdrawal of their accumulated assets.

More recently, however, researchers working at the interface of economics, finance and psychology have developed a competing framework regarding how individuals make choices. This framework, which has become known as behavioural finance, is consistent with the fundamental economic proposition that individuals do try to maximize their self-interest, but also recognizes that under mental or emotional constraints and complications, choices are often made with less-than optimal outcomes[2]. As Bateman, Eckert et al. (2012) state:

"Retirement savings that outsource government provision to private financial institutions and individuals depend on ordinary people possessing the skills needed to manage their financial responsibilities well. Evidence is mounting that many households in both the developed world and the developing world do not."

And again, recently emphasised by Dorothée, Aida Caldera et al. (2019):

[2] For a review see: Kahneman, D. (2003). "Maps of bounded rationality: Psychology for behavioural economics." American economic review 93(5): 1449-1475. Or Mullainathan, S., & Thaler, R. H. (2000). Behavioural economics (No. w7948). National Bureau of Economic Research.

"People are set to become more involved in making individualised choices for their retirement arrangements… Yet, a majority of people do not have basic financial literacy in many G20 countries… These financial behaviours raise the risk of underestimating future financial needs, accumulating insufficient savings or picking inadequate financial investments."

Further compounding this problem, is the inherent complexity of DC schemes. For example, when describing the Australian DC scheme during a government review, a financial institution managing over AU$200 billion stated (IOOF 2019, IOOF 2020):

"Each individual component of the retirement income system has its own complexities, let alone the interactions between each element of the system. The level of complexity is such that even well-educated, experienced financial advisers can struggle to determine the interactions between tax, superannuation and social security laws to provide a meaningful estimate of retirement income to individuals with even moderate wealth."

How do retirees invest and drawdown their accumulated savings during crises?

Of additional interest, however, is investigating retirees' behaviours during periods of financial crisis. This is because behavioural finance postulates that the increased financial uncertainty and complexity caused by crises, are likely to increase the incidence of behavioural heuristics (mental shortcuts), which can systematically bias the decisions of retirees. Given that behavioural biases have been shown to affect asset prices (Kogan, Ross et al. 2006), return volatility (Foucault, Sraer et al. 2011), and even the macro-economy (Korniotis and Kumar 2011), it is surprising how little research has documented their effect on the investment and drawdown decisions of retirees[3]. Therefore, not only it is important

[3] I would be doing an injustice by not noting the seminal works of Richard Thaler, among many others, and their contributions within the pre-retirement accumulation phase. However, in motivating this thesis, I am

to investigate retirees' behaviours as a means of identifying and documenting biases in their decision making, but also as a means of developing a fact base that assists with the evaluation and development of DC schemes.

Critically, financial crises also serve to highlight the impact of sequencing risk on retirees' post-retirement investment and drawdown decisions[4]. For example, drawdowns can be thought of as a percentage sale of an investment portfolio that supplies an income stream. If a financial crisis occurs, more and more units must be sold to provide the same income stream and/or higher investment returns are required to offset the smaller portfolio size. It then follows that less than optimal drawdown and investment decisions during crises – especially in early retirement where wealth is close to its lifecycle maximum – can be disproportionality costly for retirees lifetime outcomes (Bengen 2001). Given the transfer of responsibility and risk, from institutions to individuals, it is important to document how modern retirees manage this sequencing risk during crises.

Given the significance of DC assets – US$22 trillion globally (Thinking Ahead Institute 2020) – and the growing portion of individuals soon to retire, retirees' collective decisions during periods of calm and crisis will not only have significant implications for their own welfare, but also the economy in aggregate. For example, in Australia, of AU$1.6 trillion total DC assets, only AU$450 million are currently in the drawdown phase (APRA 2020). This means a significant and growing portion of assets will soon be controlled by retirees. As a result, understanding retirees post-retirement drawdown and investment behaviours

focusing explicitly on the lack of work conducted within the post-retirement decumulation phase of mandatory DC schemes.

[4] Sequencing risk refers to the impact of the timing of cash flows on an investment portfolio, whereby drawdowns after negative investment returns have a greater impact on the long-term growth of the portfolio than drawdowns after positive returns: Andréasson, J. G., et al. (2017). "Optimal consumption, investment and housing with means-tested public pension in retirement." Insurance: Mathematics and Economics **75**: 32-47.

within these DC schemes – as well as the factors that moderate them – is a subject of considerable interest to government, industry and academics across the globe.

There has been little documentation of retirees' investment and drawdown decisions

Despite this transfer of responsibility as well as the complexity of decisions that retirees now face, it is surprising that little documentation of retirees' actual decisions exists. Although there is a wealth of literature investigating how individuals should make decisions[5] and a growing empirical literature documenting pre-retirement investment decision, there is little to no empirical literature examining post-retirement drawdown and investment decisions. As stated by the Griffith Centre for Personal Finance and Superannuation (2020):

"Voluminous research has been dedicated towards understanding the accumulation phase… In contrast, little attention has been allocated to the retirement (and aged-care) phase."

This lack of attention is primarily because the majority of workforce-wide DC schemes were first introduced in the 1990's, therefore individuals with substantial balances have only in the last decade started entering retirement. Hence, it is now timely to begin investigating post-retirement drawdown and investment decisions within these new DC schemes.

To date, the little empirical literature that does exist has focused on examining post-retirement drawdown behaviours within DC schemes. For example, Balnozan, Fiebig et al. (2020) and Balnozan (2018) in Australia and Poterba, Venti et al. (2011) in the US.

[5] For a review of the positive economics see section *2.1 Normative Economics*, or Kingston, G. and S. Thorp (2019). "Superannuation in Australia: a survey of the literature." Economic Record 95(308): 141-160.

However, no studies have focused on examining post-retirement investment behaviours within DC schemes, or the impact of financial crises on these behaviours.

1.3 The Australian Retirement System

The Australian Defined-Contribution Scheme

"Many countries look to the Australian system, and similarly designed retirement systems, as exemplars in reforming their own systems." (CEPAR 2020)

To investigate these behaviours, it is important to focus on the Australian DC scheme. This is because, for three key reasons, the Australian DC scheme is comparatively free from the selection effects present in other countries and has global external validity. First, until the introduction of the Superannuation Guarantee in 1992, Australia was almost unique among developing countries in having no universal second-tier retirement scheme. Therefore, by 2019, Australia's DC scheme – already amongst the seven largest pension markets in the world – had grown to have the highest proportion of DC assets at 86 percent[6] (Thinking Ahead Institute 2020) and an extremely high coverage ratio (94 percent as of 2009 (ABS 2009)) [7]. Second, since the Superannuation Tax Reforms of 2006, income and assets within the drawdown phase have been exempted from taxation (Commonwealth of Australia 2006), and as of 2019, the majority of Australian retirees accumulated superannuation assets have been withdrawn through personal pension accounts (51 percent as of 2020 APRA (2020)). Third, the Australian DC scheme provides members with more investment flexibility than other countries, like Chile and Switzerland, where asset allocations are regulated. As a result of these three reasons, the Australian setting is an ideal case study to investigate retirees' investment and drawdown behaviours, with externally valid results.

[6] For example, of Australia's $2.1 trillion in total pension assets, 86 percent are held within its DC scheme.
[7] This means that 94% of Australian employees have superannuation coverage.

Australian Account-based Pension's

Upon entering the decumulation phase, retirees within Australia's DC scheme can access their accumulated assets through withdrawing them as a lump sum, purchasing a life annuity, or opening a personal pension account. Although several types of personal pension accounts exist, as of 2016, Account-based Pension's (**ABP**) have encompassed both the majority of pension member accounts and assets (APRA 2020). Hence, Australian ABP's are the primary focus of this thesis.

ABP's are financial products that allow retirees to invest and drawdown their accumulated assets to generate retirement incomes. Upon opening an ABP, retirees are responsible for making at least two key choices. First, they must choose an investment option(s) to invest their assets. Second, they must choose a drawdown rate to withdraw their assets. A third possible choice, however, pertains to retirees that select multiple investment options for their ABP assets; choosing a drawdown investment strategy[8]. After making these initial choices, retirees can voluntarily change them in the future.

Minimum drawdown rates for Australian Account-based Pensions

It is important to note that prior to 2007, these ABP's were referred to as 'allocated-pensions' and retirees' drawdown rates were subjected to both minimum and maximum limits that were calculated with age-dependent pension valuation factors (Commonwealth of Australia 2020). However, after the implementation of the "Simplified Superannuation" Bill in 2007, these maximum limits were scrapped and simplified minimum drawdown requirements were introduced (*Table 1.1*) (Parliament of Australia 2007). The purpose of these simplified minimum drawdown requirements were to ensure that ABP's were used

[8] For example, given an ABP that is invested across multiple investment options, which option should a retiree drawdown from first?

to provide income in retirement and not to accumulate tax-advantaged wealth (see *Appendix: 1* for an illustration) (Australian Treasury 2016).

Table 1.1: Minimum Drawdown Rates for ABP's[9]

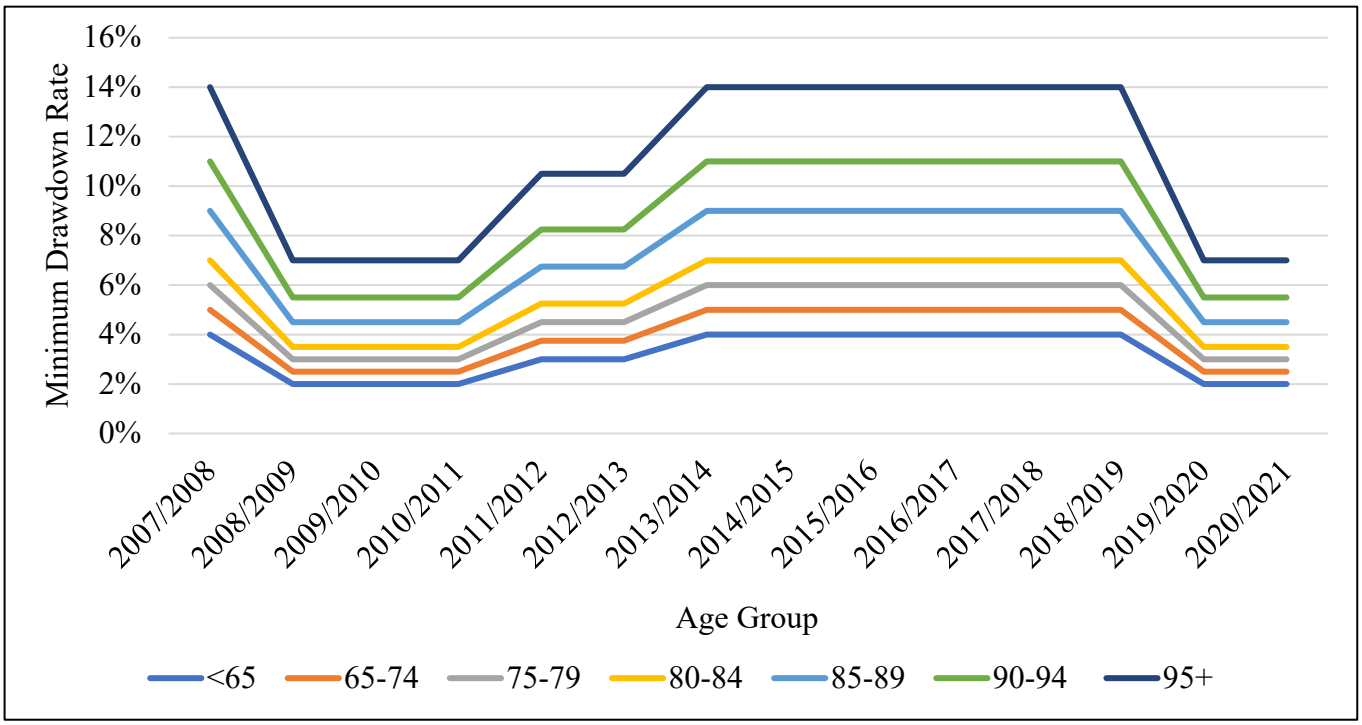
Age	<65	65-74	75-79	80-84	85-89	90-94	95+
Minimum Drawdown Rate (%)	0.04	0.05	0.06	0.07	0.09	0.11	0.14

Further, to assist retirees with the significant losses they experience during periods of financial crisis[10], the Australian government temporarily reduced these minimum drawdown rates (*Figure 1.1*)(Australian Taxation Office 2020):

- In response to the Global Financial Crisis (**GFC**), minimum drawdown rates were reduced by 50% for the 2008/2009, 2009/2010 and 2010/2011 financial years.
- In response to the European Debt Crisis (**EDC**), minimum drawdown rates were reduced by 25% for the 2011/2012 and 2012/2013 financial years.
- In response to Coronavirus Pandemic (**COVID-19**), minimum drawdown rates were reduced by 50% for the 2019/2020 and 2020/2021 financial years.

[9] For example, within each designated age bracket, a minimum percentage of an ABPs' balance at the beginning of each financial year must be drawn down before the end of the financial year.
[10] Retired households hold much of their wealth in ABP's that carry investment risk, meaning Australian retirees suffer large changes in financial wealth during turbulent market conditions: Spicer, A., et al. (2016). "How portfolios evolve after retirement: evidence from Australia." Economic Record 92(297): 241-267.

Figure 1.1: Minimum drawdown rates over time



1.5 Research Proposition

Using Australian Account-based Pension evidence, this thesis will investigate retirees' drawdown and investment decisions within Australia's Defined Contribution scheme. More specifically, this thesis will investigate (a) the moderating role of retirees' demographic factors on their drawdown and investment choices, and (b) how their drawdown and investment choices were modified during crisis periods, namely the GFC and EDC.

1.6 Research Significance

Significance to government

From the perspective of government, results from this thesis assist with the development and evaluation of policy. For example, in countries like Chile and Switzerland, understanding post-retirement investment behaviours assists with the evaluation of current

policies that regulate asset allocation, more specifically, whether overly conservative asset allocations are being enforced. In countries like Australia, understanding post-retirement investment and drawdown behaviours assists the government with the development of Comprehensive Income Products for Retirement (**CIPR**)[11](Australian Treasury 2014) as well the evaluation of changes to the legislated minimum drawdown rates that have been implemented during financial crises (Australian Treasury 2014). Further, throughout 2020 the Australian Government undertook a review of Australia's retirement income system and found that it was *"increasingly evident that there are many aspects of the system where there is a need to improve understanding"* (Commonwealth of Australia 2020). Critically, results from this thesis will contribute to improving this understanding through investigating how retirees' decisions are attributable to their demographic characteristics and impacted by macroeconomic and policy changes.

Significance to industry

From the perspective of industry, understanding the determinants of individuals' decisions is of interest to asset managers, financial advisors, as well as other suppliers of financial products and services. This is because changes in individuals' behaviour can affect asset prices (Kogan, Ross et al. 2006), return volatility (Foucault, Sraer et al. 2011) and financial planning choices, all of which are likely to impact financial intermediaries' profitability. Further, as of January 2020, the Prudential Standard SPS 515 came into effect, mandating all registrable Australian superannuation entities to regularly assess the outcomes provided to members and identify opportunities for improving these outcomes (APRA 2020). Critically, results from this thesis will contribute to identifying these opportunities through

[11] In order to improve retirement outcomes for Australians, CIPR aim to deliver retirees "a regular and stable income stream, longevity risk management and flexibility": Australian Treasury (2014). "Financial System Inquiry Final Report." from https://treasury.gov.au/sites/default/files/2019-03/p2014-FSI-01Final-Report.pdf.

documenting how retirees' decisions are attributable to their demographic characteristics and impacted by macroeconomic changes, therefore establishing a fact base that assists financial intermediaries in improving the services and products they supply.

Significance to academia

From the perspective of the academic literature, this thesis contributes to the existing empirical drawdown literature and establishes a new empirical literature examining post-retirement investment behaviours within DC schemes. In addition, and more broadly, it contributes to the literature examining the impact of financial crises on individual investors behaviour.

1.7 Structure of Dissertation

The remaining chapters are broken down into the following: *Chapter Two* provides a comprehensive review of the post-retirement decision making literature. *Chapter Three* builds on the research proposition and literature review to develop the hypotheses. *Chapter Four* highlights the unique data sets acquired for this study and discusses the methodologies employed to test the hypotheses. *Chapter Five* explores the results of the empirical models and discusses the findings as well as robustness checks. *Chapter Six* summarises the paper, outlines its limitations and explores future research applications.

Chapter Two: Literature Review

In reviewing the post-retirement decision making literature, this thesis distinguishes between the (i) *Normative Economics* of choice, (ii) *Behavioural Economics* of choice, and (iii) *Positive Economics* of choice. In addition, given the Australian context of this thesis, a specific emphasis is placed on highlighting Australian literature.

2.1 Normative Economics

Literature examining optimal investment and drawdowns decisions is heavily rooted within multi-period life-cycle allocation models. This is primarily because these models allow reasonable expectations to be developed regarding how retirees should invest and drawdown their ABP assets.

Post-retirement drawdown decisions

At the heart of these multi-period models is the life-cycle model (**LCM**) of savings and consumption. Originally postulated by Fisher (1930) and refined by Ando and Modigliani (1963) and Modigliani (1986), the conceptual underpinning of the LCM is the notion of consumption smoothing, whereby utility maximising individuals save wealth pre-retirement, and drawdown said wealth post-retirement, in order to maintain a level consumption profile over their life cycle. Applied to retirees, the classical LCM assumes retirees have perfect information regarding their lifetime consumption and savings needs and therefore engage in perfect consumption smoothing during retirement.

Recognising that retirees do not have perfect information, related literature has sought to build on the classical LCM through identifying and incorporating additional factors that affect saving and consumption. Broadly speaking, these factors can be categorised as either precautionary; focusing on retirees age-dependent risks (e.g. the risks retirees face as they

age), or bequest; focusing on the utility retirees receive from bequeathing wealth to their survivors (e.g. leaving their children an inheritance). Precautionary literature has incorporated a number of age-dependent risks into the LMC including longevity risk[12] (Yaari 1965, Huang and Milevsky 2008, Milevsky 2013, Shen and Wei 2016), minimum subsistence requirements[13] (Rubinstein 1976, Thorp, Kingston et al. 2007), age dependent risk aversion[14] (Lichtenstern, Shevchenko et al. 2020) as well as unexpected medical expenses and health depreciation[15] (Palumbo 1999, Coile and Milligan 2009, Dobrescu 2015, Yogo 2016). Contributions from the bequest literature include incorporation of luxury bequests[16] (Ding 2014, De Nardi, French et al. 2016).

With respect to these precautionary factors, *Normative Economics* has long asserted that it is inherently inefficient for a retiree to self-insure against these age-dependent risks and asserted that the optimal solution for retirees is to risk-pool through purchasing different types of insurance[17] (e.g. Yaari (1965) and Brown and Warshawsky (2013)). As an example, for a retiree looking to protect themselves from longevity risk, *Normative Economics* suggests that the optimal solution is to purchase a life annuity[18] (Milevsky 2013). This is because, contingent on several assumptions (including the lack of a bequest motives), life annuities effectively insure retirees against longevity risk, allowing them to engage in perfect consumption smoothing throughout retirement. In the absence of adequate insurance or annuitisation, however, *Normative Economics* has also long

[12] Longevity risk refers to the risk of a retiree outliving their savings.
[13] Classical LCM's assume retirees derive utility from the absolute level of their consumption. An alternative perspective suggests that this is an oversimplification and retirees' minimum subsistence requirements imply utility from consumption is better measured relative to a consumption floor.
[14] Age dependent risk aversion posits that as retirees age, their risk aversion increases.
[15] Health depreciation posits that retirees' marginal product of consumption decreases as they age.
[16] The term luxury bequest refers to the fact that the marginal utility of a luxury bequest is constant, corresponding to a retirees perfectly elastic demand for bequests with respect to wealth.
[17] Barring health depreciation and age-dependent risk aversion, as by definition, they are un-insurable.
[18] Life annuities, purchased with retirement monies, can be viewed as fixed income bonds that pay monthly coupons to annuitants until their death.

recognised that retirees should self-insure against these age-related risks through progressively reducing their consumption and building a buffer-stock of wealth as they age. As an example, for Australian retirees, Bateman and Thorp (2008) found that progressively reducing consumption through following the legislated age-dependent minimum drawdown rates closely resembled this optimal path[19] (*Table 1.1*) (*Appendix 1*).

