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RESEARCH ARTICLE

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The impact of post-retirement financial market participation on retirement income sufficiency in Australia

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Abstract

Using HILDA survey data, we document a strong positive relationship between post-retirement financial market participation and retiree income sufficiency in Australia. We find a 17% improvement in the income replacement ratio and a 3.26 times higher annuitised net wealth for financial market participants compared to non-participants. We further investigate how age, residence area, relationship status, education, health, and employment affect the main finding in all and female retirees. The results highlight the value of financial market participation in facilitating household retirement security and provide further support for the active promotion of household financial market participation, both in Australia and globally.

KEYWORDS

Ageing population, Annuitised net wealth, Financial market participation, Replacement ratio, Subjective financial wellbeing

JEL CLASSIFICATION

G11, D14, D31

1 | INTRODUCTION

A well-designed pension system protects people against poverty and smooths people's income throughout the life cycle. In order to achieve these goals, countries set up their own pension systems, but these can differ in significant ways. While it is difficult to compare one country's pension system with another, there are certain universal elements that can lead to adequate and stable support for pensioners, including adequacy, sustainability, and integrity.[1] The pen-

[1]https://www.ai-cio.com/news/netherlands-denmark-australia-rated-worlds-top-pension-systems/.

sion systems in many western countries are organised and affected by demographic ageing. According to the Organisation for Economic Co-operation and Development (OECD), the aged (those aged 65 years and above) represented 17.20% of the entire population across all OECD countries in 2018. This number was 10.76% in 1980 and 13.08% in 2000, and is expected to increase to 27.1% by 2050.[2] Therefore, a good system needs to be reviewed, and reforms may be required to keep it sustainable and adequate.

Australia, one of the OECD countries, at a time when pension systems around the world are creaking, is a standout, as documented by Bloomberg in March 2020.[3] According to the latest Melbourne Mercer Global Pension Index (MMGPI), published in 2022, Australia is ranked 6th among the 44 pension systems around the world covered in the survey in terms of financial security for retirees.[4] The Retirement Income Review (RIR)[5] 2020 report points out that exposure to market returns is a key strength of Australia's superannuation income system. As documented by Giannetti and Koskinen (2010), Australia has the highest domestic stock market participation rate among the 26 countries examined.[6]

However, despite the fortunate retirement saving pillars and high financial market participation which already feature in the Australian pension system, there are calls for reforms to a system that will see employer retirement contributions projected to grow from A$3 trillion to A$5.4 trillion within a decade. This is mainly due to the ageing of the Australian population, with the number of aged persons expected to increase from 15.7% in 2018 to 19.1% by 2050.[7] This unarguably presents significant social and economic challenges for the Australian government. Even though Australia has a well-established three-pillar pension system, the Australian government expects to increase the qualifying age for its Age Pension from 65 to 67 years by July 2023. Australians have become increasingly liable to save for their own retirements. As reported in the RIR, while the Age Pension, combined with other support provided to retirees, effectively ensures most Australians achieve a minimum standard of living in retirement, retirees who rent or retire early involuntarily still suffer higher levels of financial stress. Further, the report finds a narrowed gap between the superannuation balances of men and women but points out the gap will remain due to a gender gap in earnings and labour force participation. Additionally, retirees who want to live beyond the minimum standard need to consider higher private retirement savings.

Financial market participation is considered to be the engine to drive an individual's net wealth. Motivated by the above, this paper examines the relationship between financial market participation and retirees' income sufficiency in Australia. The Household, Income and Labour Dynamics Australia (HILDA) survey data provides an excellent platform to undertake the current study. We attempt to answer the following questions: Does financial market participation post-retirement help to enhance retirees' income sufficiency, and, if so, to what degree and through what channels?

While there is ample evidence in the existing literature to show that financial market participation enhances individuals' financial position (Calvet et al., 2007; Cocco & Gomes, 2012), including saving for future retirement (Gustman & Steinmeier, 2002), very few studies focus on retirees as a standalone group and study their financial market

[2] https://data.oecd.org/pop/elderly-population.htm.

[3] https://www.bloomberg.com/news/articles/2020-03-06/why-australia-s-pension-system-isn-t-super-enough-quicktake.

[4] https://www.mercer.com/our-thinking/global-pension-index.html#contactForm.

[5] https://treasury.gov.au/sites/default/files/2021-02/p2020-100554-udcomplete-report.pdf.

[6] Across all 26 countries studied by Giannetti and Koskinen (2010), Australia's participation rate reached 40.4%, followed by New Zealand, the United Kingdom, Japan, Denmark, and the United States, at participation rates of, respectively, 31.0%, 30.0%, 29.7%, 28.0%, and 26.0%.

[7] https://www.abs.gov.au/AUSSTATS/abs@.nsf/Previousproducts/3101.0Feature%20Article1Jun%202018.

participation post-retirement. We believe this group deserves special attention, because their financial behaviour and investment motivation differs from that of other age groups. While asset accumulation remains a key target for working-age groups, asset decumulation defines the tone for retirement financial planning. Also, individuals' income generally decreases significantly after retirement; retirees live mainly on investment income, savings and/or pensions. In addition, it is important for retirees to pay attention to longevity risk. The average life expectancy in Australia increased by 4.06 years over the 20-year period from 2000 to 2020, with an average life expectancy of 83.50, according to the World Health Organization.[8] This highlights the importance of recognising the dynamics of life expectancy (i.e., the planning window) in assessing the adequacy of retirement income sufficiency. Traditionally, retirees reduce investment risk exposure post-retirement, so they may opt for bond-like assets. However, the inadequacy of the public pension system and the increasing ageing population at the macroeconomic level, together with the micro-level concerns such as decreasing income and longevity risk, can motivate retirees to invest in growth assets post-retirement to supplement their pension and other incomes. Alternative solutions for insufficient retirement savings, such as remaining in the workforce for a longer period (Bronshtein et al., 2019), may not be viable for everyone, and retirees may want to improve their retirement lifestyle. These factors could further motivate investment in financial markets post-retirement.

Relying on the HILDA[9] 2018 survey data from 2791 retirees in Australia, we examine the impact on retirees' income sufficiency from post-retirement financial market participation, using the retirement income replacement ratio (Bernheim et al., 2001; Biggs & Springstead, 2008) and the retiree's annuitised net wealth (Knoef et al., 2014; Love et al., 2009) as two key measures of retirees' income sufficiency. The replacement ratio is calculated as the ratio of the disposable post-retirement income to the disposable pre-retirement income. It identifies retirees' income sufficiency from the income channel. Our second measure is annuitised net wealth. It is calculated as the annuitised present value of a retiree's projected wealth from all his/her current and future financial resources including net assets, social security payments, and any pensions paid, multiplied by the annualising factor calculated following Love et al. (2009) and taking into account the discount rate, mortality/surviving possibilities and remaining life expectancy. This measure determines the income sufficiency from the wealth channel. Both measures are tailored to consider individual retirees' unique income patterns and respective planning windows.

We gather information on whether a retiree receives income or dividends from company shares, managed funds and property trusts, as well as the amount received, as our proxies for financial market participation. Our baseline results highlight that there are significant benefits for retirees to participate in financial markets. We find that the replacement ratio for financial market participants is 17% greater than that of non-participants. That is, a retiree who participates in financial markets enjoys 17% more post-retirement disposable income, compared to those who do not participate in the financial markets. Moreover, on average, retiree (financial market) participants show 3.26 times more annuitised net wealth than non-participants. In addition, we also find higher replacement ratio and annuitised net wealth by employing the amount of investment as the alternative explanatory variable. For every A$1000 invested, these retiree participants experience a 1.3% higher replacement ratio and 2.6% more annuitised net wealth. Using subsamples, our analysis further reveals that retiree characteristics play certain roles in determining the channel to benefit from financial market savings. We find that retirees who are older, male, live in non-major cities, co-reside with a partner,

[8] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/life-expectancy-at-birth-(years).

[9] See subsection 3.1 for more details on HILDA.

own their homes, and receive pensions, benefit more from financial market participation by being able to 'replace' more of their pre-retirement incomes (that is, they have higher income replacement ratios). For female retirees and for retirees who are younger, and live with a partner, financial market participation allows them to accumulate more wealth in the long-term (i.e., higher annuitised net wealth).

All our main results are based on extended regression models (ERMs) using maximum likelihood estimates where instrumental variables are employed to deal with common statistical problems, which could result in endogeneity. We also further conduct several robustness tests including: applying alternative financial market participation measures; instead using the standard ordinary least squares (OLS) with fixed effects as the model; following a three-step approach per Adams et al. (2009) and standard two-stage least squares (2SLS) as alternative methods to address any endogeneity issue; using different retiree samples; employing different methods to calculate the key measures for retirement income sufficiency; and additionally adopting two measures to assess subjective retirement financial wellbeing.[10] Our results from these tests widely support our baseline results.

We contribute to the existing literature in several important ways: (i) to the best of our knowledge, this is the first empirical research to address the importance of the post-retirement financial market participation on retirees' income sufficiency in Australia. Existing literature almost exclusively focuses on the benefits of financial market participation for the overall population (e.g., Calvet et al., 2007; Cocco & Gomes, 2012), while no specific study addresses retirees' financial adequacy, which is underpinned by inherently different saving needs, motives, and challenges; and (ii) our study has important policy implications given the Australian government's initiative to encourage more private savings towards retirement. Our results provide new timely evidence to support governments' allocation of greater resources for financial education that encourages financial market participation (Fong et al., 2020; Niu et al., 2020). Although the financial market participation rate is relatively high in Australia, Campbell (2006) documents that most households neither follow portfolios theories nor hold sufficient portfolios. Therefore, for the regulators, financial literacy education should go beyond simply encouraging participation. Households should be educated on the detrimental effect on their ultimate retirement wellbeing if they do not invest adequately and efficiently, even after retirement. In addition, this education should be tailored to accommodate individuals' financial habits (Eugster, 2019). Relevant strategies should be applied when targeting retirees of different backgrounds (Lusardi et al., 2009). Relatedly, these results also have practical implications for the financial services sector, as it plays an important role in facilitating better retirement planning. When retirees plan better collectively, it will ease the strain on the current pension system, and in turn help promote sustainable economic growth in the long-run. Thus, our paper contributes to the existing literature, sheds extra light on the impact of financial market participation, and has important social, economic, and political implications.