In addition to these precautionary factors and age-related risks, bequest factors also affect retirees' consumption and saving decisions during retirement. This is because retirees may receive utility from bequeathing wealth to their survivors, most notably their children or alternatively their caregivers (De Nardi, French et al. 2016). To investigate the role of bequests, Ding (2014) incorporated luxury bequests (as well as minimum subsistence consumption requirements) into an LCM that was calibrated for Australian retirees; the term luxury bequests refers to the fact that the marginal utility of a luxury bequest is constant, corresponding to a retirees perfectly elastic demand for bequests with respect to wealth (as studied in Lockwood (2018) and De Nardi, French et al. (2010)). Critically, Ding (2014) found that because luxury bequests were perfectly elastic with respect to wealth, they acted as shock absorbers that buffered age-related risks. As a consequence, for retirees seeking to leave bequests, it was optimal for them to further increase their buffer-stock of wealth through further reducing their consumption during retirement.

Post-retirement investment decisions

The leading theoretical proposition for the *Normative Economics* of post-retirement investment decisions originated from (Yaari 1965) and was later extended by Merton (1969) and Samuelson (1969). This approach – hereby referred to as the 'Merton model'

[19] Although, it is important to note, that for highly risk-averse retirees, relative to their theoretically optimal drawdown strategy, Bateman and Thorp (2008) also found that these minimum drawdown rates forced them to drawdown their wealth faster, especially at later ages.

approach – treats the portfolio allocation problem as part of a constrained-optimisation problem – posed either informally or mathematically – where investment returns are mostly assumed to be deterministic, following geometric Brownian motion with constant drift and volatility parameters (Kingston and Thorp 2019).

In explaining the relationship between wealth and portfolio allocation for retirees, Merton (1969) laid the theoretical foundations for asset-liability matching[20]. It asserts that retirees should match their minimum subsistence requirements (i.e. consumption of necessities) with safe assets, especially in early retirement, and match their discretionary requirements (i.e. consumption of luxuries) with growth assets, especially in late retirement. This proposes that as wealth falls, retirees should progressively concentrate their wealth in safe assets to generate a dependable income that satisfies their minimum subsistence consumption. Similarly, as wealth increases, retirees should increase their proportionate exposure to risky assets to satisfy their discretionary consumption.

With regard to the effect of age, conventional folk wisdom has long asserted that retirees' equity allocations should decrease as they age. Conversely however, Samuelson (1969) and Merton (1969) argued that this view is in fact mistaken, and asserted that it was optimal for equity allocation to be constant with respect to age (although, work by Samuelson (1991) did show that the folk wisdom could be supported if the assumption of a random walk for security returns was replaced with mean reversion and negative serial dependency in returns). Upon further investigating security returns, McNaughton, Piggott et al. (1999) argued that these early works were biased as they excluded the differential return to risky and safe assets. After accounting for differential returns, McNaughton, Piggott et al. (1999) suggested that retiree's equity allocations should actually increase with age.

[20] Asset-liability matching elucidates the spending preferences and funding sources of retirees before engaging in an expected utility maximisation.

Critically, Bodie, Merton et al. (1992) and Bodie (2003) extended this line of literature through showing that a key restrictive assumption of these early 'Merton models' was that individuals had no human capital (i.e. labour income). After accounting for human capital, they asserted that equity allocations should actually decrease with age. Their key argument was that as individuals aged, their human capital diminished, thereby reducing their ability to diversify away investment risk. Related literature has also suggested that equity allocation should decrease with age due to age-dependent risk aversion (Bellante and Green 2004) and information costs (Haliassos and Bertaut 1995).

Acknowledging and consolidating the contributions of previous works, Thorp, Kingston et al. (2007) calibrated a 'Merton model' for Australian retirees under the assumptions they had (a) minimum subsistence requirements, (b) a choice between one risk-free and one risky asset, and (c) no human capital. Critically, they found that under these assumptions, in order to protect their minimum subsistence requirements, it was optimal for Australian retirees to increase their equity allocation as they aged. Kingston and Fisher (2014) carried out a comparable exercise and found that for a retiree with $1 million in wealth, their optimal equity allocation should be 45% upon retirement and rise to 73% after 30 years of retirement.

Ding (2014) extended the 'Merton model' of Thorp, Kingston et al. (2007) to include luxury bequests. Ding (2014) found that retirees planning to leave luxury bequests should further increase their equity allocations as they aged. As previously discussed, this was because luxury bequests acted as shock absorbers that buffered risks[21], in this case, investment risk. In addition, they found that this buffer was particularly prominent at later ages, when retirees had less expected future consumption requirements.

[21] Recall that the marginal utility of a luxury bequest is constant, corresponding to a retirees perfectly elastic demand for bequests with respect to wealth.

In addition to the aforementioned factors, Australia's Age Pension[22] also acts as an important determinant of portfolio allocation. This is because, considered as a financial instrument, the Age Pension is free of investment risk, offers longevity insurance, and serves as a 'negative-beta' security for those entitled to receive it (Kingston and Thorp 2019). As a result, when Ding (2014) calibrated a 'Merton model' that incorporated Australia's Age Pension, it acted as a factor that offset the initial relationship, between equity allocation and age, originally discussed by Thorp, Kingston et al. (2007). In addition, Ding (2014) found that retirees' optimal equity allocations were highly sensitive to their Age Pension entitlement and that sensitivity faded as they aged. The former was because Age Pension entitlement buffered retirees' investment risk, enabling them a greater equity allocation. The latter was because the present value of the Age Pension was highest at the onset of retirement (analogous to the present value of wages at the onset of working life), however, as retirees aged and their life-expectancy decreased, their expected investment risk buffer decreased and equity allocation needed to be decreased to compensate.

Andréasson, Shevchenko et al. (2017) further extended the work of Ding (2014) through incorporating details of Australia's legislated minimum drawdown rates as well as details of the means-testing (i.e. eligibility requirements) for Australia's Age Pension. Critically, Andréasson, Shevchenko et al. (2017) found that when the legislated minimum drawdown rates were enforced, the relationship between the investment risk buffer provided by the Age Pension and retirees age weakened. Furthermore, they found that the means-testing for the Age Pension produced a complex relationship with retirees' optimal equity allocations, however, as some general rules they suggested that (a) as retirees' wealth decreases, their

[22] The Age Pension, introduced in 1909, is a publicly funded, age-dependent and means tested social security payment for Australian retirees (i.e. a first-tier DB scheme). The Age Pension, considered as a financial instrument, is free of investment risk, offers longevity insurance, and serves as a 'negative-beta' security for those entitled to receive it (Kingston and Thorp 2019).

equity allocation should increase, (b) equity allocation should increase with age for less wealthy retirees, and (c) equity allocation should decrease with age for wealthier retirees.

In addition to the aforementioned 'Merton model' approach, Bengen (2001) pioneered an alternative, 'simulation-based' approach, for modelling post retirement investment decisions. Within this approach, optimal equity allocations were chosen by minimising the average fail rate of a pre-planned rate of consumption, as determined by simulations with repeat sampling on historical returns to different asset classes. Importantly, the use of historical returns allowed investment returns to be modelled non-parametrically, thereby accounting for sequencing risk.

Utilising this 'simulation-based' approach, Bengen (2001) found that in order to manage sequencing risk, it was optimal for equity allocations to remain constant with respect to age. On the contrary however, after following a similar 'simulation-based' approach Basu and Drew (2009) asserted that equity allocations should in fact decrease with age on account of the portfolio size effect; retirees should take advantage of the fact that wealth will typically be close to its lifecycle maximum at the point of retirement. Conversely, Doran and Bornholt (2017) asserted that these existing repeat sampling simulations were biased as they failed to incorporate the serial dependency evident in long-term asset class returns. After compensating for this serial dependency, Doran and Bornholt (2017) asserted that equity allocations should in fact increase with age.

2.2 Behavioural Economics

In addition to the aforementioned *Normative Economics* frameworks, over the second half of the 20th century, researchers working at the interface of economics, finance and psychology developed a different framework regarding how 'real' people make decisions. Although consistent with the fundamental economic proposition that 'real' people can and

do try to maximize their self-interest, this framework asserts that under mental or emotional constraints and complexity, 'real' people do not always behave as the rational utility maximising agents assumed by *Normative Economics*. This approach is now known as *Behavioural Economics.*

Mental and emotional constraints

Herbert Simon (1955) first introduced the term 'bounded rationality' as a shorthand for his argument against the *Normative Economics* assumption of homo economicus. Instead, Simon asserted that in the 'real' world, individuals' decisions were subject to 'bounded rationality', whereby their cognitive limitations meant certain choices were simply too complex to be made perfectly. In the context of post-retirement decision making, this view suggests that the extent of retirees' cognitive limitations – in this context, financial literacy[23] – dictates their capacity to make optimal decisions during retirement.

Another such constraint is the notion of 'bounded self-control'. Introduced by Mullainathan and Thaler (2000), 'bounded self-control' asserts that individuals have the right intentions, but lack the will power to make appropriate decisions. One such example of 'bounded self-control' is procrastination, whereby the more naïve individuals are, the more pronounced their tendency to postpone important tasks, like planning for retirement (Thaler and Benartzi 2004), or writing a thesis (Knott 2020). For example, within a retirement setting, Samuelson and Zeckhauser (1988) showed that procrastination produced a strong tendency towards decision inertia – which they subsequently dubbed the status quo bias – whereby once a retiree made an initial decision, thereby establishing a status quo, they tended to

[23] Financial literacy can be defined as the set of skills and knowledge that allows an individual to make informed and effective financial decisions.

stick with it until the expected benefit-to-cost ratio of changing their decision is substantial enough to incite a change.

Another important finding of behavioural economics is that individuals' forecasts are often characterized by widespread overconfidence (Mitchell and Utkus 2006). It is suggested that such overconfidence is partly the result of their excessive optimism and their inability to understand the role of random chance in determining the future (Miller and Ross 1975). Whilst overconfidence has evolutionary benefits (Johnson and Fowler 2011), in the investment field, it has been shown to lead to sub-optimal behaviour (Barber and Odean 2001). Further, psychologists have long found that gender differences in overconfidence that are highly task dependent (Lundeberg, Fox et al. 1994) and that in areas such as finance, men are more overconfident than women (Prince 1993).

Behavioural heuristics

When making judgements under uncertainty, Tversky and Kahneman (1974), found that individuals adopted simple heuristics or 'rules of thumb' which lead to systematic biases in their decision making. Kahneman, Slovic et al. (1982) asserted that individuals adopted these simple heuristics or 'rules of thumb' to reduce the task complexity in their judgment and choice. In this light, the remainder of this section explores some of the key heuristics that can systematically affect retirees' drawdown and investment decisions.

One such heuristic – to reduce task complexity – is to select a default option[24]. For example, it has been found that when faced with a complex decision under uncertainty, many individuals will try to avoid it altogether (i.e. procrastinate), when that is not possible, they will look for a default option (Reeson and Dunstall 2009). In areas relating to retirement

[24] A default option is a prescribed alternative for an individual that fails to make an active choice, or decides not to choose between alternatives.

planning, default options have found to be effective in guiding retirees' decisions due to their implied endorsement (i.e. the notion that the government knows best) (Alonso-García, Bateman et al. 2018).

Another such heuristic is the availability heuristic. The availability heuristic posits that individuals' estimations of an event's likelihood are mediated by an assessment of their availability within associative memory or by the ease with which the relevant instances come to mind (Tversky and Kahneman 1973). This heuristic exploits the notion that the brains' associative bonds are strengthened by repetition (Hintzman 1976). For example, in judging the likelihood of an event, individuals scan their memory for similar instances in which it has occurred, thus, recent occurrences of an event may increase their availability within individuals' memories and the perceived likelihood that it will occur in the future.

2.3 Positive Economics

While the *Normative Economics* and *Behavioural Economics* sections are concerned with reviewing the theoretical determinants of post-retirement decision making, the *Positive Economics* section is concerned with reviewing the actual empirical evidence and reconciling it with theory.

Financial literacy

Assumptions about retirees' capacity to interpret and evaluate financial information are central to predictions of both *Normative Economics* as well as *Behavioural Economics*. Therefore, it is important to begin by reviewing the validity of this assumption through

examining the extent of retirees' financial literacy[25] as well as the complexity of decisions they must make.

Lusardi and Mitchell have long been powerhouses in the area of financial literacy. Critically, in 2007, they showed evidence that retirees did not have the requisite financial literacy required to deal with the complex financial decisions retirement now presents (Lusardi and Mitchell 2007). Furthermore, in 2017, they showed that around the world (a) women were less financially literate then men, (b) older individuals believed themselves to be more financially literate, despite being less financially literate, (c) more educated people were more financially literate, and (d) the more financially literate individuals were, the more likely they planned for retirement (Lusardi and Mitchell 2017).

Investigating Australia more specifically, not only has it been found that Australians exhibit poor financial literacy (ANZ Survey of Adult Financial Literacy 2015), but also that they are less financially literate in matters relating to retirement planning than financial matters in general (Productivity Commission 2015). It has also been found that Australia's retirement income system is complex to navigate for both retirees (Commonwealth of Australia 2020) and financial advisors (IOOF 2019).

Critically, when conducting a review of Australia's retirement system, the Commonwealth of Australia (2020) found that low levels of financial literacy, combined with the complexity of the retirement system, made it hard for retirees to make well-informed choices about their retirement.

Use of life annuities

[25] There also exists a wealth of literature documents the positive relationship between cognitive impairment and age. See Agarwal, S., et al. (2009). "The age of reason: Financial decisions over the life cycle and implications for regulation." Brookings Papers on Economic Activity 2009(2): 51-117. However, for brevity, this is not included.

Although *Normative Economics* posits that life annuities are the optimal solution for managing longevity risk during retirement, their use by Australian retirees has been virtually non-existent. For example, Bateman and Piggott (2010) found that the number of life annuities sold in Australia had decreased from 1,927 in 2001, to fewer than 20 in 2009. This dearth in annuitization is not unique to Australia, and has been documented in the U.S. (see Brown, Mitchell et al. (2000) and Brown (2009)) and around the world more generally (see James and Song (2001)). While *Normative Economics* is unable to completely explain this observed discrepancy (Lockwood 2012), *Behavioral Economics* has offered explanations in its stead. For example, Brown (2009) suggested low use of annuities may be the result of retirees inability to make appropriate choices (i.e. low financial literacy) and/or their susceptibility to cognitive biases (i.e. behavioral heuristics).

Inertia (i.e. status quo bias)

If retirees resemble homo economicus, as assumed by *Normative Economics*, it should be reasonable to expect them to exercise investment choices as their circumstances change. However, examining pre-retirement investment behaviours within DC schemes, the most significant empirical finding is that of inertia. For example, in Australian samples, Bowman (2003) found only 10-15% per cent of individuals had exercised an investment choice. Similarly, Gerrans, Gardner et al. (2006) found that only 8% of individuals had made an investment switch over a 40-month period. Inertia in retirement decision making has also been observed within U.S. samples (see Choi, Laibson et al. (2004) and Ameriks and Zeldes (2004)). Furthermore, and congruent with concepts from *Behavioural Economics*, namely overconfidence, empirical literature has also generally identified a relationship between inertia and gender, with males identified as more likely to make investment switches (see Gerrans and Yap (2010) and Gerrans and Clark-Murphy (2004) in Australia, and Mitchell, Mottola et al. (2006) in the United States). Surprisingly however, when documenting the

investment choices of Australians during the GFC, Gerrans (2012) found the opposite relationship whereby women with larger balances were more likely to make an investment switch.

Use of default options

Normative Economics assumes that the decisions of retirees are the result of a careful weighing of costs and benefits which are informed by existing preferences. Despite this, a substantial body of evidence finds that although members of DC schemes have the flexibility to choose their own strategy, a substantial portion choose a default option instead. For example, within the accumulation phase, $731 billion of $1.6 trillion of Australian DC assets are invested in default options[26] (APRA 2020), similarly in the U.S. up to 80% of assets in different plans are invested in the default fund (Choi, Laibson et al. 2004). Critically, empirical literature has also found that if defaults are not carefully chosen, their characteristic stickiness (i.e. becoming the status quo) can lead to sub-optimal outcomes (e.g. Goda and Manchester (2013) and Cronqvist and Thaler (2004)).

While there is no explicit default investment or drawdown option in Australia's post-retirement phase, there is reasonable premise and evidence to expect that the governments' legislated minimum drawdown rates act as an implied default option for retirees[27] (Commonwealth of Australia 2020). Alonso-García, Bateman et al. (2018) investigated the effect of the implied endorsement of legislated minimum drawdown rates through conducting a survey within Australia and the Netherlands. Critically, they found that those

[26] Default options refer to the 'MySuper' products.
[27] The premise is because the objective of minimum drawdown rates are to ensure that ABP's are used to provide retirement income, see: Australian Treasury (2016), "*Retirement Income Streams Review"*. The evidence refers to the fact that roughly half of retirees draw at the legislated minimum rate (discussed later).

who were overconfident about their capabilities (i.e. males), found the implied endorsement less important and were more susceptible to making adverse choices.

Drawdown behaviours within ABP's

Due to a lack of data availability, empirical investigations of retirees' actual drawdown behaviours within ABP's have been limited (Productivity Commission 2015). However, it has generally been observed that the use of the legislated minimum drawdown rates are positively related to retiree age, account balance, gender (being female) and risk aversion (see Rothman and Wang (2013), Reeson, Zhu et al. (2016), Balnozan (2018) and Balnozan, Fiebig et al. (2020)). In addition, work by Balnozan (2018) and Balnozan, Fiebig et al. (2020) shows that two simple behaviours explain more than three quarters of the variation in drawdown behaviours, namely (a) drawing constant dollar amounts (28%), and (b) following closely the legislated minimum drawdown rates (48%).

When documenting the effects of the temporary reductions to the legislated minimum drawdown rates introduced during the GFC, both Rothman and Wang (2013) and Balnozan (2018) found that roughly one-third of retirees previously drawing at the minimum rate, reduced their drawdowns to the new temporary minimum. Furthermore, and consistent with the notion that those drawing at the minimum rate are less reliant on their ABP's and/or wishing to accumulate tax-advantaged wealth, Rothman and Wang (2013) also found that the use of the temporary minimum increased with wealth. For example, they found that use of the temporary minimum varied from around 30% for retirees with roughly $100,000 of ABP assets, to over 60% for retirees at the highest asset ranges.

It is important to note that the extent to which these findings are attributable to the notion that retirees are engaging in consumption smoothing, as asserted by *Normative Economics*,

or are simply adopting simple 'rules of thumb' when making a complex decision, as asserted by *Behavioural Economics*, remains inconclusive.

Post-retirement investment behaviours

No empirical literature has documented investment behaviours within ABP's. As a result, other helpful literature related to financial risk tolerance instead.

Financial risk tolerance can be defined as the psychological component of decision making under financial uncertainty; a situation in which individuals evaluate the desirability of possible outcomes and their likelihood of occurring (Kahneman and Tversky, 1979). Despite difficulty in measuring financial risk tolerance due to its multidimensional nature (Trone, Allbright et al. 1996), a plethora of empirical literature has generally identified that it increases with wealth (Cohn, Lewellen et al. 1975), education (Hallahan, Faff et al. 2004), being married as well as being male (for a review see Lippi and Rossi (2020)). Further, studies have found that it varies with age (McInish 1982), although this variation isn't necessarily linear (Lippi and Rossi 2020).