The rest of the paper is organised as follows: Section 2 presents background information on the Australian pension system and the existing literature; Section 3 describes the data and the methodology used; Section 4 presents our baseline results and further results from subsample analysis; Section 5 conducts our robustness tests; and Section 6 concludes.

[10]In addition to objective measures, two subjective measures from the survey data are used to determine retirees' financial wellbeing when conducting the robustness test. These are questions related to the level of satisfaction in their financial situation, and how well current financial needs and responsibilities are met. We are aware of different measures for subjective wellbeing in the literature (e.g., Diener et al., 1985; Diener & Wirtz, 2009; Netemeyer et al., 2018). However, due to the focus of our research and the limitation of the data, we applied the two questions which best reflected retirees' subjective financial wellbeing.

2 | INSTITUTIONAL BACKGROUND AND LITERATURE REVIEW

2.1 | The Australian three-pillar retirement income system

In this section, we briefly discuss the three-pillar architecture of Australia's retirement income system, consisting of a publicly funded age pension, a privately managed superannuation system, and voluntary savings. The first pillar is the means-tested age pension, which provides a minimum standard of living in retirement for Australians with limited financial means. The qualifying age was increased to 66 years and 6 months on 1 July 2021, and it is scheduled to increase by 6 months every two years until it reaches 67 years on 1 July 2023. The level of the age pension is determined after assessing retirees' income and assets. All eligible retirees with the same level of income and assets receive the same amount, which could be zero if they have more income or assets than the thresholds. As of 20 March 2022, the maximum age pension an eligible person can receive is A$987.60 per fortnight for singles and A$1488.80 for couples combined.[11] According to the World Bank, the objective of this pillar is to ensure all Australians receive a safety net level of income throughout their retirement that is adequate to provide a reasonable minimum standard of living.

The second pillar is introduced as a superannuation scheme that includes both a compulsory element and a voluntary contribution. This pillar ensures a reasonable minimum share of employee income is saved to contribute extra resources towards retirement. The compulsory element serves as mandatory defined-contribution insurance. Employers in Australia are required to contribute to employees' superannuation accounts once certain conditions are met (e.g., minimum working hours and wages). The current minimum Superannuation Guarantee (SG) increased to 10.5% of certain wages and salaries into a superannuation fund as of 1 July 2022, and this ratio is scheduled to increase to 12% in 0.5% annual increments by 1 July 2025. This is the first time the SG has been scheduled to increase since 2014. Connolly and Kohler (2003) suggest such compulsory superannuation has contributed to enhancing both household savings and wealth. However, these schemes are only available to individuals who are employed and, thus, benefit only a portion of the population. For example, only 31.78% of our sample received regular payments from superannuation, annuities, or private pensions during the survey period, and only 6.78% received any irregular superannuation lump sum payments in the previous financial year. The voluntary superannuation contribution provides certain flexibility for people not covered by the SG, allowing them to make some catch-up contributions when they are out of the workforce, or make additional contributions.

The third pillar, voluntary savings (including voluntary contributions from the second pillar), is another important element influencing post-retirement income sufficiency. According to the RIR report, homeownership is the most important component of voluntary savings, as homeownership supports retirement income by reducing housing expenses and acts as a store of wealth that can be drawn on in retirement. For example, Evans and Razeed (2019) and Yates and Bradbury (2010), document that retirees liquidate or downsize their houses to increase savings for retirement, even though it is suggested to be the last resort for retirement savings (Skinner, 2007). Other saving options under this pillar include financial assets, such as shares and bonds, business assets or bank deposits.

Overall, global retirement income systems are under an increasing level of pressure due to the ageing population. Australia aims to ensure its retirement income system is sustainable over the long-term. There are several factors that affect this sustainability including the state Age Pension, compulsory superannuation, voluntary savings, and the balance between the number of workers and retirees. Therefore, there is an immediate need to make certain reforms to the Australian retirement income system (Ganegoda & Evans, 2017). This is because less public pension support will be available in the future, and regulators are placing greater

[11] https://www.servicesaustralia.gov.au/individuals/services/centrelink/age-pension/how-much-you-can-get#a1.

emphasis and responsibility on employers' and individuals' own retirement savings (Gerrans et al., 2018). The limitations of the first and second pillars highlight the importance of the third pillar in securing a desirable post-retirement lifestyle (Hurley et al., 2017).

2.2 | Literature review on retiree income sufficiency

Retirees face various challenges to maintain their income sufficiency. On the income side, the literature supplies ample evidence that retirees' income invariably reduces significantly when they stop working (e.g., Bardasi et al., 2002; Munnell et al., 2006). On the consumption side, the literature suggests consumption heterogeneity because some retirees fail to recognise the change in their income patterns (Hurst, 2008), and some retirees need to not only support their basic retirement expenditure but also fund leisure activities, such as travel and social activities for their retirement wellbeing (Adams et al., 2011), while some others find deterioration in post-retirement consumption (e.g., Bernheim et al., 2001; Denton et al., 2011). Jointly, existing literature documents heterogeneous income sufficiency after retirement in different countries, often dependent on the underlying pension systems and the benchmarks used to assess retirement income sufficiency (e.g., Binswanger & Schunk, 2012; Bresser & Knoef, 2015; Denton et al., 2011; Prus, 2000). Among them, many suggest retirement income insufficiency in other nations (e.g., Crawford & O'Dea, 2020; Mitchell & Moore, 1998; Rhee, 2011; Yuh et al., 1998).

Australian retirees are in a relatively fortunate position compared to retirees in other nations. According to the RIR report, which carries out one of the most comprehensive reviews of this topic, the Australian retirement income system is effective, sound and its costs are broadly sustainable. Most retirees can achieve a minimum standard of living in retirement, but there are two exceptions. The first exception includes those who do not own their homes, in this case rent-related costs result in a significant adverse effect on their income sufficiency. Yates and Bradbury (2010) find consistent evidence that Australian retirees without homeownership are disadvantaged in many ways due to higher housing expenses and lower disposable incomes. The number of retirees in this cohort keeps increasing persistently. The second exception group are those who retire involuntarily due to job-related reasons. For these retirees, their living standards before becoming eligible for a pension are highly dependent on other government supports available to them, and these retirees also enjoy reduced benefits from the work-based pension system due to early retirement. This is consistent with the findings of Feng (2018), that even with the compulsory work-based pension system in Australia, substantial gaps between savings and retirement needs may still exist.

Moreover, retirees are exposed to significant longevity risk over time. There is evidence from other nations showing how retirees' replacement ratio drops as the retirement years become longer (e.g., Bloom et al., 2003; Cocco & Gomes, 2012; De Nardi et al., 2009; Dudel et al., 2016; Purcell, 2012). In Australia, while the Age Pension serves as a form of longevity insurance for those who outlive their retirement savings, as suggested by the RIR report, lessons from other countries suggest more challenging retirement planning in recent decades (e.g., Haveman, Holden, Wolfe, & Romanov, 2007), which could lead to concerns about future government support availability. For example, Italians' subjective expectations for the decreasing replacement ratios have pushed them to increase their participation in second or third pillar retirement savings (Jappelli et al., 2021). Moreover, the RIR projection assumes that retirees will run down their superannuation assets by age 92, and also assumes that retirees leave no bequest and will purchase a longevity product at retirement to provide income from age 92. For retirees that have a different situation from this assumption, a higher level of saving is probably required to safeguard against longevity risk. The higher saving needs are particularly relevant considering the overall increasing life expectancy of the population, which may further increase over time.

Given the amount of heterogeneity and uncertainty in post-retirement financial planning, and further considering benefits such as greater investment flexibility and desires to live beyond the minimum living standards, it is important that retirees are well prepared for retirement financially through, for example, investing in financial markets. As the RIR report points out, exposure to financial markets is a significant contributing factor to the success of its highly regarded retirement income system worldwide, which lets people enjoy the benefits of higher returns. We follow the previous literature in studying how financial market participation helps to improve retirees' income sufficiency, using the retirement replacement ratio and annuitised net wealth. The two measures focus on retirees' income and wealth sufficiency, respectively. As defined by Bernheim et al. (2001), the retirement replacement ratio measures post-retirement income as a percentage of pre-retirement income, to assess whether the same standard of living can be maintained after retirement. This measure captures the dynamic flows of post-retirement income without consuming lifelong savings at given time points. Our second measure is annuitised net wealth, as defined by Love et al. (2009). This measure first calculates a household's total net wealth by including existing net wealth and the present value of any projected future incomes (e.g., pensions). Then the total net wealth is adjusted by the annualising factor, which takes into account the remaining life expectancy of each individual to arrive at the annualised net wealth. The calculated annualised net wealth is then compared to a benchmark to define sufficiency/insufficiency. A common benchmark in the literature consists of multiples of the local poverty line; for example, 1.5 times or twice the poverty line (Butrica et al., 2007). We follow the literature in using the two measures, which we discuss in more detail in subsection 3.2.

2.3 | Financial market participation puzzle

Previous evidence shows that individuals benefit from participating in financial markets, which increases individuals' savings in the long-run (Gustman & Steinmeier, 2002). For example, Bovenberg et al. (2007) employ a stylised life cycle savings model and document a 12% loss in wealth when individuals do not participate in the stock market at all (either directly or indirectly via pension savings managed by superannuation funds). In addition, Cocco and Gomes (2012) report a loss of up to 4% in wealth for those who do not participate in the stock market, using different values for several parameters of interest and comparing to a benchmark situation that takes borrowing constraints into account. Calvet et al. (2007) estimate an annual loss of 4.3% in returns by Swedish households due to a lack of participation in the stock market.

Despite the benefits, however, governments around the world have found it challenging to encourage financial market participation. Grinblatt et al. (2011) reveal a participation puzzle, in that only 50% of US households invest in stocks either directly or indirectly, and this number is rather lower in Europe. Gomes and Michaelides (2005) use a life cycle asset allocation model with uninsurable labour income to explain the low stock market participation rates in the US among those younger than 75 years from 1976 to 1993. A similar puzzle has been documented in Australia. According to a survey conducted by the Australian Securities Exchange (ASX) in 2014, individuals' direct and indirect financial market participation rates have dropped since 2004.[12] The indirect ownership dropped from 32% in 2004 to 10% in 2014, and 44% of Australians invested directly in 2004, compared with 33% in 2014.