There is also growing empirical literature showing that individuals' financial risk tolerance may not be stable when subjected to extreme events. For example, when examining Australian investment behaviours during the GFC, Cardak, Martin et al. (2019), found that households became myopic and more sensitive to large decreases in experienced returns. The results also revealed that high wealth households were less myopic, while surprisingly, factors such as age and education had no significant impact. Empirical applications that investigate financial risk aversion before and after the GFC are also given by Hoffmann et al. (2013), Weber et al. (2013), Hoffmann and Post (2017), Guiso, Sapienza et al. (2018) and Lippi and Rossi (2020).

Examining Australian post-retirement investment behaviors more generally, Hulley, McKibbin et al. (2013) found that at a household level, equity allocations decreased with age and increased with wealth. Globally, these results are consistent with (Poterba and Samwick 2001) and Coile and Milligan (2009) in the United States, and Van Ooijen, Alessie et al. (2015) in the Netherlands.

Chapter Three: Hypotheses Development

Through connection of the normative, behavioural and positive literature components, this section formulates two groups of testable hypotheses. The first group relates to retirees' drawdown behaviours and the second to investment behaviours.

3.1 Drawdown Hypotheses

In developing the drawdown hypotheses, this thesis seeks to address the aforementioned gaps in the positive economics literature. Specifically, this thesis seeks to investigate how gender differences amongst retirees have moderated their decisions to adopt the minimum drawdown rates as well as temporary minimum drawdown rates introduced during periods of crisis. To do so, this thesis uses concepts from *Behavioural Economics*. This is because *Normative Economics* makes no direct assertions regarding the impact of gender on optimal drawdown strategies[28].

H1a

In developing H1a, this thesis asserts the following: First, for a retiree, the selection of an appropriate drawdown rate is complex and heterogeneous problem (IOOF 2019, Kingston and Thorp 2019, Commonwealth of Australia 2020); Second, in the face of this uncertainty and to reduce this tasks complexity, retirees will search for the implied endorsement of a default option (Kahneman, Slovic et al. 1982, Reeson and Dunstall 2009), which in this case is represented by the legislated minimum drawdown rates (Thorp, Kingston et al. 2007, Alonso-García, Bateman et al. 2018, Balnozan 2018, Commonwealth of Australia

[28] An argument can be made due to the differences in life expectancy between men and women, however, this is expected to have minimal effect on their drawdown behaviors immediately before and after crisis periods.

2020); Third, retirees whom are less confident will be more likely to find the implied endorsement of these legislated minimum drawdown rates important[29] (Alonso-García, Bateman et al. 2018), which in this financial setting, can be proxied for by gender (Prince 1993, Lundeberg, Fox et al. 1994, Barber and Odean 2001).

In light of the above, *H1a* asserts that women will be more susceptible to the implied endorsement of the legislated minimum drawdown rates, thereby increasing their likelihood of drawing at the legislated minimum drawdown rates.

H1a: Women are more likely than men to drawdown at the legislated minimum rates.

H1b

Given that the aforementioned heuristics (mental shortcuts) are mediated by task uncertainty and complexity, it can be hypothesised that during periods of crisis and rule changes, their incidence will increase, thereby strengthening the relationships described in *H1a*. Therefore, *H1b* asserts that during the 2008/2009 and 2011/2012 financial years, where financial crises increased uncertainty (i.e. the GFC and EDC) and rule changes increased complexity (i.e. changes to the legislated minimum drawdown rates), women will become even more likely than men to drawdown at the legislated minimum drawdown rates.

H1b: During periods of financial crisis and rule changes, women become even more likely than men to drawdown at the legislated minimum rates.

Before continuing, it is important to emphasise a caveat within *H1b*. Reductions to the legislated minimum drawdown rates for the 2008/2009 financial year were announced in

[29] This is because more overconfident retirees will exhibit an increased optimism in their capability to choose optimal drawdown rates and overestimate their ability to maintain a higher drawdown rate. whereas individuals who are less confident will be more susceptible to the implied endorsement of the legislated minimum drawdown rates.

March of 2009 (Commonwealth of Australia 2009), whereas changes to the legislated minimum drawdown rates for the 2011/2012 financial year were announced in November of 2011 (Commonwealth of Australia 2011). This means that when the 50 percent reduction occurred in March of 2009, many retirees' cumulative drawdowns over the first seven months of the financial year had likely already exceeded the new temporary minimum, leaving them little opportunity to adjust to the new minimum. Whereas when the 25 percent reduction occurred in November of 2011, it is unlikely that retirees' cumulative drawdowns over the first five months of the financial year exceeded the temporary minimum, meaning they had a greater opportunity to adjust to the new minimum. As a result, it is likely that the prevalence of the relationship described in *H1b* will be more prominent in the 2011/2012 financial year then the 2008/2009 financial year.

3.2 Investment Hypotheses

Given that no existing empirical literature has documented post-retirement investment behaviours within DC schemes, this thesis seeks to begin by investigating some simple predictions of the *Normative Economics* literature. Once this is completed, this thesis seeks to investigate some more adventurous predictions using *Behavioural Economics* literature.

Normative Economics: H2a and H2b

In developing these normative hypotheses, predictions from the 'Merton model' literature rather than the 'simulation-based' literature are used. This is because the 'Merton model' literature clearly articulates how factors such as wealth (Merton 1969), age (Merton 1969, Samuelson 1969, Samuelson 1991, Bodie, Merton et al. 1992, McNaughton, Piggott et al. 1999, Bodie 2003, Thorp, Kingston et al. 2007), bequest motives (Ding 2014), Age Pension entitlement (Ding 2014) as well as the legislated minimum drawdown rates (Andréasson, Shevchenko et al. 2017) influence retirees' optimal equity allocations.

Further, given that this thesis is investigating the behaviour of Australian retirees, particular emphasis is given to 'Merton model' literature that incorporates the specifics of the Australian setting. As a result, hypotheses are primarily developed from the recent work of Andréasson, Shevchenko et al. (2017) who built on earlier Australian specific works of Ding (2014) and Thorp, Kingston et al. (2007) (See *2.1: Normative Economics* for a review).

Critically, Andréasson, Shevchenko et al. (2017) found that Australia's means-tested Age Pension and minimum drawdown rates produced a complex relationship between retirees' optimal equity allocation, wealth and age. However, as general rules Andréasson, Shevchenko et al. (2017) suggested that (a) as retirees' wealth decreases, their equity allocation should increase, and (b) equity allocation should increase with age for less wealthy retirees and decrease with age for wealthier retirees. Following these general suggestions, the following hypotheses are formed:

H2a: Equity allocation is negatively related to wealth.

H2b: Equity allocation and age are positively related for less wealthy retirees and negatively related for wealthy retirees.

Behavioural Economics: H3a

As discussed within section *2.3: Positive Economics,* one of the most significant empirical findings within the pre-retirement phase is that of decision inertia. Therefore, this thesis seeks to examine the extent of decision inertia within the post-retirement phase. To do this, factors that moderate retirees' propensities to revisit and change their account opening investment strategies are investigated. For example, for a retiree that has just opened an ABP, what factors moderate their propensity to revisit and change their investment strategy?

In developing this first hypothesis, this thesis asserts the following: First, overconfident retirees will overestimate the precision of their information (Barber and Odean 2001), therefore the expected gains of revisiting and changing their account opening investment strategies. Second, in this financial setting, since overconfidence can be proxied for by gender (Prince 1993, Lundeberg, Fox et al. 1994, Barber and Odean 2001), men will be more likely than women to revisit and change their account opening investment strategies.

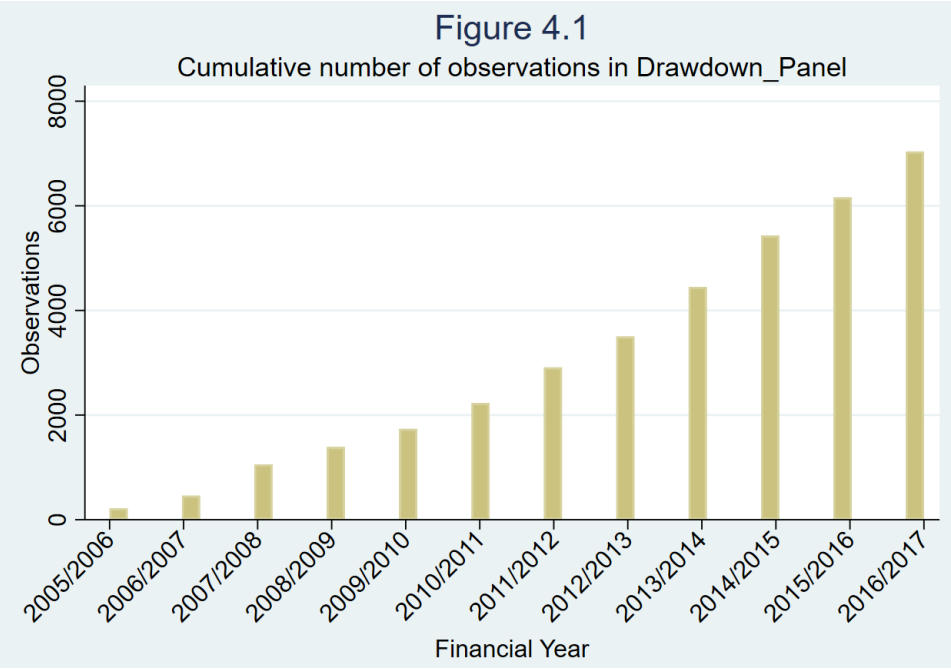
H3a: Men are more likely than women to revisit and change their account opening investment strategies.

Chapter Four: Data and Methodology

4.1 Overview

To test these hypotheses, this thesis uses a dataset provided by a large Australian financial institution. The dataset contains both administrative and transactional data for the institution's flagship retirement income product. The administrative data allows this thesis to obtain retirees' gender and date of birth. The transactional data allows this thesis to obtain the time, date, size and investment option(s) selection of all transactions involving retirees' ABP assets. Combined together, this administrative and transactional data allows this thesis to observe 8,921 retirees' investment and drawdown behaviours, as well as factors that moderate them, between 2005 and 2017.

It is important to note that because this institutions ABP product was only introduced in the early 2000's, observations are heavily skewed towards the later years of the sample (*Figure 4.1*). As a consequence, inferences relating to earlier years have less statistical power than inferences relating to later years.



Financial advice restriction

"Quite often the selection of the mutual fund is made by an adviser at the bank as opposed to the choice of the investor" (Abreu, Mendes et al. 2011)

While this large Australian financial institution does provide financial advice to retirees as required, the dataset utilised by this thesis explicitly refers to those retirees whom are not advised by the institution during the time they are observed[30]. This restriction improves the external validity of the results as it allows this thesis to focus on retirees' individual investment and drawdown decisions, as distinct from the decisions made by retirees receiving advice[31].

Calculation of equity allocation

When retirees open their ABP they are able to select from a menu of different investment options for their ABP assets. Over the sample period this menu expanded from 69-148 options. To determine the equity allocation of each investment option, details from the institutions ABP product disclosure statement (PDS) [32] are utilised. The equity allocation for each retiree is computed as the weighted average of the equity allocation of each option selected, as identified by the nominated weights in the PDS.

4.2 Data and Methodology: Drawdown Hypotheses

Drawdown hypotheses: Variables and panel construction

To investigate retirees' drawdown behaviours over time, the administrative and transactional data have been reconstructed into a panel dataset. This panel dataset is hereby

[30] It is possible that they were previously advised by the institution providing their ABP.
[31] It is also possible that the retirees within the dataset are receiving financial advice from an entity other than the institution providing their ABP.
[32] The PDS, and updates, are the primary documents which summarise the investment options available to investors.

referred to as the *Drawdown_Panel.* Within the *Drawdown_Panel*, each panel refers to a single ABP (referred to as a 'retiree') over the financial years it is observed.

The key variable of interest is whether each retirees' drawdown rate ($drawdown\_rate_{i,t}$) equals their respective minimum drawdown rate ($min\_drawdown_{i,t}$). This is calculated in accordance with the Superannuation Industry Regulations[33] (Commonwealth of Australia 1994) and accounts for the temporary reductions implemented during crises.

$$drawdown\_rate_{i,t} = \frac{\sum All\ Drawdowns\ made\ throught\ the\ financial\ year_{i,t}}{Account\ balance\ at\ start\ of\ finanical\ year_{i,t}} \qquad (Equation\ 1)$$

$$min\_drawdown_{i,t} = \begin{cases} 1, & drawdown\_rate_{i,t} = min\_drawdown\_rate_{i,t} \\ 0, & drawdown\_rate_{i,t} \neq min\_drawdown\_rate_{i,t} \end{cases} (Equation\ 2)$$

The independent variable of interest is retirees' gender ($gender_i$), which is constructed as:

$$gender_i = \begin{cases} 1, & male_i \\ 0, & female_i \end{cases}$$

As discussed within the *Normative Economics* section, retirees' optimal drawdown strategies are affected by: their wealth (Fisher 1930, Modigliani 1986); their risk aversion (Rubinstein 1976, Thorp, Kingston et al. 2007, Lichtenstern, Shevchenko et al. 2020); the age dependent risks they face (Yaari 1965, Palumbo 1999, Huang and Milevsky 2008, Coile and Milligan 2009, Milevsky 2013, Dobrescu 2015, Shen and Wei 2016, Yogo 2016); and their bequest motives (Ding 2014, De Nardi, French et al. 2016).

[33] First, for each retiree, their annual drawdown rate is computed each financial year using Equation 1. When an account is not opened at the start of the financial year, retirees' drawdown rates as well as their legislated minimum rates are calculated proportionately from the account opening date to the end of the financial year. Second, retirees calculated drawdown rates are then compared to their respective minimum drawdown rate using Equation 2. Third, as discussed in Section 1.4: Australian Account-based Pensions, if the date is prior to the introduction of the "Simplified Superannuation" Bill in 2007, each retirees' respective minimum drawdown rate is computed using their respective pension valuation factor, whereas is the date is after the introduction of the Bill, each retirees' respective minimum drawdown rate is computed using the current legislated minimum drawdown rates (see Figure 1.1).

To control for these factors – as well as to observe how they moderate retirees' drawdown decisions – this thesis computes the following control variables: To control for wealth, retirees' ABP balances ($account\_balance_{i,t}$) are computed at the start of each financial year. To control for risk aversion, retirees' weighted average equity allocations (inv_equity_i) are computed at the first point they are observed. To control for age dependent risks, each retirees' age ($age_{i,t}$) is computed as at the start of each financial year.

This thesis is unable to compute an appropriate control variable for retirees' bequest motives, although they are likely positively correlated with retirees' wealth (Ding 2014). Further, this thesis does not control for cohort effects as suggested by Lindström and Kokko (2002). Cohort effects are excluded in order to reduce multicollinearity with other age related variables (as shown by Balnozan (2018)). However, this thesis does control for the unobserved time variant heterogeneity that is constant across all retirees but varies over time. This is done through including dummy variables for each financial year ($year_t$).

Table 4.1: Drawdown_Panel Variables

This table reports the characteristics of the variables that comprise the Drawdown_Panel. *min_drawdown* is a dummy variable representing whether a retiree draws down at the minimum rate (1=true*). age* represents retirees' age at the start of the financial year. *account_balance* represents retirees' *ABP* balance at the start of each financial year. *gender* represents retirees' gender (1=male). *inv_equity* represents retirees' first recorded equity allocation. *year* represents the financial year of the observation.

Variable	Type	Description	Time-variant
min_drawdown	Dependent	Binary	Yes
gender	Independent	Binary	No
account_balance	Control	Continuous	Yes
age	Control	Categorical	Yes
inv_equity	Control	Continuous	No
year	Control	Categorical	Yes

Drawdown hypotheses: Methodology

To test *H1a* and *H1b*, the aforementioned variables are used to specify the following model:

$$Prob(min\_drawdown_{i,t} = 1) = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance_{i,t} +$$

$$\beta_3 age_{i,t} + \beta_4 inv\_equity_i + \beta year_t + \beta gender_i * year_t + \mu_i + e_{i,t}$$

Because the dependent variable is binary – representing the probability a retiree draws at the legislated minimum rate – the above model is estimated using a Logit regression. Because the regressor coefficients of Logit regressions represent relative changes to the log-odds ratio for a corresponding unit change in the regressor, they are not directly interpretable as changes to the probability that a retiree draws at the legislated minimum rate. Hence the Average Marginal Effect (**AME**) of each regressor is reported instead. AME's are calculated with Statas' 'margins' function.

In choosing a specification for the Logit regression, it is important to discuss the characteristics of the *Drawdown_Panel* and the objectives of the hypotheses. With regards to the *Drawdown_Panel,* because it observes retirees' behaviours and characteristics over time, it is likely that there will be unobserved time-invariant heterogeneity in the behaviour of each retiree (μ_i) that is not captured by the available regressors. As a result, a pooled cross-section model would likely be mis-specified. Fortunately, contingent on certain assumptions, other panel regression specifications, such as Fixed Effects (**FE**) and Random Effects (**RE**), are able to control for this unobserved time-invariant heterogeneity across retirees (μ_i). A key distinction between the FE and RE models it that the FE model removes time invariant heterogeneity, to produce 'within' effects. However, a limitation of this transformation is that it also removes all other time invariant regressors as well as observations where there is no time variation. Since this thesis is primarily interested in both the time invariant and time varying role of gender, the RE model is preferred[34]. Further, this thesis also estimates a linear probability model for comparison purposes

[34] In addition, as an extra robustness test for the time-varying role of gender (*h1b*), this thesis also examines also estimates a FE Linear Probability model.

(Hippel 2017). Because the mean probability of a retiree drawing at the minimum rate is 45 percent with a standard deviation of 50 percent, the Linear Probability Function will likely approximate the Logistic Function (see Hellevik (2009). Hence the Linear Probability model will provide an easily interpretable comparison to the RE model.

A critical assumption of the RE model is that retirees' unobserved heterogeneity is uncorrelated with the independent variables. If this assumption is violated, the RE model is considered inefficient and inconsistent. To investigate this assumption, this thesis also estimates a Correlated Random Effects (**CRE)** model (Antonakis, Bastardoz et al. 2019). The CRE model is implemented identically to that of the RE model, with the additional inclusion of cluster means for time-varying retiree specific variables ($\overline{account\_balance_i}$ and $\overline{age}_i$).

$$Prob(min\_drawdown_{i,t} = 1) = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance_{i,t} + \beta_3 age_{i,t} + \beta_4 inv\_equity_i + \beta year_t + \beta gender_i * year_t + \beta_7 \overline{account\_balance_i} + \beta_8 \overline{age}_i + \mu_i + e_{i,t}$$

An advantage of the CRE model is that it uses time-invariant heterogeneity to control for correlation between retirees' unobserved time-invariant heterogeneity and the regressors, thus relaxing the strong assumptions of the RE model. Further, a likelihood ratio test can be used to compare the maximum likelihood estimates of the RE model against the CRE model, where a statistically significant χ 2 value implies a rejection of the RE assumption. In addition, the RE assumption can also be tested through a post estimation Wald test that all contextual effects (i.e. coefficients on $\overline{account\_balance_i}$ and $\overline{age}_i$) are zero.

A limitation of the CRE model is that the time-invariant regressors are also used as controls for time-invariant heterogeneity (Antonakis, Bastardoz et al. 2019). As a result, the key independent variable, gender, cannot be interpreted as impacting the dependent variable.

Although its sign can still be examined for logical consistency (Wooldridge 2016). As a result, the CRE model is primarily used for (a) a robustness check for the aforementioned endogeneity within the RE model, and (b) a robustness check for the sign of the gender effect.