[12]The ASX Australian Share Ownership Study was conducted between September and November 2014. The survey aims to provide a comprehensive insight into the behaviours, attitudes, and knowledge of direct financial market participants in Australia. In the survey, a direct investor refers to an individual who holds shares and/or listed investments directly in his or her own name through a private portfolio, a self-managed superfund, or a company structure. An indirect investor refers to an individual who owns shares and/or listed investments through unlisted managed funds outside of superannuation funds.

Retirees, who have different risk preferences, income patterns, and investment horizons from those still in the workforce, may be disadvantaged even more from non-participation in the financial markets. For example, Australia's interest rates were around only 1.5% during the 2017–2018 financial year, but the inflation rate was 1.91% – the real purchasing power of retirees' savings could be diminishing if they only invest in passive term deposits. While younger generations can afford to wait longer, retirees who rely on interest incomes will be significantly disadvantaged if they keep their savings as bank deposits. Boyle Torrey and Teauber (1986) have also shown that other post-retirement incomes, for example, rent from investment properties and interest incomes from passive investments such as bonds, are also significantly reduced in a low-interest rate environment. Horneff et al. (2018) show that Americans are predicted to save less and tend to draw down their 401(k) earlier to finance their consumption during periods of low interest rates, which subsequently puts more pressure on retirees, especially due to longer life expectancies.

Few studies specifically address the importance of financial market participation for retirees. Following the literature (Brown et al., 2008), an individual is considered a direct financial market participant if the individual buys financial products under his or her own discretion, such as shares, trusts, or managed funds under his or her name. In contrast, indirect financial market participation refers to passive financial market holdings through retirement schemes or insurance. Participating in financial markets is not the main goal of the individuals in these scenarios, and they also do not make the decisions about their investments. For example, an individual can indirectly participate in financial markets through an employer pension scheme, but the contribution is made by the employer and enforced by the law, so it does not reflect the individual's active decision to save and benefit from the financial markets. For retirees in particular, who may have indirect access to financial markets through retirement schemes, we argue it is more appropriate to consider their holdings outside retirement schemes to capture their post-retirement investment motive and behaviour. Most retirees draw down their retirement schemes because, at this stage, benefits like tax advantages and employer contributions generally vanish and, most importantly, most retirees can no longer contribute further to their retirement schemes.[13] It is worth mentioning that the Australian super system has an attractive feature in that it allows for self-managed super funds (SMSF), which means savers have more control and responsibility over their own super, as with investments in a standard investment fund. However, SMSFs represents less than 5% of Australia's population and about 25% of assets invested in super.[14] Also, like other industry or retail super funds, the contribution limit applies after one reaches the retirement age. Nevertheless, to the extent that overall financial market participation matters, holdings through the super fund cannot be easily brushed aside as people may see other benefits like professional management and stricter regulation, so we take indirect financial market participation into account in our robustness checks to verify our main findings.[15]

[13]Once a person reaches age 67, he/she must satisfy a work test or use the one-off work test exemption before his/her super fund can accept further contributions. Once he/she hits age 75, his/her super fund is generally unable to accept further contributions into the account. In addition, there are contribution caps, being A$27,500 per financial year for the general concessional contribution and A$110,000 for any non-concessional contribution. If the total superannuation balance is greater than or equal to A$1.7 million on 30 June in the previous financial year, a person is not able to make any non-concessional contributions. For more details, see Contributing to your super in your late 60s: What are the rules? (superguide.com.au).

[14]See SMSF statistics: 1.1 million members with $822bn in super (superguide.com.au).

[15]We thank Associate Professor Geoff Warren for this valuable suggestion.

3 | DATA AND METHODOLOGY

3.1 | The HILDA survey data

We use data from the HILDA Survey. The HILDA survey is a household-based panel study that collects information on household economic and personal wellbeing, labour market dynamics, and family life. The survey started in 2001 and is funded by the Australian Government through the Department of Social Services, and administered by the Melbourne Institute at the University of Melbourne. It collects information on household and family relationships, income, employment, health, and education from more than 17,000 Australians each year. Our study focuses on the 2018 wave of the HILDA Survey, primarily because it provides sufficient variables and observations to draw meaningful conclusions. We include only those aged 65 years and above as of June 2018, since our focus is on retirees. We thus obtain 3527 observations from 2565 households: 1604 households in the sample have one aged person, 960 households have two aged people, and one household has three aged people.

We collect all relevant variables from the survey data for all observations, including both dependent and explanatory variables. Our dependent variables include the regular retirement income replacement ratio (calculated as the ratio of the weekly regular disposable retirement income to the weekly median pre-retirement disposable income) and the individual annuitised net wealth as the two objective measures. We also include two subjective measures for post-retirement financial wellbeing as robustness checks. Our first main explanatory variable is financial market participation, a dummy variable that takes a value of one if an individual retiree participates in the financial markets, and zero otherwise. Second, we also use the corresponding amount of investment as the explanatory variable, although this is available for a smaller sample due to HILDA data availability. Following Brown et al. (2008), we define those who receive an income or dividends from company shares, managed funds, or property trusts as participating directly in the financial market.[16] We acknowledge the fact that someone can participate in the financial market but not receive any dividends or capital gain. However, the likelihood of such a case should be relatively low in our sample. According to the Reserve Bank of Australia, from July 2017 to June 2018, 93% of Australian companies reported a profit, and 90% paid dividends.[17]

Other variables include age, gender, living area (major city = 1, elsewhere = 0), employment status (unemployment = 1, <35 h per week = 2, more than 35 h per week = 3), self-rated health (poor = 1, fair = 2, good = 3, very good = 4, excellent = 5), highest education (year 12 or below = 1, certificate or diploma = 2, university degree or above = 3), financial literacy (score 1–5 from five financial literacy questions), living status (living with a partner = 1, otherwise = 0), risk preference (no risk = 1, average risk = 2, above-average risk = 3, substantial risk = 4), disposable retirement income (used to calculate the replacement ratio), individual net wealth (assets minus debts by interview time), the relationship with neighbours (ranging from 1 to 7), and age pension eligibility. A detailed description of each variable and related survey questions is presented in Table A1 in the Appendix.

[16]In the HILDA survey, income from bonds is not included in the question regarding income from financial assets. The nature of income from bonds is somewhat similar to passive and fixed interest income from term deposits. Therefore, investments in bonds might not fully represent an individual's proactive approach to benefits from financial markets. In any case, the inclusion of bond investments in the analysis should only emphasise further the importance of participating in financial markets.

[17]See Mathews (2019).

3.2 | Income sufficiency measures

We use the retirement income replacement ratio and the annuitised net wealth to measure post-retirement income sufficiency. The post-retirement income replacement ratio is the product of the post-retirement disposable income in relation to the disposable pre-retirement income.[18] The post-retirement income is the sum of any wages and salaries (if the individual is still employed), business income, investment income, private pension, private transfers, and Australian public transfers. All values are after tax, and these represent the main sources of post-retirement income. We do not include irregular or less frequent items, such as gifts, because it is more appropriate to assess the overall post-retirement income sufficiency based on foreseeable regular incomes that are affected by individuals' decisions to participate in financial markets. This also ensures consistency since the pre-retirement income does not include irregular items. However, we include irregular incomes when undertaking the robustness test in subsection 5.4.

Pre-retirement incomes are not readily available from the survey data. We use median disposable salaries by industry and gender as a proxy for the pre-retirement income, based on the pre-retirement occupation.[19] The following rules apply in identifying the pre-retirement industries. First, if an individual is under employment after retirement, we use the individual's post-retirement industry, because it is unlikely that the individual changes industry after retirement. Second, for individuals who are not employed, we use the pre-retirement industry. Third, if we cannot determine either the post- or pre-retirement industry from the 2018 wave data, we trace it back to the 2017 wave data. Similarly, we use the post-retirement industry first, if possible, and then the pre-retirement industry. We continue adopting this approach until the 2001 wave data, which constitutes the first wave of the HILDA survey. All 18 waves of the survey cover 2477 observations of individuals' pre-retirement industries. We then match the pre-retirement industries to the Australian and New Zealand Standard Industry Classification (ANZSIC) 2006 categories to obtain the before-tax pre-retirement income, since the Australian Bureau of Statistics records median weekly salaries by gender, based on full-time ordinary earnings for these industries. We use the tax calculator from the Australian Taxation Office to obtain the median disposable income by gender and industry.[20] Therefore, an individual's retirement replacement ratio is measured as the weekly post-retirement disposable income divided by the weekly pre-retirement industry median disposable earnings, by gender. This ratio ranges between zero and one, since the post-retirement income is usually less than the pre-retirement income.[21]

For the second measure, annuitised net wealth, we first obtain the individual's estimated life expectancy and the household's net wealth. We use the life expectancy published by the

[18]The income replacement ratio has been widely adopted as a key matrix of retirement income sufficiency, for example by the OECD and the World Bank. In the previous literature, Palmer (1989) uses the ratio to assess the impact of a tax reform on retiree income sufficiency. Smith (2003) calculates retirement income–replacement rates for all labour market cohorts across 25 years and describes the changing contributions made by private pensions, social security, and assets. Burnett et al. (2018) project the ratio as a key measure of retirement saving adequacy in a sample of the Australian population aged 40 and above. Binswanger and Schunk (2012) rely on the ratio to assess adequate standard of living during retirement in the US and The Netherlands. All the studies adopt a similar methodology to ours to calculate the ratio.

[19]Pre-retirement income has been calculated in different ways in the literature, often driven by data availability (Denton et al., 2011; Purcell, 2012), and there is no consensus on the best solution. Therefore, we choose the median disposable income by industry and gender as a proxy for pre-retirement income.

[20]https://www.ato.gov.au/calculators-and-tools/simple-tax-calculator/.

[21]Due to data limitations, the sample contains negative replacement ratios and some replacement ratios greater than one. These are replaced by the two extreme values zero and one, respectively, for the following analysis, to allow as many observations as possible. Alternatively, we also exclude them from the analysis to check our results. The results are consistent.

Australian Bureau of Statistics for 2018–2020,[22] corresponding to the individual's gender and state of residence. The household net wealth is further decomposed into net wealth at the time of the survey and the present value of any projected future cash inflows. We calculate the total net wealth at the time of the survey as the difference between total household assets and debt. Total household assets include the balances of joint and individual bank accounts and the value of superannuation, business assets, cash, equity investment, collectables, home and other property assets, life insurance, trust funds, and vehicles. Total household debt includes the balances of any student loans, joint and individual credit cards, other personal debt, business debt, home and other property debt, and any overdue household bills. The present value of projected future cash flows equals the total Age Pension for the remaining years of life. We use the current Age Pension as a proxy for future pension, and we multiply the current pension by the number of remaining years of life, calculated based on life expectancy, to obtain the present value of total projected future cash flows.

We then need to 'annuitise' the calculated household net wealth. Several problems may occur. First, in our calculation, for simplicity, we use current pension as a proxy based on the assumption that future pension is benchmarked against the Consumer Price Index (CPI) to reflect the impact of inflation, hence, it offsets the need to discount to present value. In practice, however, this is a rather more complicated and dynamic task. Age pension indexation is also tied to average weekly earnings and relationship status (i.e., singles and couples).[23] Second, the eligibility of Age Pension may change dependent on the means test of assets (e.g., home ownership), which will interact with an assumed drawdown rate and mortality. While an individual's pension eligibility is unlikely to change in our context,[24] the quantum of pension received may vary, and we also need to take into account reasonable assumptions of mortality. Third, retirees may also receive other government subsidies with their pension on, for example, rent and medical costs. We acknowledge the limitation that we are not able to incorporate all the concerns mainly due to data availability, but we attempt to tackle some of the issues by following the methodology of Love et al. (2009). Specifically, their methodology allows us to reasonably incorporate relationship status and mortality. It defines annualised wealth for each individual as:

$$AW_t = a_t W_t, \tag{1}$$

where AW_t is an individual's annuitised net wealth. W_t is a household's comprehensive net wealth at age t, a_t is the annualising factor calculated as below:

$$a_t = \left[\sum_{i=0}^{T} \left\{ \frac{\alpha S^f_{t+i} S^m_{t+i} + S^f_{t+i}\left(1 - S^m_{t+i}\right) + S^m_{t+i}\left(1 - S^f_{t+i}\right)}{(1+r)^i} \right\} \right]^{-1}, \tag{2}$$

where S^f_{t+i} is the probability that a female currently aged t lives to age $t+$i, and S^m_{t+i} is the analogous probability for males. T is the maximum attainable age for any person, r is the real discount rate,

[22] https://www.abs.gov.au/statistics/people/population/life-tables/latest-release.

[23] The age pension is currently indexed by the greater of the movement in the Consumer Price Index (CPI) or the Pensioner and Beneficiary Living Cost Index (PBLCI), and then benchmarked against a percentage of Male Total Average Weekly Earnings (MTAWE). However, benchmarking against the average weekly earnings may lead to pension dominating if simulated over the long-run. Also, the process is dynamic depending on the macroeconomic environment. Therefore, we simplify the process for the purpose of the research. For more information on pension indexation, see Pension-indexation – Parliament of Australia (aph.gov.au).

[24] We check the Age Pension receiving status among all 18 waves of HILDA from 2002 to 2018. On average, only 24 retirees experience a change of pension eligibility and only 20 retirees maintain this change of status in the following year in each wave (0.57% of the overall sample).

and α is an adjustment for household economies of scale that allows couples to spend less per person than single retirees. Consistent with Love et al. (2009), we use the inflation-adjusted T-bill rate in Australia in 2018 as r, T is proxied by the 2018–2020 life expectancy from the Australian Bureau of Statistics, and α equals 2 (1.67) for a single (two-person) household. We present our calculation of the annualising factor in Appendix Table A2; it is highly consistent with that reported by Love et al. (2009).

3.3 | Methodology

We run the following regression for two income sufficiency measures separately:

$$\begin{aligned} INCOME\_SUFFICIENCY_i = {} & \alpha_i + \beta_1 FINANCIAL\_MARKET\_PARTICIPATION\_IV_i + \beta_2 AGE_i + \\ & \beta_3 MALE_i + \beta_4 LIVING\_AREA_i + \beta_5 EMPLOYMENT\_STATUS_i + \\ & \beta_6 SELFRATED\_HEALTH_i + \beta_7 HIGHEST\_EDUCATION_i + \\ & \beta_8 FINANCIAL\_LITERACY_i + \beta_9 LIVING\_STATUS_i + \\ & \beta_{10} RISK\_PREFERENCE_i + \beta_{11} REGULAR\_DISPOSABLE\_RETIREMENT\_INCOME_i + \\ & \beta_{12} HOUSEHOLD\_NET\_WEALTH_i + \varepsilon_i, \end{aligned} \tag{3}$$

where $INCOME\_SUFFICIENCY_i$ represents the replacement ratio or the natural logarithm of annuitised net wealth, and $FINANCIAL\_MARKET\_PARTICIPATION_i$ is either: (i) a dummy variable that equals one when the individual directly participates in financial markets, and zero otherwise; or (ii) the corresponding amount directly invested in financial markets. We also include basic demographic factors as control variables that have been documented to influence retiree income sufficiency, including age (Alan et al., 2008), gender (Jefferson & Preston, 2005), living area (Metzger, 2017), employment status, self-rated health (Rosen & Wu, 2004), highest level of education (Yuh et al., 1998), financial literacy (Agnew et al., 2012), living status (Khongboon et al., 2016), risk preferences, regular disposable retirement income, and household net wealth.[25]

We note there could be a possible endogeneity problem. For example, one could choose to participate in financial markets if one tended to have adequate income. We use an instrumented 'participation' to address this problem. Our instrument is a retiree's relationship with their neighbours. Kaustia and Knüpfer (2012), Hong et al. (2004), and Brown et al. (2008) demonstrate that individuals are more likely to participate in the stock market when they have more social interactions. If retirees feel they get along with their neighbourhood, they are more likely to interact with each other. As a result, they invest, or invest more, in financial markets. In our sample, the average rating for the relationship with the neighbourhood is 2.44 out of 7, showing they do not agree that they are not getting along with each other on average. The correlation between financial market participation and the neighbourhood score is −0.086 (significant at the 1% level), supporting the validity of the instrument.

To accommodate continuous dependent, endogenous binary independent, and ordered instrumental variables, we use the extended regression model (ERM) to estimate our parameters, following Wooldridge (2002, 2010). This model is similar to a standard 2SLS model, which allows us to run a probit model (instead of OLS) in the first stage, because the independent

[25]We control for regular disposable retirement income only for the annuitised net wealth measure. We do not control for regular disposable retirement income when examining the replacement ratio to avoid endogeneity, since regular retirement income is the numerator for calculating the replacement ratio. Similarly, we only control household net wealth for the replacement ratio measure, and we do not control household net wealth for annuitised net wealth, as household net wealth is part of the calculation for annuitised net wealth.

variable is binary. In the second stage, we run a standard OLS model by using the predicted values of the instrumented variable from the first stage. A standard 2SLS model is inappropriate in our situation, since the first stage is nonlinear. Wooldridge (2002) refers to this as the forbidden regression problem, and, as Cameron and Trivedi (2005) point out, only a modified 2SLS estimator that correctly specifies the first stage is appropriate. More specifically, the ERM applies maximum likelihood estimation in both stages to ensure the first-stage result is specified to avoid any inconsistency issues (Wooldridge, 2010). In subsection 5.2, we apply three alternative models, namely, standard OLS, standard OLS with fixed effects, and the three-stage model proposed by Adams et al. (2009).

4 | EMPIRICAL ANALYSIS

4.1 | Summary statistics

Table 1 presents summary statistics for all variables. Our sample retirees have an average replacement ratio of 0.64, suggesting Australian retirees maintain 64% of their pre-retirement disposable income after retirement. The average annuitised net wealth for our sample is 11.13, which is equivalent to A$68,186 per annum.[26] For the two main dependent variables, the median values are 0.62 and 11.14 respectively, highly similar to the average values. We observe that 29% of the retirees in our sample participate directly in the financial markets and the average amount invested is A$189,259. Note that the median amount invested is around A$25,000, indicating the skewed financial market investment among retirees. For the two subjective financial wellbeing measures, first, retirees are asked to self-rate the level of satisfaction toward their financial situation (with a score ranging from 1 to 10); our sample average is 7.46 (median = 8). Second, retirees are asked to answer a question about their financial status given their current needs and financial responsibilities (with a score ranging from 1 to 6); our sample average is 3.90 (median = 4).

The average age in our sample is 74.34 years, 46% are male, 57% live in a major city, 62% live with a partner, and 63% receive Age Pension. Interestingly, the average financial literacy score is 3.98 out of 5, and a median score 5 (the highest score possible) is observed. This indicates a considerably high level of financial literacy among Australian retirees, even though the overall level of education is lower, with an average score of 1.68. This is not surprising given the fact that Australia has the highest financial market participation rate of all OECD countries. On average, the risk preference score is 1.4 out of 4, consistent with our expectation of a low-risk preference for retirees (Chambers et al., 2019). Among all the observations, 3027 are reported as unemployed, representing 85.82% of the sample. The wealth and income related variables show some skewness. The respective mean and median values of weekly regular disposable retirement incomes are A$710 and A$470, and for household net wealth they are A$1,330,000 and A$820,000.

4.2 | Baseline results

We present our baseline results in Table 2. Both the replacement ratio and the annuitised net wealth are used as the dependent variables to represent the income sufficiency in Equation (3).[27] The coefficients on the financial market participation variables are positive

[26]The annuitised net wealth is in natural logarithm and this amount is A$68,186 per annum if the life-cycle model is not taken into consideration.

[27]Chao and Swanson (2005) document that the ERM is generally less sensitive to the weak instrumental variable problem, since it is based on maximum likelihood estimation. Nevertheless, we report our first-stage results in Appendix Table A3. We find the instruments are negatively associated with the instrumented variables in all cases, which is consistent with our expectation.

TABLE 1 Summary statistics.