Drawdown hypotheses: Descriptive statistics

Table 4.2 reports summary statistics for the *Drawdown_Panel.* Consistent with Balnozan (2018) and Reeson, Zhu et al. (2016), Panel A shows that almost half (45%) of retirees' drawdown at the legislated minimum rate. Interestingly, Panel's B and C show that the proportion of retirees drawing at the minimum rate has increased 12 percentage points from 2007 to 2017, perhaps reflecting that the sample has aged (discussed next). Regarding *age*, Panel A reports a similar mean and median to that of Balnozan (2018) although the minimum age is much lower. Investigating this further, this thesis finds that approximately 0.28 percent of the sample is under the age of 55, which likely reflects a portion of individuals experiencing financial hardships or terminal illnesses being eligible to open an ABP early (Australian Taxation Office 2020). Consistent with the global demographic trends discussed in the introduction, Panel's B and C also show that the mean age of retirees has increased 4 years throughout the period[35]. Though a portion of this is likely attributable to the 1.5 year increase in the minimum retirement age that has occurred throughout the period (Department of Social Services 2020). To investigate this further, this thesis examines the mean age of sample entrants and finds that it has increased from 63 in 2007 to 66 in 2017, suggesting that retirees were also choosing to retire later. With respect to *gender*, Panel A reports that 58 percent of the sample is male while Panel's B and C show that this proportion has been decreasing over time. Examining *inv_equity*, Panel A reports

[35] Although, a portion of this is likely attributable to the 1.5-year increase in the minimum retirement age that has occurred throughout the period (Department of Social Services 2020)

the sample mean to be 35 percent and Panel's B and C show that average equity allocations have slightly decreased between 2007 and 2017.

Table 4.2 reveals that the mean *account_balance* of retirees within the *Drawdown_Panel* is almost double that of the samples of Balnozan (2018) and Reeson, Zhu et al. (2016). This suggests retirees within the *Drawdown_Panel* are much wealthier than those in previous studies, meaning they may not be representative of the Australian population. Panel's B and Panel C also reveal that mean *account_balance's* have decreased from 2007 to 2017, which may reflect that the sample has aged, has a greater proportion of women[36] and allocates lower to equity.

Table 4.3 further investigates the representativeness of the *Drawdown_Panel* through comparing it with summary statistics published by Australian Prudential Regulatory Authority **(APRA)**(APRA 2019). Critically, the APRA statistics encompass the majority of Australian Superannuation entities, meaning they are likely representative of the Australian population of retirees. It is important to note that the APRA statistics are only available for 2019 and encompass both ABP's and other types of pension products[37], meaning *Table 4.3* is not a like-to-like comparison. Notwithstanding this limitation, *Table 4.3* suggests that relative to the Australian population, retirees within the *Drawdown_Panel* are less wealthy at younger ages, but also drawdown their wealth more slowly, leaving them with larger balances at older ages. It is unclear what causes this discrepancy, although it may represent that retirees within the *Drawdown_Panel* do not receive financial advice. More importantly, this comparison suggests that on average, relative to the Australian population, retirees within the *Drawdown_Panel* are not wealthier, rather, samples examined by the previous literature may be less wealthy.

[36] Women have lower account balances (discussed later)
[37] Namely Annuities, transition to retirement accounts and other pension benefits.

Table 4.2: Descriptive Statistics

This table reports descriptive statistics for variables comprising the Drawdown_Panel. Panel A reports the pooled descriptive statistics. Panel B reports the descriptive statistics for a snapshot of the 2006/7 financial year. Panel C reports the descriptive statistics for a snapshot of the 2016/17 financial year. *min_drawdown* is a dummy variable representing whether a retiree draws down at the minimum rate (1=true*). age* represents retirees' age at the start of the financial year. *account_balance* represents retirees' *ABP* balance at the start of each financial year. *gender* represents retirees' gender (1=male). *inv_equity* represents retirees' first recorded equity allocation. *year* represents the financial year of the observation.

Panel A: Descriptive Statistics - Pooled						
Variable	N	Min	Median	Mean	Max	Std. Dev.
min_drawdown	36,654	0	0	45%	1	50%
age	36,654	17	67	67	92	6
account_balance ($ 000)	36,654	0	187	266	4,785	255
gender	36,654	0	1	58%	1	49%
inv_equity	36,654	0%	34%	35%	100%	32%
Panel B: Descriptive Statistics - Snapshot of 2007						
Variable	N	Min	Median	Mean	Max	Std. Dev.
min_drawdown	459	0	0	38%	1	49%
age	459	44	64	64	79	5.2
account_balance ($ 000)	459	31	207	295	2,013	233
gender	459	0	1	60%	1	49%
inv_equity	459	0%	37%	36%	100%	34%
Panel C: Descriptive Statistics - Snapshot of 2017						
Variable	N	Min	Median	Mean	Max	Std. Dev.
min_drawdown	7,038	0	0	50%	1	50%
age	7,038	19	69	68	90	6
account_balance ($ 000)	7,038	2	178	260	4,785	264
gender	7,038	0	1	57%	1	50%
inv_equity	7,038	0%	35%	35%	100%	30%

Table 4.3: APRA Comparison

This table reports a 2016/2017 financial year snapshot of average account balances ($ 000) from the Drawdown_Panel and compares them with a 2018/2019 financial year snapshot of the average pension members benefits ($ 000) computed from the APRA 2019 Superannuation Bulletin[38].

	APRA ($000)		Drawdown_Panel ($000)	
Retiree Age Bracket	Female	Male	Female	Male
60 to 64	308	383	243	293
65 to 69	318	373	260	299
70 to 74	260	315	229	273

[38] See table 13 onwards from APRA (2019). "Annual superannuation bulletin." from https://www.apra.gov.au/annual-superannuation-bulletin.

75 to 84	170	207	215	236
85+	82	107	192	214

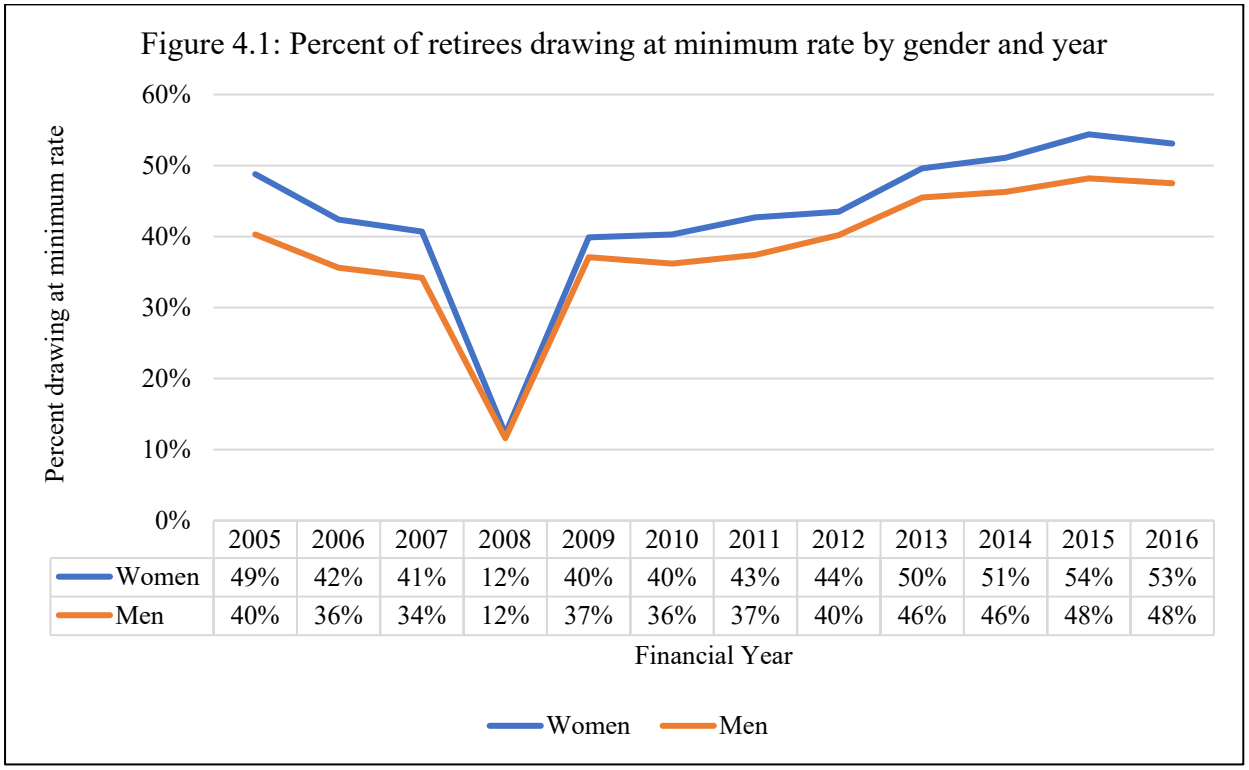


Figure 4.1 partitions the *Drawdown_Panel* by gender and shows the portion drawing at the minimum rate each financial year. In line with *H1a*, *Figure 4.1* suggests, on average, women are 5 percentage points more likely to drawdown at the minimum rates than men. Support for *H1b* would be indicated by the blue line increasing by more than the red line during the 2008/2009 and 2011/2012 financial years (i.e. a widening gap between the blue and red lines during crises). In the 2008/2009 financial year (i.e. the GFC), this effect is not observed, instead the gender gap decreased by 5 percentage points, suggesting that the opposite relationship was present. Conversely, in the 2011 financial year (i.e. the EDC), support for *H1b* is marginally present as the gender gap increased by 2 percentage points. As a result, summary statistics find mixed evidence for *H2a.* Interestingly however, *Figure 4.1* also suggests that between 2008 and 2017, the gender gap has been widening (discussed later).

Table 4.4: Correlations for Drawdown_Panel

This table reports the Correlations for the variables that comprise the Drawdown_Panel. Tetrachoric correlations are reported for the binary variable pairs. Pearson Pairwise correlations are reported for other variable pairs. *min_drawdown* is a dummy variable representing whether a retiree draws down at the minimum rate (1=true*). age* represents retirees' age at the start of the financial year. *account_balance* represents retirees' *ABP* balance at the start of each financial year. *gender* represents retirees' gender (1=male). *inv_equity* represents retirees' first recorded equity allocation. *year* represents the financial year of the observation. * p<0.1; ** p<0.05; *** p<0.01.

Variable	*min_drawdown*	*age*	*account_balance*	*gender*	*inv_equity*
min_drawdown	1				
age	0.134***	1			
account_balance	0.096***	-0.066***	1		
gender	-0.083***	0.003	0.077***	1	
inv_equity	-0.252***	-0.018	0.052***	0.074***	1

Table 4.4 reports the correlations amongst the variables comprising the *Drawdown_Panel.* All variable pairs, excluding *age* and *gender*, are significantly but weakly correlated. Further, the weak tetrachoric correlation between *min_drawdown* and *gender* supports *H1a*. Other correlation pairs are either in-line with the predictions from the *Normative Economics* literature[39] or findings from related empirical literature[40]. Comparing these correlations with Balnozan (2018), they are mostly consistent, however, the variables *age* and *account_balance* are more weakly correlated with *inv_equity*. This discrepancy likely reflects differences in how this thesis has measured risk aversion[41]. Overall, the weak correlations amongst the regressors raises no immediate concerns that multicollinearity is substantially present.

4.3 Data and Methodology: Investment Hypotheses

Investment hypotheses: Variables and panel construction

[39] Namely, correlations between drawing at the minimum rates with age, wealth, risk aversion.
[40] Namely, correlations between gender, account_balance and inv_equity.
[41] This thesis proxies for risk aversion using retirees' direct equity allocations. Balnozan (2018) proxied for risk aversion through calculating the magnitude of the average ratio between retirees' investment returns and the S&P/ASX 200 index returns.

Given the substantial evidence of decision inertia within the pre-retirement phase of DC schemes (see section *2.3 Positive Economics*), it is reasonable to expect that account opening equity allocations will be the cleanest reflection of retirees' risk tolerance. Hence, to investigate the investment hypotheses, this thesis subsets the *Drawdown_Panel* into a sample of account openings, hereby referred to as the *Investment_Sample*[42].

With regards to *H2a* and *H2b*, the key variables of interest is retirees equity allocation upon their account opening (inv_equity_i). As discussed in section *4.1 Overview*, retirees' equity allocations are computed as the weighted average of the equity allocation of each option selected using the nominated weights in the PDS.

With regards to *H3a,* the key behaviour of interest is whether retirees' revisit and change their account opening investment strategies. To measure this, a binary variable is computed that corresponds to whether each retiree made an investment switch in the six (or twelve) months following the opening of their ABP (inv_switch_i). To ensure that this variable reflects retirees revisiting and switching their investment strategies, the following procedures are followed: First, any administratively generated switches due to closures of investment options are excluded; Second, any switches that involve a term deposit option and cash option are excluded, as these largely reflect maturing term deposits which are rolled over or returned to cash, not retirees' investment switches; Third, to ensure that any administrative switches involving the automatic re-balancing of a retirees' portfolio are excluded, only 'economically significant' switches are included. Although 'economic significance' is an arbitrary classification, this thesis defines economic significance as an administrative switch with a turnover greater than 1 percent of a retirees ABP assets

[42] There exists a very small portion of retirees that open multiple ABP's. Clustering residuals at the retiree level helps control for this.

($account\_balance_i$). Fourth, to reduce survivorship bias, only retirees that were observed for the full six (or twelve) months were included.

Table 4.5 specifies the variables that comprise the *Investment_Sample*. Retirees' wealth ($account\_balance_i$) upon their account opening are calculated identically as they were in the *Drawdown_Panel* (see section *4.2 Drawdown behaviour*). Retirees' age (age_i) is computed at the day of their account opening.

Table 4.5: Investment_Sample Variables

This table reports the characteristics of the variables that comprise the Investment_Sample. *inv_equity* represents retirees' account opening equity allocation. *age* represents retirees age at account opening. *account_balance* represents retirees *account* balance. *gender* represents retirees' gender (1=male). Inv_switch is a dummy variable corresponding to whether retirees' switched their investment strategies in the 6 (or 12) months following their account opening.

Variable	Type	Description	Time-variant
inv_equity	Dependent	Continuous	No
inv_switch (6,12)	Dependent	Binary	No
gender	Independent	Binary	No
account_balance	Independent	Continuous	No
age	Independent	Continuous	No
financial year	Control	Categorical	Yes

As discussed in section *4.3 Normative Economics*, retirees' optimal equity allocations are also determined by factors such as bequest motives (Ding 2014), Age Pension entitlement (Ding 2014) as well as the legislated minimum drawdown rates (Andréasson, Shevchenko et al. 2017). This thesis does not control for these factors. Although it is important to note that bequest motives are likely positively correlated with wealth, and Age Pension entitlement negatively correlated with wealth (Ding 2014, Andréasson, Shevchenko et al. 2017). Further, with respect to the minimum drawdown rates, given that they are age dependent, this thesis also notes that they are likely highly correlated with retirees' age. In addition, this thesis does not control for cohort effects as suggested by Lindström and Kokko (2002). Cohort effects are excluded in order to reduce multicollinearity with other

age-related variables. However, this thesis does control for the unobserved time variant heterogeneity that is constant across all retirees. This is done through including dummy variables for each financial year ($year_t$).

Investment hypotheses: Methodology

To test the *H2a*, this thesis specifies the following base model:

$$equity\_allocation_i = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance_{i,t} + \beta_3 age_{i,t} + \beta year_t + \beta gender_i * year_t + e_i$$

To test *H2b,* the above model is augmented in two ways. First, retirees' *account_balance*'s are partitioned into tertiles ($account\_balance\_thirds_i$). These tertiles correspond to whether retirees' account balances fall within the bottom, middle or top third of the *Investment_Sample*.

$$account\_balance\_tertile_i = \begin{cases} 0, if\, account\_balance_i\ is\ in\ bottom\ tertile \\ 1, if\, account\_balance_i\ is\ in\ middle\ tertile \\ 2, if\, account\_balance_i\ is\ in\ top\ tertile \end{cases}$$

Second, an interaction term between each of these tertiles and retirees' age is included ($account\_balance\_thirds_i * \beta_3 age_i$).

$$equity\_allocation_i = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance\_tertile_i + \beta_3 age_i + \beta year_t + \beta gender_i * year_t + \beta_2 account\_balance\_tertile_i * age_i + e_i$$

Because equity allocations are naturally censored between 0 percent and 100 percent, it is sensible to consider estimating the above models using a censored regression such as a Tobit model, censored at zero and one. However, a limitation of this approach is that the Tobit estimator is consistent only when all distributions are normal and homoscedastic (Brown, Liang et al. 2007).

Given 37 percent of the sample allocates 0 percent to equity and 7 percent of the sample allocates 100 percent to equity (*Figure 4.3*), it would be imprudent to assume that the Tobit estimator would produce consistent estimates. As a result, the above models are estimated as a fractional regression with a logit specification. Crucially, fractional regressions do not require the dependent variable to be normally distributed and produce satisfying econometric properties when there are extreme probability densities at zero and one (Papke and Wooldridge 1996). The fractional regression is implemented using Stata's 'fracreg logit' function. As per *Section 4.*1, the marginal effect of each regressor are reported using Average Marginal Effects (**AME**) calculated with Statas' 'margins' function.

To investigate *H3a*, the following models are specified:

$$P(inv\_switch\_6\_month_i = 1) = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance_i + \beta_3 age_i + \beta year_t + \beta gender_i * year_t + e_i$$

$$P(inv\_switch\_12\_month_i = 1) = \alpha_0 + \beta_1 gender_i + \beta_2 account\_balance_i + \beta_3 age_i + \beta year_t + \beta gender_i * year_t + e_i$$

Because the dependent variable is binary – representing the probability a retiree switches their investment strategy – the above model is estimated using a Logit regression. Because the regressor coefficients of Logit regressions represent relative changes to the log-odds ratio for a corresponding unit change in the regressor, they are not directly interpretable as changes to the probability that a retiree draws at the legislated minimum rate. Hence the Average Marginal Effect (**AME**) of each regressor is reported instead. AME's are calculated with Statas' 'margins' function.

Investment hypotheses: Descriptive statistics

Table 4.6 reports the descriptive statistics for the variables that comprise the *Investment_Sample*. Examining the number of observations, it is evident that there are fewer retirees than in the *Drawdown_Panel*. This is because, due to changes in investment option menu offered by the large Australian financial institution, not all retirees' opening equity allocations were observed[43]. Further examining *Table 4.6*, we can see that the mean equity allocation is 33 percent, suggesting retirees are conservative on average. The mean age at account opening is 64 years, 3 years fewer than in the *Drawdown_Panel*, which is to be expected given account openings are being observed. Interestingly however, this also suggests that retirees within the *Investment_Sample* retire later than the average Australian who retires at 55 (ABS 2019). Examining the distribution of *account_balance*, similarly to table 4.2, they appear heavily right skewed. With regards to retirees propensity to switch their investment strategies (*inv_switch),* 19 (25) percent switch in the 6 (12) months following their account opening. These figures suggest that (a) retirees are more likely to make a switch in the first 6 months of their account opening then the first 12 months (i.e. retirees are more likely to switch sooner rather than later), and (b) relative to individuals in Australia's accumulation phase (see Gerrans, Gardner et al. (2006) and Bowman (2003)), retirees within the decumulation phase seem substantially more active[44].

Table 4.6: Descriptive Statistics

This table reports the descriptive statistics for the variables that comprise the Investment_Sample. *inv_equity* represents retirees' account opening equity allocation. *age* represents retirees age at account opening. *account_balance* represents retirees *account* balance. *gender* represents retirees' gender (1=male). Inv_switch is a dummy variable corresponding to whether retirees' switched their investment strategies in the 6 (or 12) months following their account opening.

Variable	N.	Min	Median	Mean	Max	Std. Dev.
inv_equity	5,216	0	27%	33%	1	33%
inv_switch (6m)	4,794	0	0	19%	1	39%

[43] For example, consider a retiree that opened an account in 2006 and selected a fictional 'option 1' to invest their ABP assets. If this 'option 1' was removed by the institution in 2010, this thesis would be unable to calculate the equity allocation of the retiree. Hence, the observation would be removed from the *Investment_Sample*. The potential bias this produces is discussed in more detail in section 6.3: Limitations.

[44] It is important to note that due to the difficulty in distinguishing an investment switch from an administrative switch, this may not be a like-for-like comparison.

inv_switch (12m)	4,248	0	0	25%	1	43%
age	5,216	17	64	64	90	5.7
account_balance ($ 000)	5,216	21	200	297	4,024	298
gender	5,216	0	1	58%	1	49%

Figure 4.3 illustrates distribution of account opening equity allocations. Equity allocations are heavily grouped at the values of 0 percent, 20 percent, 100 percent and between the values of 40 to 60 percent. Which suggests that behavioural groups may be present, and/or retirees adopting simple heuristics – such as selecting round numbers – when choosing an initial equity allocation.

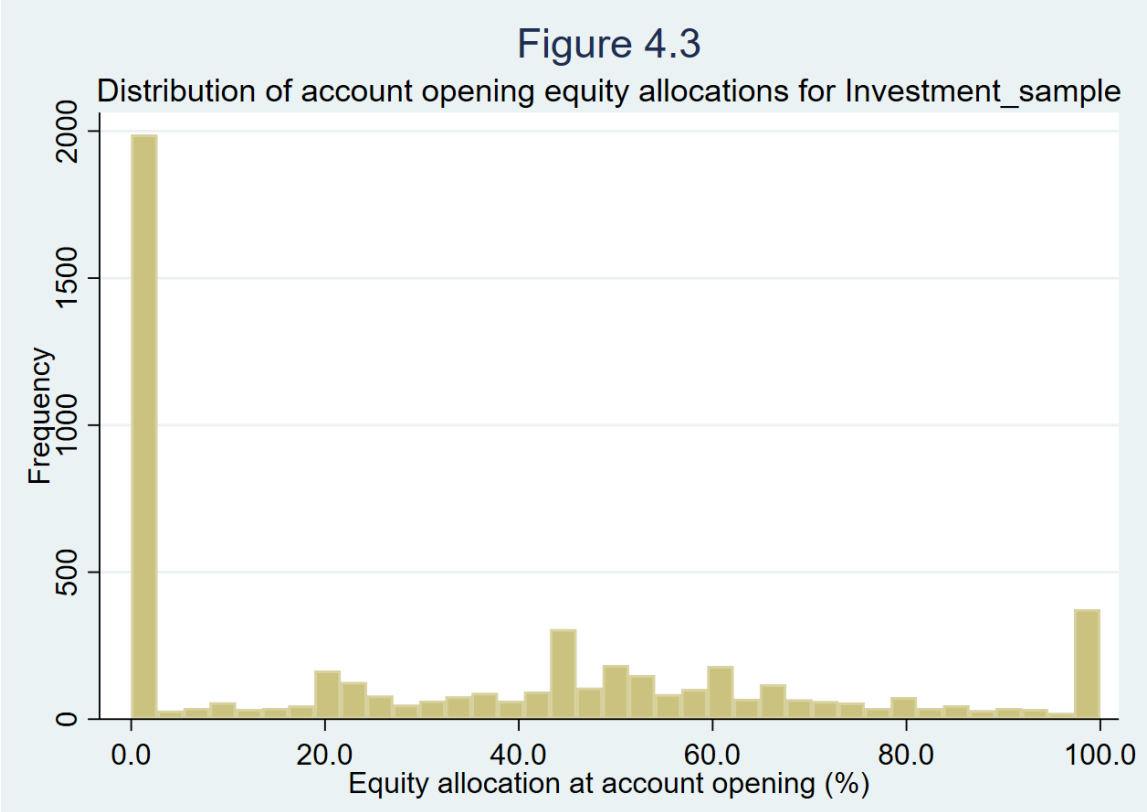


Figure 4.4 illustrates the average of account opening equity allocations over time, split by gender. Opening equity allocations fluctuate over time, with notable dips during the 2008/2009 GFC and the 2010/2011 to 2011/2012 EDC. This finding confirms the need to incorporate dummy variables for each financial year. Further, and in line with findings

examining the accumulations phase (see Gerrans (2012)), women appear to allocate lower to equity then men.

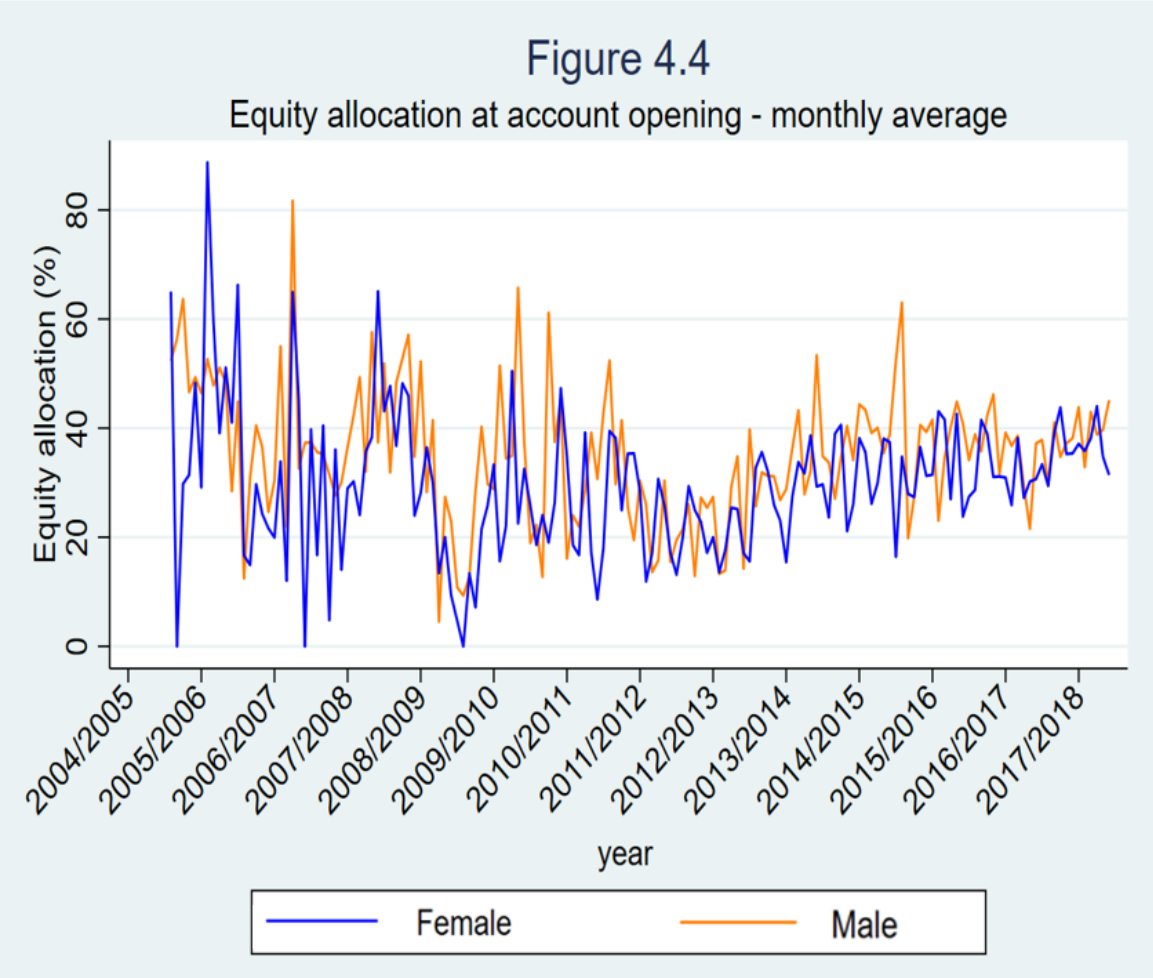


Table 4.7: Pearson Pairwise Correlations

This table reports the Correlations for the variables that comprise the Investment_Sample. Tetrachoric correlations are reported for the binary variable pairs *inv_equity* represents retirees' account opening equity allocation. *age* represents retirees age at account opening. *account_balance* represents retirees *account* balance. *gender* represents retirees' gender (1=male). Inv_switch is a dummy variable corresponding to whether retirees' switched their investment strategies in the 6 months following their ABP opening (12m not included).* p<0.1; ** p<0.05; *** p<0.01.

Variable	inv_equity	age	account_balance	gender	inv_switch (6m)
inv_equity	1				
age	-.050***	1			
account_balance ($ 000)	.071***	-.018***	1		
gender	.074***	-.070***	.088***	1	
inv_switch (6m)	.012	-.057***	.110***	.092**	1

Table 4.4 reports the correlations amongst the variables comprising the *Investment_Sample*[45]. All variable pairs, excluding *inv_switch* and *inv_equity,* are significantly but weakly correlated. The weak correlation between *inv_equity* and *account_balance* supports *H2a*. Further, the weak tetrachoric correlation between *inv_switch* and *gender* supports *H3a*. Overall, the weak correlations amongst the regressors raises no immediate concerns that multicollinearity is substantially present.

[45] It is important to note that these correlations with inv_equity may be mis-specified given that inv_equity is a censored variable.

Chapter Five: Results and Discussion

5.1 Results and Discussion: Drawdown Hypotheses

H1a

To investigate *H1a*, *Table 5.1* reports the AME's for the RE Logit model and coefficients for the Linear Probability model. Standard errors have been clustered at the account level. Support for *H1a* would be indicated by economically and statistically significant, negative coefficients on *gender*.

Table 5.1

This table reports the Average marginal Effects (AME) and standard errors (SE) for the RE logit model and the coefficients and standard errors for the linear probability model. These models were used to investigate the drawdown hypotheses. The year and gender interactions for the RE logit are displayed graphically in Figure 5.1. Standard errors have been clustered at the account level. min_drawdown is a dummy variable representing whether a retiree draws down at the minimum rate (1=true). Age represents retirees' age at the start of the financial year. account_balance represents retirees' ABP balance at the start of each financial year. gender represents retirees' gender (1=male). inv_equity represents retirees' first recorded equity allocation. * p<0.1; ** p<0.05; *** p<0.01.

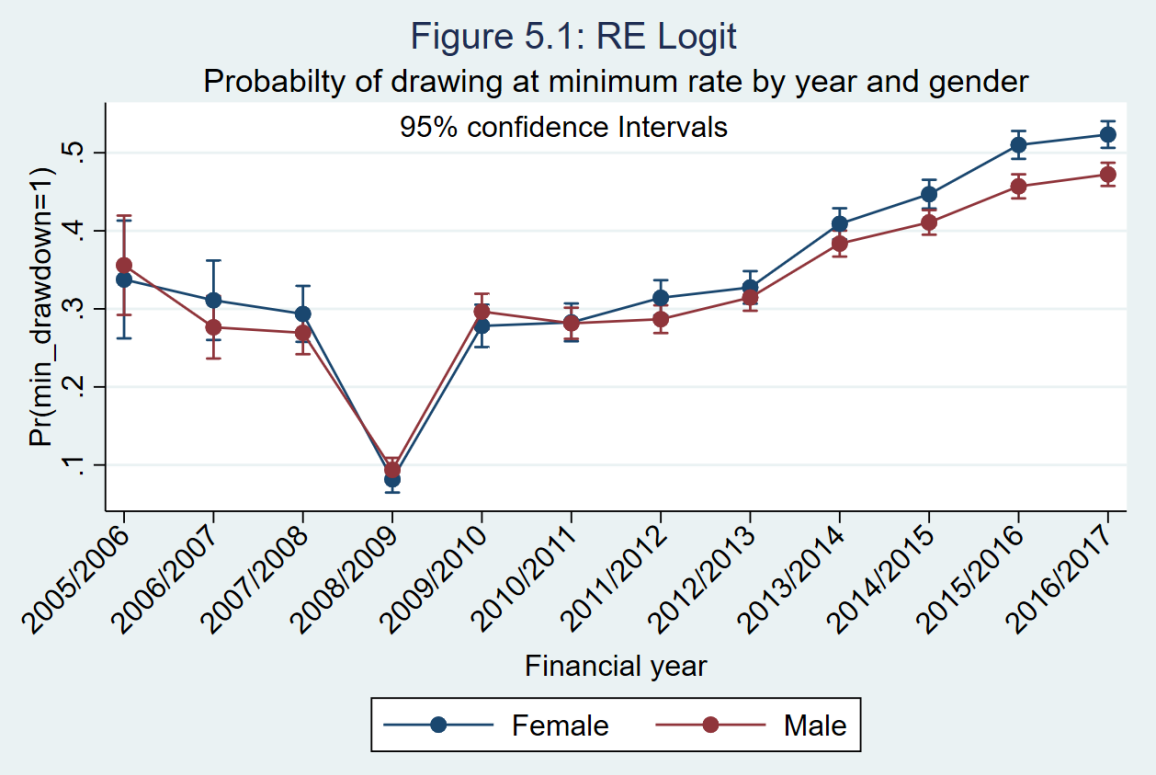
	Random Effects Logit Model			
Dependent Variable:	$Prob(min\_drawdown_{i,t} = 1)$		Linear Probability	
	AME's	SE's	Coef.	SE's
gender: male	-.030***	.007	-.052***	.011
account_balance ($ millions)	.155***	.014	.188***	.051
Age	.010***	.001	.011***	.001
inv_equity	-.002***	.000	-.002***	.000
Financial year:				
2005/2006	-.145***	.036	-.128**	.056
2006/2007	-.203***	.024	-.164***	.037
2007/2008	-.214***	.015	-.176***	.025
2008/2009	-.405***	.011	-.464***	.019
2009/2010	-.205***	.011	-.197***	.017
2010/2011	-.212***	.010	-.197***	.015
2011/2012	-.195***	.009	-.170***	.014
2012/2013	-.174***	.008	-.164***	.013
2013/2014	-.099***	.007	-.090***	.011
2014/2015	-.068***	.006	-.060***	.009
2015/2016	-.015**	.005	-.006	.008
2016/2017	Base Year		Base Year	

year and gender interactions	Yes – Figure 5.1	Yes – Appendix 1.4
observations	36,654	36,654
clusters	8,922	8,922
Wald chi2(28)	1367***	N/A
R Squared: Within	N/A	0.120

Examining *Table 5.1,* the coefficients on *gender* are negative and statistically significant at the 1% level for both the RE and Linear Probability models. The RE and Linear Probability models suggest that being male is associated with an average 3 and 5 percentage point decrease in the probability of drawing at the minimum rate. These results are also consistent with the bivariate descriptive statistics reported in *Figure 4.1.* Hence, these results indicate statistically significant support for *H1a*.

H1b

To investigate *H1b, Figure 5.1* displays the predicted probability that a retirees' drawdown rate equals the minimum rate, as estimated by the year and gender interactions produced by the RE Logit model in *Table 5.1*. Support for *H1b* would be indicated by the blue line increasing by more than the red line between the 2007/2008 and 2008/2009 financial years as well as between the 2010/2011 and 2011/2012 financial years (i.e. a widening gap between the blue and red lines during the GFC and EDC).



Between the 2007/2008 and 2008/2009 financial years (i.e. the GFC), this effect does not seem to be observed. Instead the gender gap appears to decrease by 3.6 percentage points, suggesting that the opposite relationship may be present. However, after performing a Wald test to determine whether this gender difference is significant, it appears to be statistically insignificant (p-value = 0.187). Conversely, between the 2010/2011 and 2011/2012 financial years (i.e. the EDC), this effect does seem to be present as the gender gap increases by 1.6 percentage points. After performing an equivalent Wald test, this effect appears to be statistically significant at the 10 percent level (p-value = 0.096). These results are also consistent with the bivariate statistics reported in *Figure 4.1.*

It deciphering these weak results, is important to reiterate some previously mentioned caveats. First, as discussed in section *3.1 Drawdown Hypotheses,* due to the timings of the reductions to the minimum drawdown rates, the gender effect was expected to be more prominent in the 2011/2012 financial year then the 2008/2009 financial year. This notion is supported by both the empirical evidence above and the the large dip in the 2008/2009

financial year[46]. Second, as discussed in section *4.1 Overview*, because observations are heavily skewed towards later years, it was expected that the statistical power of inferences relating to earlier years were less powerful than later years. Combined, these caveats help justify the weak evidence for *H2b.*

Gender gap phenomenon

It is important to note that the most interesting result from *Figure 5.1* is that since the new legislated minimum drawdown rates were introduced in 2007, relative to men, women have become increasingly more likely to drawdown at the minimum rates (i.e. the gap between the blue and red lines has been widening). For example, between the 2008/2009 and 2016/2017 financial year, relative to men, the predicted probability that women drawdown at the minimum rate has increased 5.1 percentage points. Further, the Wald test indicated that this effect is statistically significant (p-value = 0.019). Investigating this phenomenon further, it is found to be robust to CRE and Linear Probability models (*Appendix 1.4*), bivariate statistics (*Figure 4.1)* as well as a FE Linear Probability model (*Appendix 1.5*).

Endogeneity

As previously discussed, a critical assumption of the RE model is that retirees' time-invariant heterogeneity is uncorrelated with the independent variables. To test this, the previously discussed CRE model was estimated (see *Appendix 1.3*) and a likelihood-ratio test was conducted against the RE model. Further a post estimation Wald test that all contextual effects of the CRE model are equal to zero was performed (i.e. the coefficients

[46] To reiterate, because the 50 percent reduction occurred in March of 2009, many retirees' cumulative drawdowns over the first seven months of the financial year had likely already exceeded the new temporary minimum, leaving them little opportunity to adjust to the new minimum. Whereas when the 25 percent reduction to the minimum drawdown rates were announced in November of 2011, it is unlikely that retirees' cumulative drawdowns over the first five months of the financial year exceeded the temporary minimum, meaning they had a greater opportunity to adjust to the new minimum. This notion is supported by the large dip in the 2008/2009 financial year relative to the 20011/2012 financial year.

on $\overline{account\_balance_t}$ and $\overline{age_i}$ are equal to 0). Critically, both these tests indicated a rejection of the RE assumption (p-values of 0.000 and 0.000 respectively). Hence, providing sufficient evidence to indicate that endogeneity was present within the RE model and likely the Linear Probability model. This weakens statistical support for *H1a*, *H1b* and the aforementioned gender gap phenomenon.

However, it is important to note that the CRE model estimated the gender effect to be of equal size and significance to both the RE and Linear Probability model, suggesting that while the aforementioned endogeneity is statistically significant, it may not be economically significant. This notion is further supported by the findings the FE Linear Probability model (*Appendix 1.5*) which removed the aforementioned time invariant heterogeneity, to produce 'within' effects. More specifically, the gender and year interaction terms in the FE Linear probability model suggest that relative to the gender difference in the 2008/2009 financial year, the gender difference in the 2016/2017 financial year is 9.4 percentage points larger (p-value 0.000) (i.e. relative to males, females in 2016/2017 were 9.4 percentage points more likely to drawdown at the minimum rates than in the 2008/2009 financial year). Hence, with respect to the gender gap phenomenon, while the aforementioned endogeneity is statistically significant, it may not be economically significant.

In addition, it is possible that there is additional endogeneity between retirees' drawdown strategies and their investment strategies (*inv_equity*). For example, the extent to which retirees' investment and drawdown decisions are independent, interdependent or interrelated is unknown. Hence, instead of causality running from a retirees' investment strategy to their drawdown strategy it is possible that these decisions could be simultaneously determined by the same covariates. To investigate the extent of this interrelation, a Bivariate Probit model could be specified where the first simultaneous

equation estimates a retirees' probability of making a change to their drawdown strategy and the second estimates a retirees' probability of making a change to their investment strategy. This model was not estimated within this thesis.