	N	Mean	Median	Std. dev.	Min	Max
Replacement_Ratio	2477	0.64	0.62	0.30	0	1
Total_Disposable_Income_Replacement_Ratio	2477	0.65	0.63	0.30	0	1
Annuitised_Net_Wealth	3522	11.13	11.14	0.89	7.44	13.30
Annuitised_Net_Wealth2	3521	10.89	10.84	0.63	9.97	11.95
Financial_Market_Participation	3333	0.29	0	0.45	0	1
Financial_Market_Amount	960	189.26	25	420.56	0	3269.36
Subjective_Financial_Wellbeing (Measure 1)	3351	7.46	8	2.04	0	10
Subjective_Financial_Wellbeing (Measure 2)	3100	3.90	4	0.75	1	6
Age	3527	74.34	73	7.22	65	102
Gender	3527	0.46	0	0.50	0	1
Living_Area	3527	0.57	1	0.50	0	1
Employment_Status	3524	1.18	1	0.51	1	3
Self-rated_Health	3084	2.94	3	0.94	1	5
Highest_Education	3360	1.68	1	0.77	1	3
Financial_Literacy	3193	3.98	5	1.37	0	5
Living_Status	3359	0.62	1	0.49	0	1
Risk_Preference	3038	1.40	1	0.58	1	4
Regualr_Disposable_Retirement_Income	3527	0.71	0.47	0.82	−0.30	14.51
Household_Net_Wealth	3527	1.33	0.82	1.67	−0.12	9.43
Age_Pension_Eligibility	3359	0.63	1	0.48	0	1
Neighbourhood_Relationship	3079	2.44	2	1.53	1	7

Note: This table presents summary statistics. The values of *Regular_Disposable_Retirement_Income* and *Financial_Market_Participation_Amount* are in thousands of dollars, and those of *Household_Net_Wealth* are in millions of dollars. *Annuitised_Net_Wealth* is the natural logarithm value.

and statistically significant for both the replacement ratio and the annuitised net wealth. This suggests a positive impact on retirement income sufficiency from direct financial market participation. Specifically, retirees who participate in the financial market enjoy a 17% higher post-retirement replacement ratio than non-participants. In addition, the annuitised net wealth of those who participate in financial markets is 3.26 times higher than that of non-participants.

Moreover, Table 3[28] presents the results examining whether and how the investment amount affects replacement ratio and annuitised net wealth. We find the amount of investment is also positively correlated with retirement income sufficiency. For each A$1000 invested in financial markets, the replacement ratio increases by 1.3% and the value of annuitised net wealth rises by 2.6%. To illustrate, based on the mean values of all other variables as reported in Table 1, a replacement ratio of 65% (the lower bound of replacement ratio suggested by the RIR report) corresponds to a predicted value of financial market investment of A$75,462, and the replacement ratios increase to 75% (the upper bound of replacement ratio suggested by the RIR), and 85% if the investment amounts increase to A$83,155 and A$90,847, respectively, keeping all other factors the same. Our results reveal the importance of post-retirement financial market participation, which enhances retirement income sufficiency for Australian retirees through both the more short-term

[28]The first-stage results are presented in Appendix Table A4. All our instruments are valid.

TABLE 2 Baseline income sufficiency results with dummy independent variables.

	Replacement ratio	Annuitised net wealth
Financial_Market_ Participation_IV	0.170*** (4.04)	1.450* (1.83)
Age	−0.003*** (−2.22)	0.030*** (5.66)
Gender	−0.040*** (−3.24)	−0.076 (−1.44)
Living_Area	−0.018 (−1.60)	0.139*** (3.49)
Employment_Status	0.124*** (11.25)	0.011 (0.21)
Self-Rated_Health	0.006 (0.99)	0.053* (1.83)
Highest_Education	0.027*** (3.39)	0.086*** (3.37)
Financial_Literacy	0.000 (0.08)	0.047* (1.72)
Living_Status	−0.118*** (−9.25)	0.266*** (4.79)
Risk_Preference	0.049*** (4.17)	0.042 (0.37)
Regular_Disposable_Retirement_Income		0.142** (1.97)
Household_Net_Wealth	0.030*** (6.63)	
Constant	0.556*** (5.62)	7.580*** (14.47)
Observations	2110	2791

Note: This table presents the regression results of retiree income sufficiency on post-retirement financial market participation. The two measures are the regular disposable retirement income replacement ratio and the natural logarithm of annuitised net wealth. The variable *Financial_Market_Participation* is a dummy variable that equals one if the retiree receives income or dividends from company shares, managed funds, and property trusts, and zero otherwise. The control variables include *Age*, which represents the age of the retiree; *Gender*, a dummy variable that equals one if the retiree is male, and zero otherwise; *Living_Area* is a dummy variable that equals one if the retiree lives in a major city, and zero otherwise; *Employment_Status* is equal to one if the retiree does not work, two if the retiree works <35 h a week, and three if more than 35 h a week; *Self-Rated_Health* is the retiree's self-perception of health conditions, ranging from one to five, from poor to excellent; *Highest_Educaiton* is the highest education level achieved by the retiree at the time of the interview, which equals one if it is 12 years or less, two if the retiree has a certificate or diploma, and three if the retiree has a university degree; *Financial_Literacy* is the correct number of answers for five standardised financial literacy questions regarding inflation, compounding, and diversification; *Living_Status* is a dummy variable that equals one if the retiree is living with a partner, and zero otherwise; *Risk_Preference* is the financial risk the retiree is potentially willing to take with spare money, ranging from one to four, representing no risks to substantial risks; *Regular_Disposable_Retirement_Income* is the retiree's regular weekly average after-tax retirement income, in thousands of dollars; and *Household_Net_Wealth* is the household's net wealth, in millions of dollars, which is overall assets minus debts. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

income channel, as captured by the replacement ratio, and the relatively long-term wealth channel, represented by annuitised net wealth.

4.3 | Subsample analysis: Individual characteristics and the distribution of wealth

In this section, we perform further analysis to examine the post-retirement financial market participation impacts on income sufficiency based on retirees' individual characteristics. Due to data constraints on financial market investment levels, for our subsample analysis to be statistically viable, we base our analysis on the financial market participation dummy.

4.3.1 | Male versus female retirees

Women generally have a longer life expectancy, earn a lower income, and exhibit lower financial literacy (Williamson & Boehmer, 1997). Moreover, women tend to participate less in financial markets, since they are more risk averse than men (Säve-Söderbergh, 2012; Watson & McNaughton, 2007). Thus, females generally suffer more from income insufficiency after

TABLE 3 Baseline income sufficiency results with continuous independent variables.

	Replacement ratio	Annuitised net wealth
Financial_Market_Amount_IV	0.013*** (9.83)	0.026*** (10.06)
Age	−0.084** (−2.77)	−0.046** (−2.53)
Gender	−0.165 (−0.46)	0.576*** (2.44)
Living_Area	0.605* (1.65)	0.285 (1.25)
Employment_Status	1.126*** (3.11)	1.382*** (4.04)
Self-Rated_Health	−0.022 (−0.12)	0.225* (1.74)
Highest_Education	−0.056 (−0.21)	−0.034 (−0.17)
Financial_Literacy	−0.129 (−0.70)	−0.082 (−1.21)
Living_Status	1.430*** (3.14)	0.320 (1.28)
Risk_Preference	−0.967*** (−2.70)	−0.948*** (−2.96)
Regular_Disposable_Retirement_Income		−3.016*** (−3.93)
Household_Net_Wealth	−1.290*** (−8.30)	
Constant	7.171** (2.49)	13.696*** (8.73)
Observations	665	819

Note: This table presents the regression results of retiree income sufficiency measured by post-retirement financial market participation amount. The two income sufficiency measures are the regular disposable retirement income replacement ratio and the natural logarithm of annuitised net wealth. The main explanatory variable *Financial_Market_Amount* is a continuous variable that represents the wealth invested in company shares, managed funds, and property trusts, in thousands of dollars. The control variables include *Age*, which represents the age of the retiree; *Gender*, a dummy variable that equals one if the retiree is male, and zero otherwise; *Living_Area* is a dummy variable that equals one if the retiree lives in a major city, and zero otherwise; *Employment_Status* is equal to one if the retiree does not work, two if the retiree works <35 h a week, and three if more than 35 h a week; *Self-Rated_Health* is the retiree's self-perception of health conditions, ranging from one to five, from poor to excellent; *Highest_Education* is the highest education level achieved by the retiree at the time of the interview, which equals one if it is 12 years or less, two if the retiree has a certificate or diploma, and three if the retiree has a university degree; *Financial_Literacy* is the correct number of answers for five standardised financial literacy questions regarding inflation, compounding, and diversification; *Living_Status* is a dummy variable that equals one if the retiree is living with a partner, and zero otherwise; *Risk_Preference* is the financial risk the retiree is potentially willing to take with spare money, ranging from one to four, representing no risks to substantial risks; *Regular_Disposable_Retirement_Income* is the retiree's regular weekly average after-tax retirement income, in thousands of dollars; and *Household_Net_Wealth* is the retiree's household net wealth, in millions of dollars, which is overall assets minus debts. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

retirement than males. In our sample, 27.45% of females participate in financial markets, in contrast to 30.41% male participation, aligning with the above findings of prior research. Preston and Wright (2023), using HILDA, also find consistent evidence that the gender gap in financial literacy is an important determinant of the gender gap in pension savings. Therefore, it is particularly important to take a closer look at our results from the lens of gender differences. We thus perform our analysis for men and women subsamples separately.

The results are presented in Panel A of Table 4. Our results suggest that both male and female retirees' income sufficiency is substantially enhanced through direct financial market participation. Our results are not only statistically significant but also economically significant. Male retirees who participate in the financial market have a 20.2% higher replacement ratio compared to those who do not participate, while female financial market participants have a 15.3% higher replacement rate. Put another way, the increase in the annuitised net wealth is only statistically significant for females. Overall, the results indicate that females, who are typically more financially vulnerable, enjoy benefits from both the income and wealth channels through post-retirement financial market participation, while males mainly benefit from the income channel. Our results thus highlight post-retirement financial market participation as an important tool to address the gender disparity in post-retirement financial well-being for females, in response to the call in the RIR report, as discussed in the introduction.

TABLE 4 Gender differences.