Discussion

While *H1a* and *H1b* primarily use gender differences in overconfidence to motivate predictions, they are but one of many possible explanations. Further, it is unlikely they are wholly responsible for the widening gender gap phenomenon illustrated in *Figure 5.1*. There are several other possible explanations for this gender gap phenomenon: First, it may partially reflect growing differences in life expectancy between men and women. However, given that gender differences in Australians life expectancies have converged over the period (ABS 2020), this seems unlikely; Second, the gender gap phenomenon may reflect women being more financially risk averse (Jianakoplos and Bernasek 1998) and risk aversion generally increasing post GFC (Cardak, Martin et al. 2019); Third, the gender gap phenomenon may represent systematic gender differences in optimism (distinct from overconfidence and risk aversion) relating to economic forecasts (Jacobsen, Lee et al. 2014) and this effect growing over the period. Although, given that gender differences in the Westpac consumer sentiment index have not departed substantially over the period (*Appendix 2*), this explanation also seems unlikely; Fourth, as discussed above, it may simply be a product of endogeneity within the estimated models. Again, this seems unlikely given the results are robust to the CRE model (*Appendix 1.4*), Linear Probability (*Appendix 1.4*) and FE Linear Probability models (*Appendix 1.5*) as well as bivariate statistics (*Figure 4.1*); Last, this gender gap phenomenon may be a result of an increase in the strength of the 'default heuristic' (i.e. the implied endorsement of the legislated minimum drawdown rates) amongst retirees. More specifically, the Australian government's continued modification of the legislated minimum drawdown rates may be strengthening the impression that they are

a de-facto default option for retirees to follow. Hence, the more the government changes the minimum drawdown rates to reflect the economic conditions, the stronger this 'default heuristic' (i.e. implied endorsement) becomes. Since women are more susceptible to the 'default heuristic' than men (Alonso-García, Bateman et al. 2018) this may explain why they have become increasingly more likely to drawdown at the government mandated minimum rates.

Notwithstanding the aforementioned endogeneity, a number of important insights and comparisons can also be generated from further examining the models in *Table 5.1*. However, given the similarity between the estimates of the RE and Linear Probability Model, for brevity, only the RE model will be discussed; First, the coefficients on *age* and *inv_equity* suggest that for each increment of age and equity allocation, the probability of drawing at the minimum rate increases 1% and 0.2% on average respectively (both p-values 0.00). This supports the notion that risk aversion is an important determinant of consumption (Thorp, Kingston et al. 2007) and that the minimum drawdown rates compel older and more risk averse retirees to drawdown their wealth faster (Bateman and Thorp 2008). Interestingly however, the effect of age is half that reported by Balnozan (2018), though this discrepancy is likely reflected by his inclusion of additional age-dependent regressors[47]; Second, the coefficient on opening balance is both statistically significant and economically insignificant, as it suggests that for roughly every $1,000,000 increase in *account_balance* the probability of drawing at the minimum rate decreases by 15 percentage points. This finding suggests that wealthier retirees may not be using their

[47] Balnozan (2018) includes retirees' respective minimum rates as an additional regressor. Given that retirees minimum drawdown rates are age dependent, they are likely highly correlated. Given this, as well as the main focus of this thesis, retirees minimum drawdown rates were not included as additional regressors in order to reduce multicollinearity with the retirees' age.

ABP's to generate retirement incomes, rather, as suggested by Australian Treasury (2016), they may be using their ABP's to accumulate tax-advantaged wealth to bequeath.

5.2 Results and Discussion: Investment Hypotheses

H2a

To investigate *H2a*, *Table 5.2* reports the AME's for the Fractional Logit model specified in section *4.3: Investment Behavior*. Standard errors have been clustered at the retiree level[48]. Support for *H2a* would be indicated by economically and statistically significant, negative coefficient on *account_balance*.

Table 5.2

This table reports the Average marginal Effects (AME) and standard errors (SE) for the regression results for H2a and H2b. Standard errors have been clustered at the account level. *inv_equity* represents retirees' account opening equity allocation. *age* represents retirees age at account opening. *account_balance* represents retirees *account* balance at account opening. *gender* represents retirees' gender (1=male). * p<0.1; ** p<0.05; *** p<0.01.

Dependent variable:	inv_equity			
	H2a		*H2b*	
	AME's	SE's	AME's	SE's
gender: male	.043***	.011	.045***	.011
account_balance ($ millions)	.059***	.017	N/A	
age	-.003***	.000	-.003**	.001
year:				
2005/2006	.009	.031	.010	.030
2006/2007	-.042	.028	-.039	.028
2007/2008	.039*	.022	.046*	.023
2008/2009	-.091***	.028	-.088***	.028
2009/2010	-.018	.025	-.013	.023
2010/2011	-.066***	.023	-.063***	.019
2011/2012	-.013***	.019	-.013***	.010
2012/2013	-.091***	.020	-.089***	.020
2013/2014	-.029	.019	-.028	.019
2014/2015	.019	.017	.022	.018
2015/2016	.008*	.017	.0101*	.024
2016/2017	base year		base year	
account_balance_tertile:				
low wealth	N/A		.010	.012

[48] There exists a very small portion of retirees that open multiple ABP's. Clustering residuals at the retiree level helps control for this.

medium wealth	N/A	base tertile
high wealth	N/A	.029** .012
account_balance and *age* interaction:	N/A	N/A
Observations	5,249	5,249
Wald chi2(16)	176***	N/A
Wald chi2(19)	N/A	174***

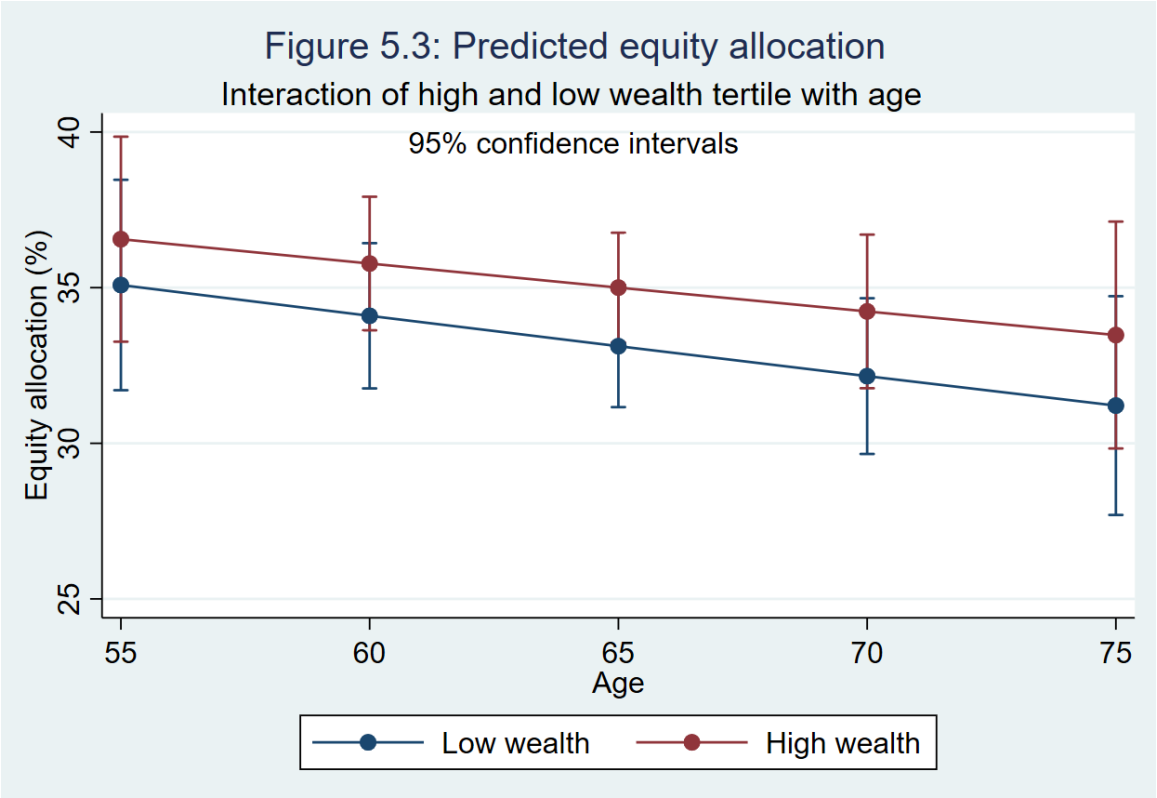
Examining *Table 5.2,* converse to *H2a,* the coefficient on *account_balance* is positive and statistically significant at the 5 percent level (p-value = 0.01). Further, the *account_balance* coefficient suggests that a one standard deviation increase in account balance is associated with a 1.8 percentage point increase in equity allocation. Hence, these results indicate statistically significant and marginally economic significant evidence against *H2a*.

This negative relationship between equity allocation and wealth for both high and low wealth retirees was similar to that of Hulley, McKibbin et al. (2013). This suggests that low wealth retirees may not be taking advantage of their ability to buffer investment risk through their Age Pension entitlement (Ding 2014), while high wealth retirees are likely taking advantage of the shock absorber provided by their bequest motives (recall that bequest motives are highly correlated with wealth). Further, retirees' equity allocations are significantly lower during crisis periods, however the extent to which this is due to the incidence of the availability heuristic, increased risk aversion or the management of sequencing risk is unclear. Moreover, their appear to be large gender differences in initial equity allocations with males allocating substantially higher.

H2b

To investigate *H2b, Figure 5.3* displays the predicted equity allocation by *age* and *account_balance_tertile* as estimated in *Table* 5.2. Support for *H2b* would be indicated by a positive slope on the tertile corresponding to low wealth retirees (i.e. the blue line increasing with age) and a negative slope on the tertile corresponding to high wealth retirees

(i.e. the red line decreasing with age). Further support for *H2b* would be indicated by the interaction terms – between low wealth and age versus high wealth and age – being statistically distinguishable from each other[49].



Contrary to *H2b, Figure 5.*3 suggests equity allocation decreases with age for both low wealth and high wealth retirees. Further, Wald tests indicate that these interactions terms are statistically indistinguishable from each other (p-value = 0.830), which insinuates that the relationship between and equity allocation and age is similar for both low and high wealth retirees. Hence, these findings do not support *H2b.*

To ensure the robustness of these results, retirees were further partitioned – via their account balances – into fifths and the same regression was run. The result was the same, albeit with larger margins of error given smaller group sizes. In addition, arbitrary classifications of high wealth (i.e. account balance over $1,000,000) and low wealth (i.e.

[49] As determined by their effects relative to the medium wealth tertile.

account balance under $20,000) were also used and the findings remained robust, again with much higher margins of error given the substantially small sample sizes.

H3a

To investigate *H3a*, *Table 5.3* reports the AME's for the Logit model specified in section *4.3: Investment Behavior*. To reiterate, the key dependent variable relates to retirees' propensity to revisit and change their investment strategy in the 6 (or 12) months following their account opening (yes = 1). Standard errors have been clustered at the retiree level[50]. Support for *H3a* would be indicated by economically and statistically significant, positive coefficients on *gender*.

Table 5.3

This table reports the Average marginal Effects (AME) and standard errors (SE) for the Logit regression results for *H3a*. Standard errors have been clustered at the account level. *age* represents retirees age at account opening. *account_balance* represents retirees *account* balance. *gender* represents retirees' gender (1=male). Inv_switch is a dummy variable corresponding to whether retirees' switched their investment strategies in the 6 (or 12) months following their account opening. * p<0.1; ** p<0.05; *** p<0.01.

Dependent variable:	*inv_switch(6m)*		*inv_switch(12m)*	
	AME's	SE's	AME's	SE's
gender: male	.024**	.013	.033**	.015
account_balance ($ millions)	.110***	.018	.141***	.022
age	-.003***	.001	-.005***	.001
year:				
2005/2006	.051	.038	.133***	.047
2006/2007	.135***	.035	.215***	.041
2007/2008	.115***	.024	.196***	.031
2008/2009	.179***	.036	.255***	.043
2009/2010	.146***	.031	.173***	.036
2010/2011	.040	.025	.098***	.033
2011/2012	.051**	.024	.119***	.032
2012/2013	.055**	.024	.110***	.033
2013/2014	.041*	.022	.067**	.029
2014/2015	.046**	.02	.079***	.028
2015/2016	-.015	.019	.000	.027
2016/2017	base year		base year	
year and *gender* interaction	Yes – *Figure 5.3*		Yes - *Appendix 1.6*	
Observations	4,794		4,248	
Wald chi2(27)	160***		198***	

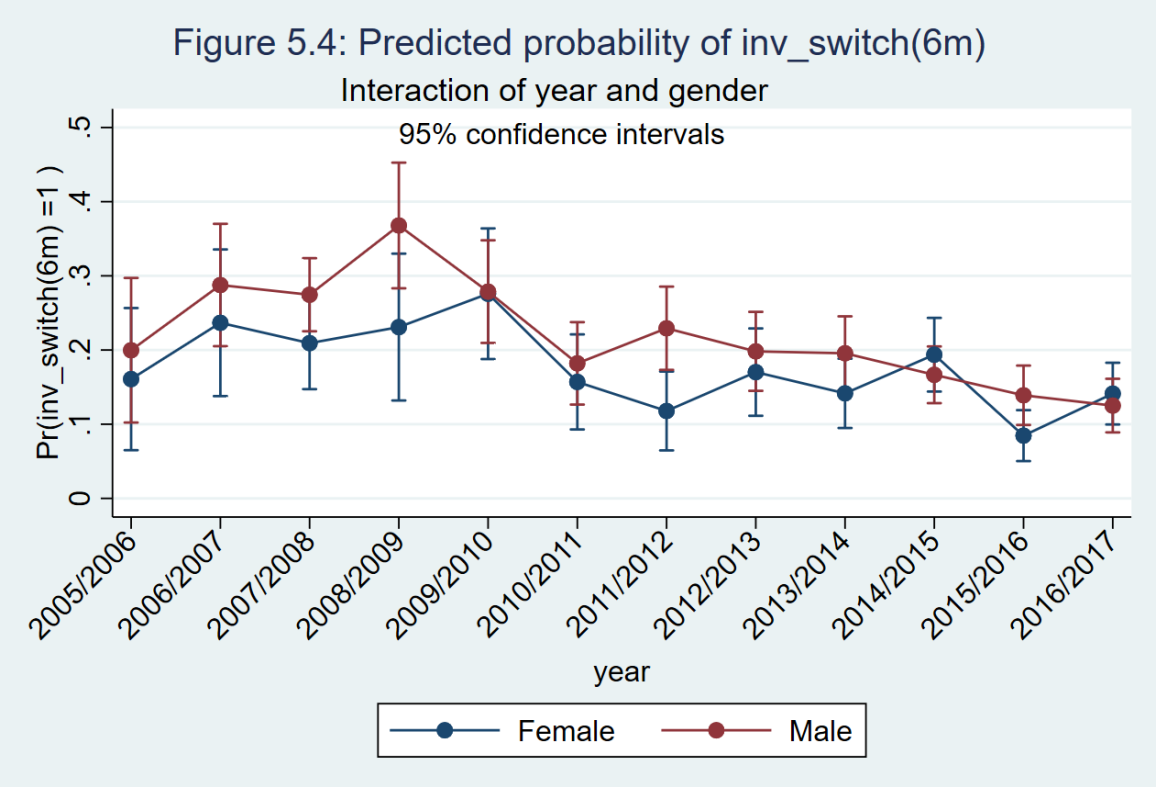
[50] There exists a very small portion of retirees that open multiple ABP's. Clustering residuals at the retiree level helps control for this.

Examining *Table 5.4,* the coefficients on gender are positive and statistically significant (p-values = 0.062 and 0.027 respectively). Further, results suggest that being male is associated with a 2.4 (3.3) percentage point increase in the likelihood of making an investment switch in the 6 (12) months after account opening. These results support *H3a.*

Figure 5.4 investigates the gender difference in the likelihood of making an investment switch over time. As illustrated, during the GFC and EDC, large gender differences are observed in retirees' propensity to revisit and change their account opening investment strategies (i.e. the gap between the blue and red lines widens during crises). During both the GFC and EDC, these gender differences are statistically significant (p-values = .054 and .014 respectively). Hence these results suggest that relative to females, male retirees whom open accounts during crises are more likely to revisit and change their investment strategies within the 6 months following the crisis. These results are also consistent with the gender differences in the predicted probabilities of revisiting and changing an investment strategy in the 12 months following a crisis (see *Appendix 1.6*).

In addition to the above, an interesting insight can be formulated through comparing *Figure 4.4* (retirees' account opening equity allocation over time) with *Figure 5.4* (retirees' propensity to revisit and change their account opening equity allocation). Observing *Figure 4.4*, it is evident that, for both men and women, average account opening equity allocations decreased substantially during both the GFC and EDC. Observing *Figure 5.4*, it is evident that, of the retirees opening ABP's during these crises, males were more likely to revisit and change their investment strategy while females were not. Taken together, this may suggest that while both men and women decided to allocate lower to equities during crises, women were less likely to revisit and change that decision. Given

women's longer life expectancy, this will likely have a negative impact on their lifetime wealth accumulation and consumption.



Endogeneity

There are several key limitations to these results: First, with respect to endogeneity related to omitted variables, it would be imprudent to assume that the limited available regressors control for all the heterogeneity across retirees. Hence, there is likely that there are many unobserved confounding variables potentially biasing the results[51]; Second, albeit also related to the first point, it may not be wholly accurate to extrapolate the opening equity allocation behavior of retirees during crises to the rest of the population. This is because it is plausible that a portion of individuals may choose to postpone their retirement in light of a crises, which would reduce the external validity of the results. Hence, as a robustness

[51] For example, effects of observed regressors are likely correlated with the effects of key unobserved regressors. Take health and age for instance, as age increases it is reasonable to expect health to deteriorate, hence when age is statistically significant as a regressor, its partial effect is confounded with the partial effect of health deterioration.

check, descriptive statistics of the *Investment_Sample* were compared to sub-samples of the GFC and EDC periods. The GFC comparison yielded no significant concerns. Conversely, the EDC comparison found that the proportion of women in the EDC sample was 7 percentage points lower than the *Investment_Sample*, suggesting that women may have postponed their retirement during the EDC[52]. This bias may reduce the external validity of the results.

[52] Or a greater proportion of men decided to retire during the crises, although this seems less likely.

Chapter Six: Conclusion

6.1 Conclusion

Using Account-based Pension evidence, this thesis investigated retirees' drawdown and investment behaviours within Australia's Defined-Contribution scheme. First, existing drawdown literature was extended through the documentation of, (a) a new gender gap phenomenon, whereby women appeared increasingly more likely to drawdown at the legislated minimum drawdown rates than men, and (b) gender differences in the adoption of the temporary minimum drawdown rates introduced during crises, whereby women appeared more likely to adopt the temporary minimum drawdown rates than men. Second, to the best of the Authors knowledge, this thesis presented the first empirical investigation into retirees' investment behaviours within a Defined-Contribution scheme. More specifically, this thesis documented, (a) retirees' account opening equity allocations, (b) retirees' propensities to revisit and change their account opening equity allocations, and (c) how these behaviours were moderated by crisis periods as well as characteristics such as age, wealth, and gender.

6.2 Limitations

There are numerous limitations to this study, for brevity, only those of the most significance will be discussed: Foremost, this thesis is only able to proxy for a fraction of the key variables that are likely to moderate retirees' investment and drawdown strategies, as a result it is only able to explain a tiny variation in retirees' behaviour [53]; Second, as discussed

[53] Key variables that this thesis is missing include: health status, medical expenses and insurance (Yaari 1965, Palumbo 1999, Huang and Milevsky 2008, Coile and Milligan 2009, Milevsky 2013, Dobrescu 2015, Shen and Wei 2016, Yogo 2016); minimum subsistence requirements (Rubinstein 1976, Thorp, Kingston et al. 2007); bequest motives (Ding 2014, De Nardi, French et al. 2016); human capital (Bodie, Merton et al. 1992, Bodie 2003); Age Pension entitlement (Ding 2014); total wealth outside of the ABP (Andréasson, Shevchenko et al. 2017); education (Hallahan, Faff et al. 2004); and marital status (Lippi and Rossi 2020).

within section *4.2 Drawdown Behaviour*, it is questionable whether this sample is representative of the Australian population, hence the results may not be externally valid; Third, within the *Investment_Sample*, this thesis is unable to observe retirees' opening equity allocations if they selected an investment options that has been removed by the large Australian wealth management company; this limits the size of the sample and potentially introduces a bias into the results[54].

6.3 Future Research

First, as discussed in *section 5.1*, it is likely that retirees' drawdown and investment strategies are interrelated rather than interdependent. Hence, to investigate the extent of this interrelation, a Bivariate Probit model could be specified where the first simultaneous equation estimates a retirees' probability of making a change to their drawdown strategy and the second estimates a retirees' probability of making a change to their investment strategy; Second, as an additional test to investigate *H1b,* future research could examine the effect of the COVID-19 crises on gender differences in the likelihood of drawing at the minimum drawdown rate; Third, given the uncertainty as to the representativeness of the data, future research could test the robustness of the gender gap phenomenon through documenting its presence in alternative samples; Fourth, because retiree equity allocations are heavily grouped at specific values (see *Figure 4.3*), a cluster analysis could be utilised to allocate retirees into distinct behavioural groups and a categorical regression could be applied to determine the likelihood of an individual belonging to a particular behavioural groups. This would assist ABP providers in identifying retirees that may be susceptible to making poor choices.

[54] For example, if the removed investment options were chosen by a substantial and distinct group of retirees (i.e. younger and more risk averse), they would be unobserved by this thesis, hence depending on the type of option removed and the retirees that selected it, a bias in the results might be produced.

References

Abreu, M., et al. (2011). "Home country bias: Does domestic experience help investors enter foreign markets?" Journal of Banking & Finance **35**(9): 2330-2340.

ABS (2009). "Trends In Superannuation Coverage." from https://www.abs.gov.au/ausstats/abs@.nsf/lookup/4102.0Main+features70march%202009.

ABS (2019). "Retirement and Retirement Intentions, Australia." from https://www.abs.gov.au/statistics/labour/employment-and-unemployment/retirement-and-retirement-intentions-australia/latest-release#:~:text=Average%20retirement%20age%20(of%20all,to%20retire%20is%2065.5%20years.

ABS (2020). "Life expectancy continues to increase in Australia." from https://www.abs.gov.au/media-centre/media-releases/life-expectancy-continues-increase-australia.

Agarwal, S., et al. (2009). "The age of reason: Financial decisions over the life cycle and implications for regulation." Brookings Papers on Economic Activity **2009**(2): 51-117.

Alonso-García, J., et al. (2018). "Retirement drawdown defaults: the role of implied endorsement." Available at SSRN 3154907.

Ameriks, J. and S. P. Zeldes (2004). How do household portfolio shares vary with age, working paper, Columbia University.

Ando, A. and F. Modigliani (1963). "The" life cycle" hypothesis of saving: Aggregate implications and tests." The American economic review **53**(1): 55-84.

Andréasson, J. G., et al. (2017). "Optimal consumption, investment and housing with means-tested public pension in retirement." Insurance: Mathematics and Economics **75**: 32-47.

Antonakis, J., et al. (2019). "On ignoring the random effects assumption in multilevel models: Review, critique, and recommendations." Organizational Research Methods: 1094428119877457.

ANZ Survey of Adult Financial Literacy (2015). "ANZ SURVEY OF ADULT FINANCIAL LITERACY IN AUSTRALIA."

APRA (2019). "Annual superannuation bulletin." from https://www.apra.gov.au/annual-superannuation-bulletin.

APRA (2020). "Prudential Standard SPS 515

Strategic Planning and Member Outcomes." from https://www.apra.gov.au/sites/default/files/sps_515_strategic_planning_and_member_outcomes_december_2018.pdf.

APRA (2020). "Quarterly superannuation statistics." from apra.gov.au/quarterly-superannuation-statistics.

Australian Taxation Office (2020). "Early access to your super." from https://www.ato.gov.au/individuals/super/withdrawing-and-using-your-super/Early-access-to-your-super/.

Australian Taxation Office (2020). "Key superannuation rates and thresholds." from https://www.ato.gov.au/rates/key-superannuation-rates-and-thresholds/?page=10.

Australian Treasury (2014). "Financial System Inquiry

Final Report." from https://treasury.gov.au/sites/default/files/2019-03/p2014-FSI-01Final-Report.pdf.

Australian Treasury (2016). "Retirement Income Streams Review." from https://treasury.gov.au/publication/retirement-income-streams-review.

Balnozan, I. (2018). Slow and Steady: Drawdown Behaviours in Phased Withdrawal Retirement Income Products. APRA, University of New South Wales.

Balnozan, I., et al. (2020). "Hidden Group Time Profiles: Heterogeneous Drawdown Behaviours in Retirement." arXiv preprint arXiv:2009.01505.

Barber, B. M. and T. Odean (2001). "Boys will be boys: Gender, overconfidence, and common stock investment." The quarterly journal of economics **116**(1): 261-292.

Basu, A. K. and M. E. Drew (2009). "Portfolio size effect in retirement accounts: What does it imply for lifecycle asset allocation funds?" The Journal of Portfolio Management **35**(3): 61-72.

Bateman, H., et al. (2012). "Financial competence and expectations formation: Evidence from Australia." Economic Record **88**(280): 39-63.

Bateman, H., et al. (2001). "Forced Savings: Mandating Private Retirement Incomes."

Bateman, H. and J. Piggott (2010). "Too much risk to insure? The Australian (non-) market for annuities."

Bateman, H. and S. Thorp (2008). "Choices and constraints over retirement income streams: comparing rules and regulations." Economic Record **84**: S17-S31.

Bellante, D. and C. A. Green (2004). "Relative risk aversion among the elderly." Review of Financial Economics **13**(3): 269-281.

Bengen, W. P. (2001). "Conserving client portfolios during retirement, part IV." Journal of Financial planning **14**(5): 110.

Bodie, Z. (2003). "Thoughts on the future: Life-cycle investing in theory and practice." Financial Analysts Journal **59**(1): 24-29.

Bodie, Z., et al. (1992). Labor supply flexibility and portfolio choice in a life-cycle model, National Bureau of Economic Research.

Bowman, L. (2003). "A matter of choice." MoneyManagement. com. au **19**.

Brown, J. and M. Warshawsky (2013). "The life care annuity: a new empirical examination of an insurance innovation that addresses problems in the markets for life annuities and long-term care insurance." Journal of Risk and Insurance **80**(3): 677-704.

Brown, J. R. (2009). "Financial education and annuities." OECD Journal: General Papers **2008**(3): 173-215.

Brown, J. R. (2009). "Understanding the role of annuities in retirement planning." Overcoming the savings slump: How to increase the effectiveness of financial education and saving programs: 178-206.

Brown, J. R., et al. (2007). "Individual account investment options and portfolio choice: Behavioral lessons from 401 (k) plans." Journal of public Economics **91**(10): 1992-2013.

Brown, J. R., et al. (2000). Mortality risk, inflation risk, and annuity products, National Bureau of Economic Research.

Cardak, B. A., et al. (2019). "The effects of the Global Financial Crisis on the stock holding decisions of Australian households." The North American Journal of Economics and Finance **50**: 100983.

CEPAR (2020). Retirement Income Review submissions.

Choi, J. J., et al. (2004). For better or for worse: Default effects and 401 (k) savings behavior. Perspectives on the Economics of Aging, University of Chicago Press**:** 81-126.

Cohn, R. A., et al. (1975). "Individual investor risk aversion and investment portfolio composition." The Journal of Finance **30**(2): 605-620.

Coile, C. and K. Milligan (2009). "How household portfolios evolve after retirement: The effect of aging and health shocks." Review of Income and Wealth **55**(2): 226-248.

Commonwealth of Australia (1994). "Superannuation Industry (Supervision) Regulations 1994." from https://www.legislation.gov.au/Details/F2020C00827.

Commonwealth of Australia (2006). "Tax Laws Amendment (Simplified Superannuation) Bill 2006." from https://www.legislation.gov.au/Details/C2006B00226/Explanatory%20Memorandum/Text.

Commonwealth of Australia (2009). "Regulations Released for Pension Drawdown Measure to Benefit Retirees." from https://ministers.treasury.gov.au/ministers/nick-sherry-2007/media-releases/regulations-released-pension-drawdown-measure-benefit.

Commonwealth of Australia (2011). "Extension of Draw-down Relief a Win for Self-funded Retirees." from https://ministers.treasury.gov.au/ministers/bill-shorten-2010/media-releases/extension-draw-down-relief-win-self-funded-retirees.

Commonwealth of Australia (2020). "Key superannuation rates and thresholds." from https://www.ato.gov.au/rates/key-superannuation-rates-and-thresholds/?page=35.

Commonwealth of Australia (2020). "Retirement Income Review Final Report." from https://treasury.gov.au/publication/p2020-100554.

Cronqvist, H. and R. H. Thaler (2004). "Design choices in privatized social-security systems: Learning from the Swedish experience." American economic review **94**(2): 424-428.

De Nardi, M., et al. (2016). "Savings after retirement: A survey." Annual Review of Economics **8**: 177-204.

Department of Social Services (2020). "Home » Seniors » Benefits & Payments » Age Pension ". from https://www.dss.gov.au/seniors/benefits-payments/age-pension.

Ding, J. (2014). "Essays on post-retirement financial planning and pension policy modelling in Australia."

Dobrescu, L. I. (2015). "To love or to pay savings and health care in older age." Journal of Human Resources **50**(1): 254-299.

Doran, B. and G. Bornholt (2017). "The Trimmed Bootstrap: An Empirical Simulation Technique for Pension Finance Researchers." The Journal of Retirement **4**(3): 77-95.

Dorothée, R., et al. (2019). "Fiscal challenges and inclusive growth in ageing societies."

Fisher, I. (1930). Theory of interest: as determined by impatience to spend income and opportunity to invest it, Augustusm Kelly Publishers, Clifton.

Foucault, T., et al. (2011). "Individual investors and volatility." The Journal of Finance **66**(4): 1369-1406.

Gerrans, P. (2012). "Retirement savings investment choices in response to the global financial crisis: Australian evidence." Australian Journal of Management **37**(3): 415-439.

Gerrans, P. and M. Clark-Murphy (2004). "Gender differences in retirement savings decisions." Journal of Pension Economics & Finance **3**(2): 145.

Gerrans, P., et al. (2006). "An investigation of home bias in superannuation investment choices." Economic Papers: A journal of applied economics and policy **25**(1): 17-31.

Gerrans, P. and G. Yap (2010). Sophistication in retirement savings investment choices. Australian Centre for Financial Studies-Finsia Banking and Finance Conference.

Goda, G. S. and C. F. Manchester (2013). "Incorporating employee heterogeneity into default rules for retirement plan selection." Journal of Human Resources **48**(1): 198-235.

Griffith Centre for Personal Finance and Superannuation (2020). Retirement Income Review submissions.

Guiso, L., et al. (2018). "Time varying risk aversion." Journal of Financial Economics **128**(3): 403-421.

Haliassos, M. and C. C. Bertaut (1995). "Why do so few hold stocks?" the economic Journal **105**(432): 1110-1129.

Hallahan, T. A., et al. (2004). "An empirical investigation of personal financial risk tolerance." Financial Services Review-greenwich- **13**(1): 57-78.

Hannah, L. and H. Leslie (1986). Inventing retirement: the development of occupational pensions in Britain, Cambridge University Press.

Hellevik, O. (2009). "Linear versus logistic regression when the dependent variable is a dichotomy." Quality & Quantity **43**(1): 59-74.

Hintzman, D. L. (1976). Repetition and memory. Psychology of learning and motivation, Elsevier. **10:** 47-91.

Hippel, P. V. (2017). "When Can You Fit a Linear Probability Model? More Often Than You Think." from https://statisticalhorizons.com/when-can-you-fit.

Hoffmann, A. O. I. and T. Post (2017). "How return and risk experiences shape investor beliefs and preferences." Accounting & Finance **57**(3): 759-788.

Huang, H. and M. A. Milevsky (2008). "Portfolio choice and mortality-contingent claims: The general HARA case." Journal of Banking & Finance **32**(11): 2444-2452.

Hulley, H., et al. (2013). "Means-Tested Public Pensions, Portfolio Choice and Decumulation in Retirement." Economic Record **89**(284): 31-51.

IOOF (2019). "Retirement Income Review." from https://treasury.gov.au/sites/default/files/2020-02/ioof030220.pdf.

IOOF (2020). "About IOOF." from https://www.ioof.com.au/about-us/about-ioof.

Jacobsen, B., et al. (2014). "Gender differences in optimism and asset allocation." Journal of Economic Behavior & Organization **107**: 630-651.

James, E. and X. Song (2001). Annuity markets around the world: money's worth and risk intermediation. American Economic Association Meetings and CeRP Working Paper.

Jianakoplos, N. A. and A. Bernasek (1998). "Are women more risk averse?" Economic inquiry **36**(4): 620-630.

Johnson, D. D. P. and J. H. Fowler (2011). "The evolution of overconfidence." Nature **477**(7364): 317-320.

Kahneman, D., et al. (1982). Judgment under uncertainty: Heuristics and biases, Cambridge university press.

Kingston, G. and L. Fisher (2014). "Down the retirement risk zone with gun and camera." Economic Papers: A journal of applied economics and policy **33**(2): 153-162.

Kingston, G. and S. Thorp (2019). "Superannuation in Australia: a survey of the literature." Economic Record **95**(308): 141-160.

Knott, A. (2020). "Reflecting on my honours year." Comment.

Kogan, L., et al. (2006). "The price impact and survival of irrational traders." The Journal of Finance **61**(1): 195-229.

Korniotis, G. M. and A. Kumar (2011). "Do behavioral biases adversely affect the macro-economy?" The Review of Financial Studies **24**(5): 1513-1559.

Lichtenstern, A., et al. (2020). "Optimal life-cycle consumption and investment decisions under age-dependent risk preferences." Mathematics and Financial Economics: 1-39.

Lindström, J. and H. Kokko (2002). "Cohort effects and population dynamics." Ecology Letters **5**(3): 338-344.

Lippi, A. and S. Rossi (2020). "Run for the hills: Italian investors' risk appetite before and during the financial crisis." International Journal of Bank Marketing.

Lockwood, L. M. (2012). "Bequest motives and the annuity puzzle." Review of economic dynamics **15**(2): 226-243.

Lundeberg, M. A., et al. (1994). "Highly confident but wrong: Gender differences and similarities in confidence judgments." Journal of educational psychology **86**(1): 114.

Lusardi, A. and O. S. Mitchell (2007). "Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth." Journal of Monetary Economics **54**(1): 205-224.

Lusardi, A. and O. S. Mitchell (2017). "How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness." Quarterly Journal of Finance **7**(03): 1750008.

McInish, T. H. (1982). "Individual investors and risk-taking." Journal of economic Psychology **2**(2): 125-136.

McNaughton, T., et al. (1999). Growing Old Gracefully: Age-Phasing, Targets and Saving Rules, Retirement Economics Group, University of New South Wales.

Merton, R. C. (1969). "Lifetime portfolio selection under uncertainty: The continuous-time case." The review of Economics and Statistics: 247-257.

Milevsky, M. A. (2013). "Life annuities: An optimal product for retirement income." CFA Institute Research Foundation Monograph.

Miller, D. T. and M. Ross (1975). "Self-serving biases in the attribution of causality: Fact or fiction?" Psychological bulletin **82**(2): 213.

Mitchell, O. S., et al. (2006). "The inattentive participant: Portfolio trading behavior in 401 (k) plans." Michigan Retirement Research Center Research Paper No. WP **115**.

Mitchell, O. S. and S. P. Utkus (2004). "Lessons from behavioral finance for retirement plan design." Pension design and structure: New lessons from behavioral finance **18**(1): 82-94.

Mitchell, O. S. and S. P. Utkus (2006). "How Behavioral Finance Can Inform Retirement Plan Design 1." Journal of Applied Corporate Finance **18**(1): 82-94.

Modigliani, F. (1986). "Life cycle, individual thrift, and the wealth of nations." Science **234**(4777): 704-712.

Mullainathan, S. and R. H. Thaler (2000). Behavioral economics, National Bureau of Economic Research.

OECD (2001). OECD 2000 Private Pensions Conference No. 1, 2001b, OECD 2000 Private Pensions Conference.

OECD (2019). "Pensions at a Glance 2019." from https://www.oecd-ilibrary.org/content/publication/b6d3dcfc-en.

Palumbo, M. G. (1999). "Uncertain medical expenses and precautionary saving near the end of the life cycle." The Review of Economic Studies **66**(2): 395-421.

Papke, L. E. and J. M. Wooldridge (1996). "Econometric methods for fractional response variables with an application to 401 (k) plan participation rates." Journal of applied econometrics **11**(6): 619-632.

Parliament of Australia (2007). "Tax Laws Amendment (Simplified Superannuation) Bill 2007." from https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r2681.

Pension Rights Centre (2020). "Pension plans that have applied to cut benefits under the Multiemployer Pension Reform Act." from http://www.pensionrights.org/publications/fact-sheet/plans-have-filed-critical-and-declining-status-notices-us-department-labor.

Poterba, J., et al. (2011). "The composition and drawdown of wealth in retirement." Journal of Economic Perspectives **25**(4): 95-118.

Poterba, J. M. and A. Samwick (2001). Household portfolio allocation over the life cycle. Aging issues in the United States and Japan, University of Chicago Press**:** 65-104.

Prince, M. (1993). "Women, men, and money styles." Journal of economic Psychology.

Productivity Commission (2015). "Superannuation Policy

for Post-Retirement." from https://www.pc.gov.au/research/completed/superannuation-post-retirement/super-post-retirement-volume1.pdf.

Reeson, A. and S. Dunstall (2009). "Behavioural Economics and Complex Decision-Making." Victoria: CSIRO.

Reeson, A., et al. (2016). "Superannuation drawdown behaviour: An analysis of longitudinal data." CSIRO-Monash Working Paper No. 2016-04.

Rothman, G. P. and H. Wang (2013). Retirement Income Decisions: Take Up and Use of Australian Lump Sums and Income Streams. Retirement and Intergenerational Modelling Unit, Department of the Treasury, paper presented at the 21st Colloquium of Superannuation Researchers University of New South Wales.

Rubinstein, M. (1976). "The valuation of uncertain income streams and the pricing of options." The Bell Journal of Economics: 407-425.

Samuelson (1987). ""“Comment”, in Bodie, Z. and Shoven, J. (eds), Financial Aspects of the United States Pension System." University of Chicago Press: 276-287.

Samuelson (1991). Money, macroeconomics, and economic policy: essays in honor of James Tobin, MIT Press.

Samuelson, P. A. (1969). "Lifetime portfolio selection by dynamic stochastic programming." The review of Economics and Statistics: 239-246.

Samuelson, W. and R. Zeckhauser (1988). "Status quo bias in decision making." Journal of risk and uncertainty **1**(1): 7-59.

Shen, Y. and J. Wei (2016). "Optimal investment-consumption-insurance with random parameters." Scandinavian Actuarial Journal **2016**(1): 37-62.

Simon, H. A. (1955). "A behavioral model of rational choice." The quarterly journal of economics **69**(1): 99-118.

Thaler, R. H. and S. Benartzi (2004). "Save more tomorrow™: Using behavioral economics to increase employee saving." Journal of political economy **112**(S1): S164-S187.

The National Herald (2017). Benefits Being Cut 70%, Greek Pensioners Can't Make Ends Meet. T. N. Herald. Greece.

Thinking Ahead Institute (2020). "Global Pension Assets Study." from https://www.thinkingaheadinstitute.org/en/Library/Public/Research-and-Ideas/2020/01/Global-Pension-Asset-Study-2020.

Thorp, S., et al. (2007). "Financial engineering for Australian annuitants." Retirement Provision in Scary Markets, Edward Elgar, UK.