Panel A: Subsample analysis by gender groups

Subsamples	Variables	Replacement ratio	No. of obs	Annuitised net wealth	No. of obs
Male	*Financial_Market_Participation_IV*	0.202** (2.03)	1097	0.571 (0.72)	1313
Female	*Financial_Market_Participation_IV*	0.153*** (3.92)	1013	1.984* (1.68)	1478

Panel B: Interaction tests by characteristics of female retirees

	Variables	Replacement ratio	Annuitised net wealth
(1)	*Financial_Market_Participation*	0.059*** (3.43)	0.450*** (11.54)
	*Participation*Age Group*	0.058** (2.40)	0.011 (0.20)
	Observations	2132	2837
(2)	*Financial_Market_Participation*	0.083*** (4.15)	0.581*** (10.96)
	*Participation*Living_Status*	−0.0002 (−0.01)	−0.195*** (−3.33)
	Observations	2132	2837
(3)	*Financial_Market_Participation*	0.102*** (5.31)	0.432*** (10.21)
	Participation Living_Area*	−0.034 (−1.39)	0.029 (0.55)
	Observations	2132	2837
(4)	*Financial_Market_Participation*	0.094*** (4.92)	0.428*** (10.20)
	*Participation * Education*	−0.020 (−0.82)	0.045 (0.82)
	Observations	2132	2837
(5)	*Financial_Market_Participation*	0.072*** (4.53)	0.512*** (14.9)
	*Participation * Health_Status*	0.030 (1.18)	−0.179*** (−3.20)
	Observations	2132	2837
(5)	*Financial_Market_Participation*	0.100*** (6.78)	0.442*** (14.20)
	*Participation * Employment Status*	−0.100*** (−3.36)	0.054 (0.66)
	Observations	2132	2837
(6)	*Financial_Market_Participation*	0.087*** (4.32)	0.457*** (10.01)
	*Participation * Financial literacy*	−0.007 (−0.30)	−0.007 (−0.12)
	Observations	2132	2837
(7)	*Financial_Market_Participation*	0.068*** (3.77)	0.482*** (12.24)
	Participation Risk Preference*	0.024 (0.96)	−0.090* (−1.66)
	Observations	2132	2837

Panel C: Interaction tests by gender in retiree subsamples with certain characteristics

Variables	Replacement ratio	Annuitised net wealth
High financial literacy retirees		
Financial_Market_Participation	0.036 (1.47)	0.443*** (8.88)
*Participation * Gender*	0.075** (2.44)	0.030 (0.46)
Observations	1245	1496
High risk-taking retirees		
Financial_Market_Participation	0.074** (2.46)	0.308*** (4.84)

(Continues)

TABLE 4 (Continued)

Panel C: Interaction tests by gender in retiree subsamples with certain characteristics

Variables	Replacement ratio	Annuitised net wealth
*Participation * Gender*	0.026 (0.69)	0.132* (1.69)
Observations	899	1041
Single retirees		
Financial_Market_Participation	0.078*** (3.19)	0.534*** (8.22)
*Participation * Gender*	0.090** (2.14)	0.110 (0.96)
Observations	648	1010

Note: This table presents the regression results for gender differences. Panel A replicates our main analysis (per Table 3) in male and female retiree subsamples, separately. Panel B reports interaction test results by interacting financial market participation with various female retiree characteristics. The full sample is classified into two groups by median values of the respective variables: Age Group = 1 (0) for retirees who are older (younger or equal to) than 73 years; Living Status = 1 (0) if living with a partner (alone); Living Area = 1 (0) if lives in major (other) cities; Education = 1 (0) if has a certificate, diploma or degree (year 12 or below); Employment = 1 (0) if employed (unemployed); Health Status = 1 (0) if healthier (less healthier) than sample median; Financial Literacy = 1 (0) if has higher (lower) financial literacy score than sample median; and Risk Preference = 1 (0) if willing to take higher (lower) risk than sample median. Panel C reports interaction test results between financial market participation and gender in three subsamples: single retirees; high financial literacy retirees; and high-risk preference retirees. OLS is used in Panels B and C as the interaction tests cannot be applied in the ERMs. The rest variable definitions are the same with the main analysis in Table 2, all control variables have been accounted for. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Further, it is intuitive to extend the analysis to determine women with which characteristics are likely to benefit most from post-retirement financial market participation. We then perform interaction analysis by interacting financial market participation with various female retiree characteristics. The results are presented in Table 4 Panel B. Overall, while the main financial market participation variable remains significant in all regressions, we find the effect of post-retirement financial market participation on replacement ratio (i.e., income supplement) is stronger for older and unemployed female retirees compared to the rest of the sample. On the other hand, in terms of wealth accumulation (i.e., annuitised net wealth), the effect is more pronounced for single, unhealthy, and risk averse female retirees. Nevertheless, the interaction tests do not seem to suggest an additional benefit of financial market participation for urban residing, better educated, or more financially literate female retirees, compared to the remainder of the sample.

As another extension, we next investigate whether there are gender differences among retirees with certain characteristics. First, for retirees that are more willing to take on risk and have high financial literacy, therefore typically more likely to invest in financial markets,[29] does post-retirement financial market participation play a different role between male and female retirees?[30] We perform the analysis by interacting the financial market participation and the gender variables in high financial literacy and high risk-taking

[29]For example, the average financial literacy score and the average risk preference score of the direct financial market participants (29% of the sample) are 4.32 and 1.6 respectively, compared to the corresponding scores of 3.98 and 1 for the full sample.

[30]Our proposition is motivated by various studies carried out using HILDA including the following. Preston (2020a) shows that 55% of adult Australian retirees are financially literate, and among them 63% are men and 48% are women. Financial literacy plays an important role in retirement savings. Preston (2020b) concludes that financial literacy is a driver of the wealth difference between males and females. West and Mitchell (2022) find financial literacy improves wealth outcomes in divorce, particularly for women. Cardak and Wilkins (2009) document many non-stockholding households appear to lack the experience and financial literacy that might enable them to benefit from direct investment in stocks. For household risk-taking, West and Worthington (2014) suggest Australians generally reduce their risk tolerance over time, and that individual demographic, socioeconomic, financial characteristics and macroeconomic conditions all jointly relate to risk attitudes. Yao (2011) documents that risk and returns exhibit a known positive relationship in the long-term, and that financial risk-taking can accumulate wealth in good economic situations in Australia.

subsamples. The results are presented in Table 4 Panel C. We find male financial market participating retirees have a higher replacement ratio (by 7.5%) than the rest of the high financial literacy retirees, while they also have higher annuitised net wealth (by 0.14 times) than the rest of the high risk-taking retirees. Second, the RIR report suggests that, while most people enter retirement as a couple, this trend is falling. In future there will be more single people in retirement, particularly women. It is therefore interesting to investigate whether post-retirement financial market participation plays a role to close the gap between single men versus women. We find this is the case in terms of annuitised net wealth, as indicated by the insignificant coefficient of the interaction term. However, single male retirees still benefit more in terms of replacement ratio than other retirees, as shown by the positively significant coefficient of the interaction term. The results in Panels B and C reveal the importance of looking at different financial wellbeing channels for retirees with different backgrounds to fully understand the role of post-retirement financial market participation. Moreover, while Panel A and Panel B results generally support the particular importance of post-retirement financial market participation for female retirees, Panel C results imply that, when controlling for financial literacy, risk-taking and relationship status, male retirees benefit more from post-retirement financial market participation.

4.3.2 | Older versus younger, single versus couple, rural versus urban retirees

Using a similar subsample test to Table 4 Panel A, we replicate our baseline analysis in various subsamples, with the results presented in Table 5. First, in Panel A, we look at how the role of post-retirement financial market participation may differ in older and younger retirees classified by the median age of the sample (73 years). The average financial market participation rates are 27.73% and 30.07% for the younger and older subsamples, respectively. The coefficients on the *Financial_Market_Participation_IV* for the younger and older retiree groups are 0.121 and 0.208, respectively. They are both statistically significant at the 5% level, indicating a strong positive impact of financial market participation on the post-retirement replacement ratio for both retiree groups, and the impact is even greater for the older group. For annuitised net wealth, we find only younger retirees who participate in the financial market have significantly greater annuitised net wealth than those retirees who do not.

These results are consistent with our expectations that younger retirees only benefit from financial market participation through the long-term wealth channel, as younger retirees may still receive income from wages and salaries. Older retirees benefit more than younger retirees from financial market participation through the income channel. As retirees become older, the likelihood of having wage/salary income deteriorates; therefore, income from direct financial market investments supplements regular incomes (i.e., pension) and benefits their post-retirement income sufficiency.

Next, whether or not an individual lives with a partner can influence their wealth and consumption decisions, as well as the decision to participate in financial markets (Arano et al., 2010; Li, 2014). Panel B of Table 5 presents the results from the living status subsample. In this group, 61.07% of retirees live with a partner, and have an average financial market participation rate of 31.90%. Retirees who live alone have a lower average financial market participation rate of 23.85%. Our findings suggest that a participant retiree living with a partner benefits more from financial market participation from both channels, while participants living alone benefit more from the income channel. Living alone requires higher costs of living on a per person basis and our results suggest that, overall, these retirees benefit more from financial market participation.

Third, there are financial pros and cons of living in a major city. People living in a major city will normally face higher living costs but may have easier and greater access to financial

TABLE 5 Subsample test results.

Subsamples	Variables	Replacement ratio	No. of obs	Annuitised net wealth	No. of obs
Panel A: Age groups					
Younger retirees	*Financial_Market_Participation_IV*	0.121** (2.32)	1281	3.032* (1.77)	1421
Older retirees	*Financial_Market_Participation_IV*	0.208** (2.36)	711	0.606 (0.61)	1370
Panel B: Living status groups					
Living with a partner	*Financial_Market_Participation_IV*	0.201*** (3.04)	1475	0.977* (1.83)	1812
Not living with a partner	*Financial_Market_Participation_IV*	0.107** (2.34)	635	2.840 (0.83)	979
Panel C: Living area groups					
Living in a major city	*Financial_Market_Participation_IV*	0.122** (2.39)	1176	1.148 (1.34)	1564
Living in other cities	*Financial_Market_Participation_IV*	0.222*** (3.74)	934	1.595 (1.45)	1227
Panel D: Age pension eligibility groups					
Pension receivers	*Financial_Market_Participation_IV*	0.299** (2.46)	1193	2.386 (1.57)	1717
Non-receivers	*Financial_Market_Participation_IV*	0.132*** (2.66)	917	1.271 (0.37)	1074
Panel E: Homeownership groups					
Homeowners	*Financial_Market_Participation_IV*	0.202*** (3.47)	1832	1.066 (1.47)	2346
Non-homeowners	*Financial_Market_Participation_IV*	0.041 (0.09)	275	0.464 (0.50)	438
Panel F: Wealth distribution groups					
Lower-wealth retirees	*Financial_Market_Participation_IV*	−0.745 (−1.00)	472	1.214 (0.68)	771
Middle-wealth retirees	*Financial_Market_Participation_IV*	0.157** (2.54)	1115	0.541 (1.18)	1426
Higher-wealth retirees	*Financial_Market_Participation_IV*	0.338* (1.75)	523	−2.207 (−0.18)	594
Panel G: Income distribution groups					
Lower-income earners	*Financial_Market_Participation_IV*	0.023 (0.36)	585	1.280 (0.76)	799
Middle-income earners	*Financial_Market_Participation_IV*	0.238** (2.41)	996	2.183 (1.01)	1401
Higher-income earners	*Financial_Market_Participation_IV*	−0.002 (−0.22)	530	−0.393 (−0.29)	591

Note: This table presents the regression results for age, gender, living status, living area, Age Pension eligibility homeownership, wealth distribution, income distribution, financial market investment, financial literacy, and risk preference subsamples. Panel A reports the age groups for younger retirees (65–73 years old) and older retirees (74 years and older). Panel B reports the results for the subsamples of retirees living with and without a partner. Panel C reports the test results for the subsamples of retirees living in major and other cities. Panel D reports the test results for the subsamples of Age Pension receivers and non-receivers. Panel E reports the test results for the subsamples of homeowners and non-homeowners. Panel F reports the test results for the subsamples of lower-wealth (no more than A$465,506), middle-wealth (between A$465,506 and A$1,971,000) and higher-wealth (more than A$1,971,000). Panel G reports the results for the subsamples of lower-income (no more than A$381 weekly), middle-income (between A$381 and A$962 weekly) and higher-income (A$962 weekly). The model and variable definitions are the same with the main analysis in Table 2, all control variables have been accounted for. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

market information. This could have a positive effect on financial market participation. Individuals' decisions could also be influenced through behavioural channels, such as regional risk preferences (Portela Maseda et al., 2019), peer effects through the workplace or neighbourhood (Gerrans et al., 2018; Zhang et al., 2018), and trust and sociability (Georgarakos & Pasini, 2011), which are likely related to their geographical location. Panel C reports the results for our living area subsample. We split our sample into those who live in a major or non-major city. The coefficients on the participation variable are positive and statistically significant for the replacement ratio, and the magnitude of the coefficient is greater for those living in non-major cities – probably explainable by the reduced opportunities to earn income (e.g., part-time work) for retirees in non-major cities. Hence, financial market participation makes a greater difference in this case. However, we find no significant results for the annuitised net wealth in either group, probably due to the reduced sample size.

4.3.3 | Pensioners versus non pensioners, homeowners versus non-homeowners

As the first pillar in the Australian retirement income system, the Age Pension plays a vital role in supporting retirees. However, not all retirees are eligible for public Age Pension in Australia. For example, a retiree must be an Australian resident and have lived in Australia for at least 10 years. Individuals must also pass income and asset tests to receive the public pension. The role of financial market participation could be more important for those who are eligible since they belong to the lower wealth quantile and need to seek retirement income supplements to finance their retirement life due to their limited wealth accumulation. Panel D of Table 5 presents the results for the Age Pension eligibility subsample analysis. Of retirees in our sample, 63.3% receive the Age Pension and 36.7% do not. We find an average stock market participation rate of 19.20% among pension receivers, and 45.3% among non-receivers. This highlights the stronger incentive for non-receivers to save and accumulate more wealth for their retirement security through investing in financial markets. Our results in Table 5 Panel E find that both groups significantly benefit from financial market participation through the income channel, however, pension receivers benefit better than non-receivers. Our results again highlight the importance of encouraging pension receivers (i.e., those with less assets) to participate in the financial market for retirement income security.

A home is often the most important asset held by retirees, and retirement planning is more challenging for those who do not own their homes (Evans & Razeed, 2019; Yates & Bradbury, 2010). In our sample, more than 82% of retirees own their principal residences. We examine whether the role of financial market participation differs for homeowners and non-homeowners. Panel E presents the results. We find homeowners significantly benefit from financial market participation through the income channel (i.e., higher replacement ratio), but not through the wealth channel, as captured by annuitised net wealth. This is probably not surprising as homeownership could actually result in less Age Pension availability as homeowners have a higher threshold for income and assets tests for Age Pension. Therefore, the income supplement function of financial market participation is particularly prominent. However, we find no significant benefit of financial market participation for non-homeowners, which is probably driven by the small sample size for this group.

4.3.4 | Different wealth and income groups

The role of post-retirement financial market participation could vary among retirees positioned at different points along the wealth distribution spectrum. According to the RIR report,

superannuation balances for people approaching retirement are skewed towards higher-wealth households. As a result, lower-wealth and lower-income households may be in most need of financial supplements from, for example, post-retirement financial market participation. However, a competing argument is that lower-wealth and lower-income households may not be able to benefit from post-retirement financial market participation due to their vulnerability to risks associated with financial market fluctuations. We therefore investigate the role of post-retirement financial market participation for higher, middle, and lower wealth and income retirees, separately. Following RIR, lower-wealth retirees are defined as those in the bottom 30% of all retirees, higher-wealth retirees are in the top 20%, and middle-wealth retirees are those in between these two. In our sample, the middle-wealth retirees' household net wealth is between A$465,506 and A$1,971,000. As expected, the participation rates are 9.24%, 28.17% and 60.98% for lower, middle and higher wealth retirees, respectively. This highlights the low participation rate in lower-wealth retirees due to reasons such as low financial literacy and limited access to financial advice. Not surprisingly, in Table 5 Panel F, we find lower-wealth retirees do not benefit significantly from post-retirement financial market participation, while the middle and higher wealth retirees' replacement ratios are 15.7% and 33.8% higher compared to the non-participants.

Similarly, in Panel G of Table 5, we perform the subsample analysis for lower (lower 30%), middle (middle 50%), and higher (top 20%) income earners. The participation rates are 18.32%, 26.20%, and 51.78% respectively. We find that, only for middle income earners, whose incomes are between A$381 and A$961 per week, the replacement ratio is on average higher than non-financial market participants (by 23.5%). Neither lower income or higher income retirees significantly benefit from post-retirement financial market participation. As discussed above, higher income retirees may not have the incentive to participate, while lower income retirees may not be willing to bear the investment risks to their savings.[31] Overall, the participation benefits middle income retirees the most.

5 | ROBUSTNESS TESTS

5.1 | Indirect financial market participation

Retirees can participate in financial markets indirectly via retirement schemes. Although this option tends to be less popular for those already retired, to capture the full picture of financial market participation, we also test the influence from indirect financial market participation. We use the HILDA question regarding retiree's capital investment in any of the following funds; Super Fund, Allocated Pension Fund, Annuity, and Roll-over Fund; to capture their indirect financial market participation. We consider a retiree as an indirect financial market participant if their holding is non-zero in any of the funds. Table 6 Panels A and B replicate our main analysis by using indirect financial market participation instead of direct financial market participation, and combing both direct and indirect financial market participation. In general, we find our main results hold when using the alternative measures for financial market participation. One exception, however, is that, when we combine direct and indirect participation, we find it does not significantly influence the replacement ratio.

[31]We also check the results in this section using retirees who live with their partners, for example middle-income couples rather than middle-income retirees, and all results remain similar. The results are available upon request.

TABLE 6 Direct and indirect financial market participation.

Variables	Replacement ratio	No. of obs	Annuitised net wealth	No. of obs
Panel A: Indirect participation				
Financial_Market__Participation_IV	0.487*** (7.16)	1660	1.550* (1.70)	2325
Panel B: Direct and indirect participation				
Financial_Market__Participation_IV	0.15 (0.17)	2110	1.272* (1.92)	2791

Note: This table presents two alternative measurements for retiree financial market participation to conduct robustness tests for the post-retirement income sufficiency results, measured by retirees' direct financial market participation using an instrumented variable. We only present results in this table for the *Financial_Market_Participation_IV* variable. We include all the control variables (age, gender, living area, employment status, self-rated health, highest education, financial literacy, living status, risk preference, income, and wealth), but do not tabulate them. Panel A presents the results for indirect financial market participation in retirement schemes only, Panel B the results including individual direct and indirect financial market participation. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.2 | Alternative models

Additionally, we use four alternative models to check the robustness of our baseline results. The first model is the standard OLS model to allow transparency without employing instrumental variables, and the second is the standard OLS with a state fixed effect to eliminate the variations between states. Third, we use standard 2SLS. Finally, we follow Adams et al. (2009) and use a three-stage procedure to account for endogeneity and deal with the causality issues. Specifically, Adams et al. (2009) first estimate a binary response model (e.g., probit) of the endogenous covariate (i.e., financial market participation in our case) on the instrument (i.e., the relationship with neighbours). The authors then compute the fitted probabilities from the first stage. Lastly, they estimate the effect of the endogenous covariate by using the fitted probabilities from the second stage as the instrument. This procedure differs from standard 2SLS, since an instrumental variables regression is run in the last step, and not the standard OLS of the outcome variable on the fitted values from the previous step. This procedure also considers the binary nature of the endogenous variable and does not require the binary response model of the first stage to be correctly specified. We present the results in Table 7. The findings are mainly consistent with the baseline results.

5.3 | Alternative retiree samples

Further, we use three alternative retiree samples based on different cut-off ages of retirement to reflect the gradually increasing retirement age in Australia. First, in Table 8 Panel A, we replicate the main regression for those aged 66 years and above. Second, HILDA has a survey question asking for an individual's self-defined retirement status (i.e., some could be doing unpaid work, some could retire early, and some could be eligible for a pension but they consider themselves not retired as they are still in employment), and only those retirees reporting themselves to be retired are included in the alternative sample in Panel B. Panel C includes only those receiving Age Pension or/and employee superannuation. We re-run our main analysis and, in all the alternative samples, the results remain highly consistent with the main findings.

TABLE 7 Alternative models.

Variables	Replacement ratio	No. of obs	Annuitised net wealth	No. of obs
Panel A: OLS				
Financial_Market__Participation	0.083*** (6.41)	2132	0.449*** (15.06)	2837
Panel B: State fixed effect				
Financial_Market__Participation	0.086*** (7.78)	2132	0.432*** (18.14)	2837
Panel C: 2SLS				
Financial_Market__Participation_IV	0.857 (1.20)	2110	1.450* (1.83)	2791
Panel D: Three-step strategy				
Financial_Market__Participation_IV	0.709*** (3.36)	2110	1.273*** (3.52)	2791

Note: This table presents three alternative models to conduct robustness tests for retiree income sufficiency results, measured by post-retirement financial market participation. We only present results in this table for the *Financial_Market_Participation_IV* variable. We include all the control variables (age, gender, living area, employment status, self-rated health, highest education, financial literacy, living status, risk preference, income, and wealth), but do not tabulate them. Panel A presents the OLS regression results, Panel B the results using state fixed effect, Panel C the results from the standard 2SLS and Panel D the results from the three-step strategy following Adams et al. (2009). The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 8 Alternative retiree samples.