Trone, D., et al. (1996). The management of investment decisions, McGraw Hill Professional.

Tversky, A. and D. Kahneman (1973). "Availability: A heuristic for judging frequency and probability." Cognitive psychology **5**(2): 207-232.

Tversky, A. and D. Kahneman (1974). "Judgment under uncertainty: Heuristics and biases." Science **185**(4157): 1124-1131.

U.S. Department of the Treasury (2020). "Bricklayers & Allied Craftsmen Local 7 Pension Fund Second Application." from https://www.treasury.gov/services/Pages/Bricklayers-and-Allied-Craftsmen-Local-7-Pension-Fund-Second-Application.aspx.

Van Ooijen, R., et al. (2015). "Saving behavior and portfolio choice after retirement." De Economist **163**(3): 353-404.

Westpac (2014). "AUSTRALIAN ECONOMIC REPORTS." from https://www.westpac.com.au/about-westpac/media/reports/australian-economic-reports/.

Wooldridge, J. M. (2016). Introductory econometrics: A modern approach, Nelson Education.

Yaari, M. E. (1965). "Uncertain lifetime, life insurance, and the theory of the consumer." The Review of Economic Studies **32**(2): 137-150.

Yogo, M. (2016). "Portfolio choice in retirement: Health risk and the demand for annuities, housing, and risky assets." Journal of Monetary Economics **80**: 17-34.

Appendix

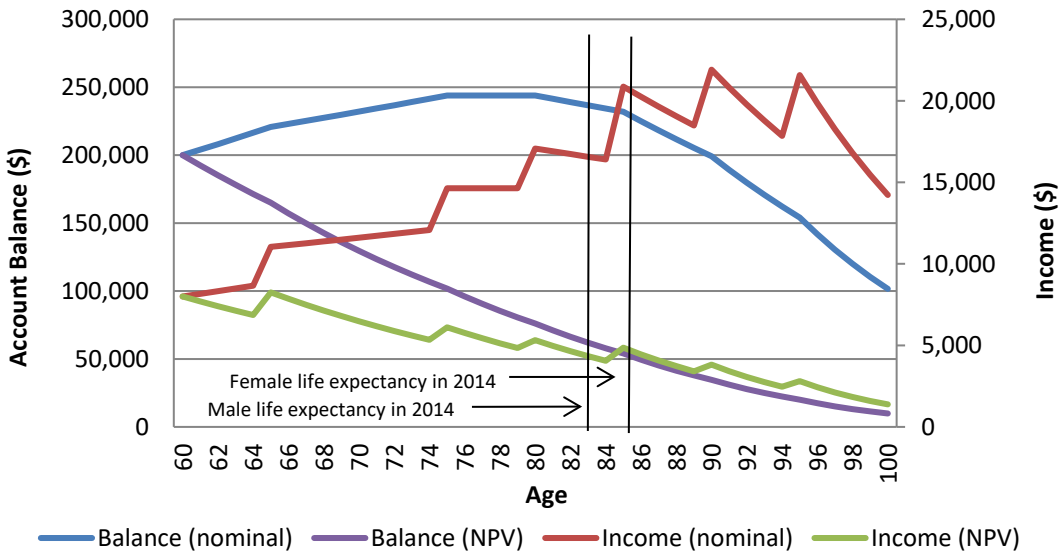
1.1

Minimum drawdowns in practice

Chart 1 (below) illustrates a drawdown scenario for male and female retirees commencing an account-based pension with a balance of $200,000 at age 60 and drawing down at the minimum payment amounts with investment returns of 6 per cent per annum. The chart shows the account balance at various ages and the income drawn down each year in both nominal and net present value (NPV) terms.

An account-based pension drawn down only at the minimum rates can be expected to last beyond average life expectancy, although the NPV of the annual income will generally gradually diminish. In the below example, the net present value of the account balance at life expectancy is around 25 per cent of the initial opening account balance. The net present value of income from the pension declines steadily over time, but 'ratcheting-up' occurs when the regulated percentages increase, resulting in a somewhat variable income stream in nominal terms.

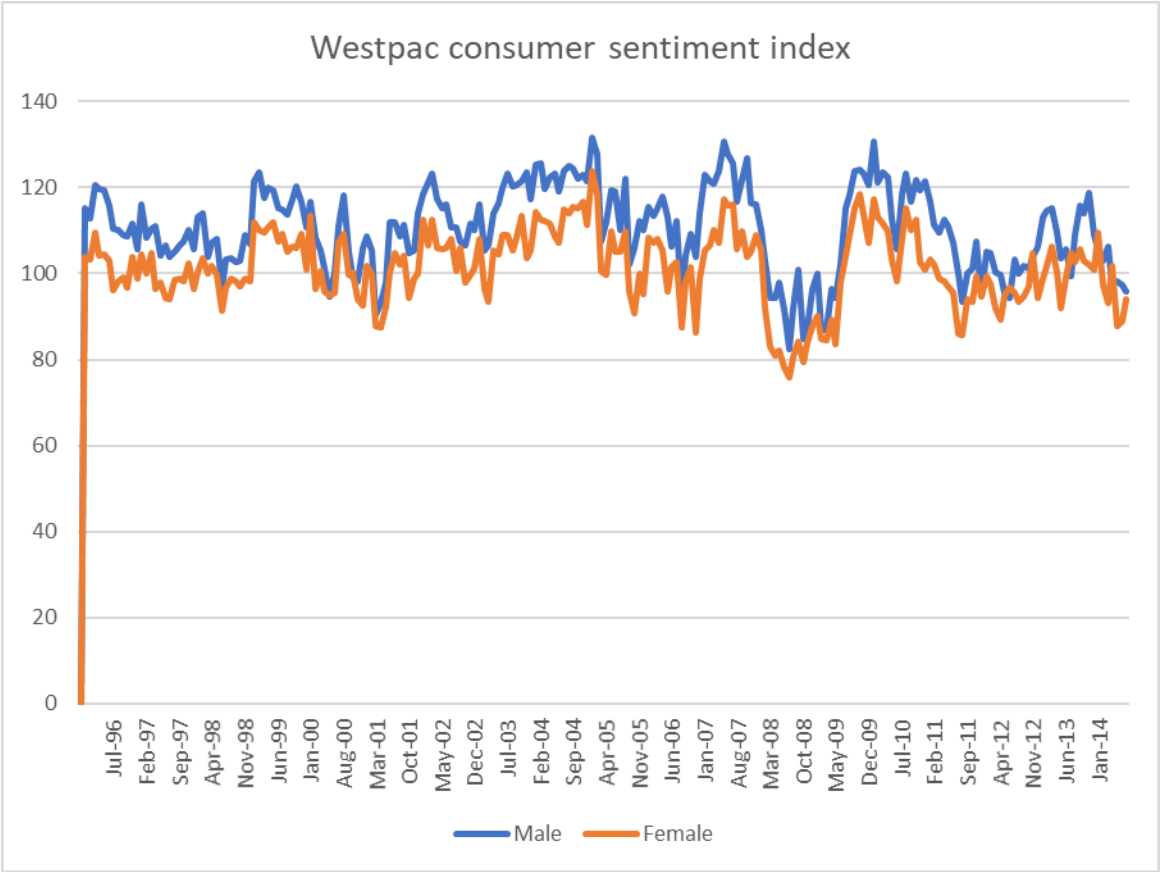
Drawdown profile for an account-based pension



Note: The analysis assumes an average nominal investment return of 6 per cent. This is also the discount rate for net present value.

Source: (Australian Treasury 2016)

1.2



Source: Westpac (2014)

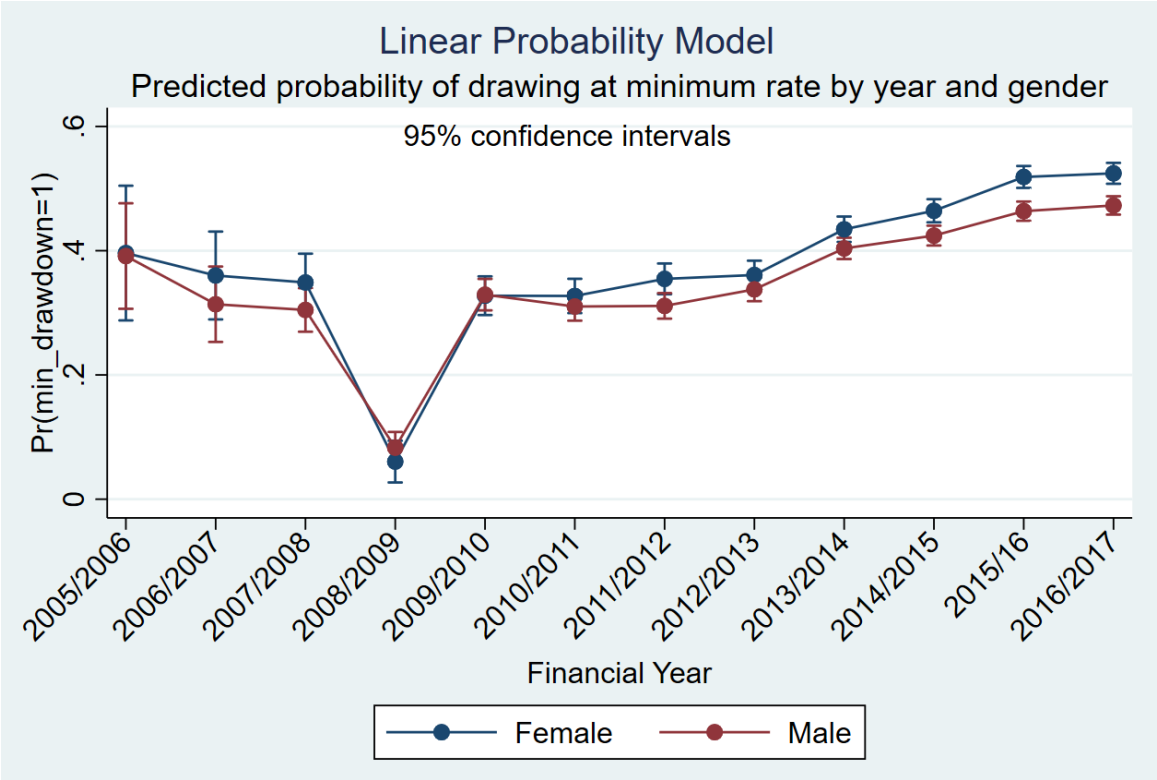
1.3

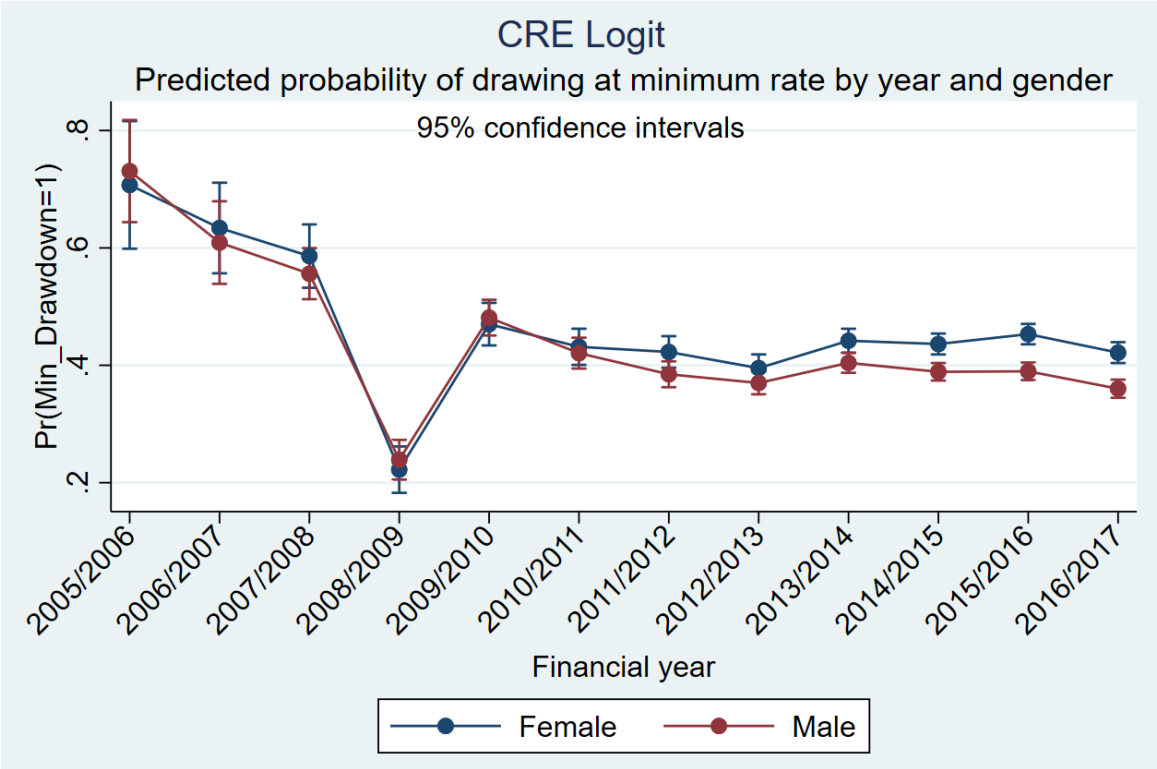
CRE Logit Model

This table reports the Average marginal Effects (AME) and robust standard errors (SE) for the CRE Logit model. Standard errors have been clustered at the account level. min_drawdown is a dummy variable representing whether a retiree draws down at the minimum rate (1=true). age represents retirees age at the start of the financial year. account_balance represents retirees ABP balance at the start of each financial year. gender represents retirees' gender (1=male). inv_equity represents retirees first recorded equity allocation. * p<0.1; ** p<0.05; *** p<0.01.

	CRE Logit	
	AME's	SE's
gender: male	-.042***	.008
account_balance ($ millions)	-8.7E-08**	.000
age	.067***	.003
inv_equity	-.002***	.000
year:		
2005/2006	.349***	.034
2006/2007	.256***	.027
2007/2008	.201***	.020
2008/2009	-.140***	.017
2009/2010	.099***	.016
2010/2011	.047***	.014
2011/2012	.022*	.012
2012/2013	-.000	.011
2013/2014	.038***	.009
2014/2015	.025***	.007
2015/2016	.032***	.005
2016/2017	base year	
cluster mean of account_balance	2.95E-07***	.000
cluster mean of age	-.060***	.003
year and gender interactions	Yes Appendix 1.4	
observations	36,654	
clusters	8,922	
Wald chi2(30)	1564***	

1.4


Linear Probability Model
Predicted probability of drawing at minimum rate by year and gender
95% confidence intervals
Pr(min_drawdown=1)
0
.2
.4
.6
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/16
2016/2017
Financial Year
Female
Male


CRE Logit
Predicted probability of drawing at minimum rate by year and gender
95% confidence intervals
Pr(Min_Drawdown=1)
.2
.4
.6
.8
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
Financial year
Female
Male

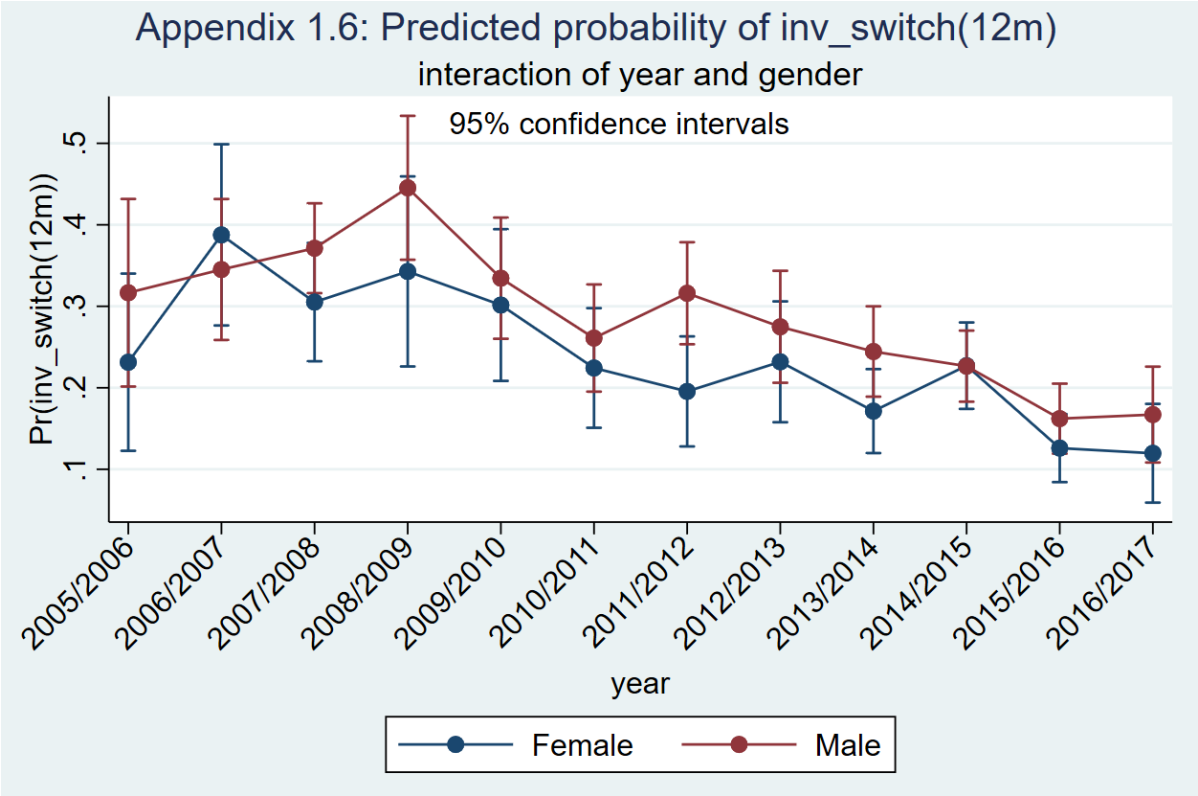
1.5

FE Linear Probability Model

This table reports the coefficients and robust standard errors for the FE Linear Probability model. This model was used as robustness test for the drawdown hypotheses. Standard errors have been clustered at the ABP level. min_drawdown is a dummy variable representing whether a retiree draws down at the minimum rate (1=true). age represents retirees' age at the start of the financial year. account_balance represents retirees' ABP balance at the start of each financial year. gender represents retirees' gender (1=male). inv_equity represents retirees' first recorded equity allocation. * p<0.1; ** p<0.05; *** p<0.01.

Dependent variable:	min_drawdown = 1	
	Coefficients	SE's
gender: male	omitted	
account_balance ($ millions)	-.060	0.065
age	-.112***	.012
inv_equity	Omitted	
year:		
2005/2006	.007	.069
2006/2007	.092**	.046
2007/2008	.184***	.030
2008/2009	base year	
2009/2010	.391***	.027
2010/2011	.514***	.034
2011/2012	.670***	.043
2012/2013	.803***	.040
2013/2014	1.013***	.064
2014/2015	1.180***	.076
2015/2016	1.373***	.087
2016/2017	1.533***	.098
Year and gender interaction:		
2005/2006#Male	-.027	.077
2006/2007#Male	-.070	.053
2007/2008#Male	-.069*	.035
2008/2009#Male	base year	
2009/2010#Male	-.026	.030
2010/2011#Male	-.044*	.029
2011/2012#Male	-.075**	.029
2012/2013#Male	-.056*	.030
2013/2014#Male	-.063**	.029
2014/2015#Male	-.074**	.029
2015/2016#Male	-.091***	.029
2016/2017#Male	-.094***	.030
observations	36,532	
clusters	8,915	
R2: within	.129	

1.6


Appendix 1.6: Predicted probability of inv_switch(12m)
interaction of year and gender
95% confidence intervals
Pr(inv_switch(12m))
.1
.2
.3
.4
.5
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
2016/2017
year
Female
Male

The End 😊