Variables	Replacement ratio	No. of obs	Annuitised net wealth	No. of obs
Panel A: Aged 66 years above				
Financial_Market__Participation_IV	0.183*** (3.95)	1933	1.776* (1.75)	2604
Panel B: Reported themselves as fully retired				
Financial_Market__Participation_IV	0.155*** (3.31)	1660	1.468* (1.71)	2326
Panel C: Age Pension or superannuation receivers				
Financial_Market__Participation_IV	0.181* (1.86)	1723	1.866* (1.84)	2317

Note: This table presents the regression results on three alternative retiree samples The regression model and variables are the same with those in Table 2. Panel A presents the results of those aged 66 years and above, Panel B the results among those retirees reported themselves as retired, and Panel C the results of those Age Pension or superannuation receivers. All control variables are included. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.4 | Alternative measures of retiree income sufficiency

Following Bernheim et al. (2001), our baseline analysis for the replacement ratio includes only regular disposable retirement income. In this section, we also use an alternative approach to include any irregular income (e.g., bequests) in calculating the replacement ratio, to conduct a further robustness check. Furthermore, we also use an alternative measure for annuitised net wealth following Haveman et al. (2006), Haveman, Holden, Romanov, and Wolfe (2007) and Haveman, Holden, Wolfe, and Romanov (2007). This method does not involve the calculation of the annuitising factor; rather, it simplifies the calculation by annuitising an individual's total net wealth with their respective remaining life and inflation-adjusted *T*-bill rate in Australia. We then replicate our baseline analysis and present the results in Table 9.[32] As expected, finan-

[32]The first-stage results are presented in the Appendix Table A5. All our instruments are valid.

TABLE 9 Alternative measures for income sufficiency.

	Total_Disposable_Retirement_Income_Replacement_Ratio	*Annuitised net wealth2*
Financial_Market_Participation_IV	0.171*** (3.97)	1.325*** (2.18)
Age	−0.003*** (−2.62)	0.027*** (6.44)
Gender	−0.039*** (−3.11)	0.043 (1.04)
Living_Area	−0.023** (−1.96)	0.128*** (4.11)
Employment_Status	0.122*** (11.22)	0.018 (0.46)
Self-Rated_Health	0.009 (1.45)	0.025 (1.10)
Highest_Education	0.027*** (3.38)	0.082*** (4.16)
Financial_Literacy	0.000 (0.02)	0.018 (0.85)
Living_Status	−0.116*** (−9.04)	−0.153*** (−3.55)
Risk_Preference	0.048*** (4.04)	0.001 (0.02)
Regular_Disposable_Retirement_Income		0.068 (1.24)
Household_Net_Wealth	0.030*** (6.58)	
Constant	0.594*** (5.98)	8.126*** (19.94)
Observations	2110	2790

Note: This table presents the regression results for alternative retiree income sufficiency calculations. The replacement ratio includes the irregular income in disposable retirement income. Annuitised individual net wealth is the overall net wealth annuitised based on the remaining life expectancy and inflation-adjusted *T*-bill rate following Haveman, Holden, Romanov, and Wolfe (2007) and Haveman, Holden, Wolfe, and Romanov (2007). All the rest remain the same as in Table 2. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

cial market participation significantly increases the replacement ratio and annuitised net wealth. This is even more so when we include irregular income and use a different method to calculate annuitised net wealth.[33]

5.5 | Subjective financial wellbeing

The replacement ratio and annuitised net wealth measure retirees' financial wellbeing objectively. Another strand of literature focuses on retirees' self-rated subjective financial wellbeing (Barrett & Kecmanovic, 2013; Shams, 2016). For example, using subjective measures, Alan et al. (2008) find that Canadian retirees are more satisfied with their finances than they were before their retirement. Yen (2018) studies subjective retirement replacement rates and subjective feelings of income sufficiency in the United Kingdom. The author concludes that retirees who have defined contribution plans feel more insecure about their retirement during times of fluctuating financial markets. Xue et al. (2019) document that elderly Australians' subjective financial wellbeing is improved through knowledge of financial literacy and non-essential consumption (e.g., alcohol, tobacco, gifts, and donations).

On the other hand, Bond and Lang (2014, 2019) suggest that subjective wellbeing measures might not be accurate, because individuals' subjective feelings are not directly comparable, and their benchmarks could be different. Nevertheless, in our context, levels of subjective and objective financial wellbeing could be quite different due to reasons such as lack of financial literacy or behavioural biases. Therefore, it is still interesting to investigate whether financial market participation improves individuals' financial wellbeing in a subjective dimension. We

[33]In the untabulated results (available upon request), the same conclusion holds for both of the alternative measures above, if we run OLS without using any instrumental variable.

use two subjective measures from the survey. The first is the survey question that asks retirees to rate their level of satisfaction with their financial situation, with scores ranging from zero to ten, indicating total dissatisfaction through to total satisfaction. The second measure is the survey question that asks participants to rate how well their current needs and financial responsibilities are met, using a scale from one to six, with one meaning very poor and six meaning prosperous. We then re-run our baseline model as in subsection 4.2, with the results presented in Table 10. Our results suggest that financial market participation positively affects the two subjective post-retirement financial wellbeing measures for Australian retirees, and the results are statistically significant. This is consistent with our baseline results when using objective measures for post-retirement income sufficiency, again indicating that our baseline results are robust.[34]

6 | CONCLUSION

This paper uses data from Australia to examine the relationship between retirees' income sufficiency and post-retirement financial market participation. Our results show a significant positive relationship between the two, in that financial market participation enhances retirees' short-term income replacement ratio and long-term wealth accumulation, which are described by the replacement ratio and annuitised net wealth measures, respectively. These measures are specifically designed to capture retirees' financial wellbeing, by taking into account the critical planning horizon (life expectancy) and various sources of income.

Further analysis reveals that retirees' characteristics play a role in improving post-retirement financial wellbeing through financial market participation. Specifically, we find retirees who are older, male, living with a partner, living in a non-major city, eligible for a public pension,

TABLE 10 Subjective financial wellbeing results.

	Subjective financial wellbeing Measure 1	Subjective financial wellbeing Measure 2
Financial_Market_Participation_IV	1.315*** (17.61)	1.264*** (9.96)
Age	0.015*** (4.42)	0.012*** (3.39)
Gender	−0.071* (−1.65)	−0.063 (−1.35)
Living_Area	−0.146*** (−3.36)	−0.115*** (−2.61)
Employment_Status	−0.111*** (−2.76)	−0.034 (−0.75)
Self-Rated_Health	0.150*** (6.43)	0.191*** (7.17)
Highest_Education	−0.011 (−0.38)	0.098*** (3.21)
Financial_Literacy	−0.027 (−1.64)	−0.015 (−0.84)
Living_Status	0.140*** (3.02)	0.184*** (3.65)
Risk_Preference	−0.080** (−2.00)	0.033 (0.70)
Regular_Disposable_Retirement_Income	0.163*** (4.44)	0.148*** (3.52)
Household_Net_Wealth	0.009 (0.49)	0.152*** (6.19)
Observations	2795	2771

Note: This table presents the regression results for two alternative measures of subjective financial wellbeing. The first measure is the level of satisfaction with one's financial situation, and the second measure is financial life satisfaction considering financial needs and responsibilities. The model and all the control variables are the same as in our main analysis per Table 2. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[34]The first-stage results are presented in Appendix Table A6. All our instruments are valid.

and are homeowners benefit more from financial market participation through the short-term income replacement channel. This could be because these retirees typically face a greater drop in post-retirement income or have higher short-term funding needs. However, for younger and female retirees, and for retirees who are living with a partner, they accumulate greater long-term wealth from participating in financial markets. Importantly, our study accounts for endogeneity issues using instrumental variables. We also use various financial market participation measures, alternative models and samples, and different measures of income sufficiency to confirm the robustness of our results.

This study documents a critical issue relating to post-retirement income sufficiency and financial market participation. The traditional retirement planning concept largely focuses on participation in financial markets while at working age to secure post-retirement income sufficiency. For example, Coile and Milligan (2009) show retired households tend to reduce risky asset holdings and are in favour of cash deposits. Spicer et al. (2016), using HILDA, suggest that older households prefer portfolios with less risk and more liquidity. Other studies such as Basu and Drew (2009) and Gerrans et al. (2010) also document similar evidence in Australia.

Our results, different from previous studies, highlight the importance of (continuous) post-retirement financial market participation, especially with the current concerns regarding an ageing population and decreased public support for retirement. Our results, therefore, have important policy implications and provide strong evidence for the Australian government's initiative to promote financial literacy. The results also have implications for practitioners in the financial services industry. We could see an increasing demand for innovative financial products which balance between the need of post-retirement investment and risk management, for example, tailored glide-path investing products that allow for retiree-specific target risk level or a target retirement date. For financial advisers, financial planners, and financial educators, it highlights there is not a one-size-fits-all approach for retirement portfolio management. It is vital that they assist clients by constantly monitoring the dynamic risk exposure (e.g., longevity risk, investment risk, and macroeconomic risk) to determine the appropriate proportion of retiree's wealth invested in different asset classes.

Last, but certainly not least, we acknowledge several limitations of our work, mainly driven by data availability. When more micro-level observations become available, they could allow for fruitful new findings in the field. First, as discussed above, dynamic managing, and monitoring the proportion of a retiree's wealth invested in different financial assets is probably the key driver to ensure post-retirement investment success. For example, in our sample which is cross-sectional as of 2018, the mean and median proportions are 1.6% and 8.0%, respectively. It could be insightful to learn how these numbers change over time with retiree characteristics when longitudinal data is available. Second, possibly due to the relatively low level of financial market participation among retirees, we do not have enough information to study whether investment income from different sources and the concentration of investment types could lead to differed outcomes for retirees.

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DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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APPENDIX 1

TABLE A1 Variable definitions.

Variable	Description	Observations
Replacement Ratio	Regular Disposable Retirement Income Replacement Ratio = Weekly Regular Disposable Retirement Income/ Weekly Pre-retirement Median Earnings by Industry and Gender	2477
Weekly Regular Disposable Retirement Income	Weekly regular disposable retirement income includes wages and salary, business income, investment income, private pension, private transfer, and Australian public transfers after taxes in the 2018 survey Weekly Regular Disposable Retirement Income = Financial Year Regular Disposable Income/52 Weeks	3527
Weekly Pre-retirement Disposable Median Income	Weekly Pre-retirement Disposable Median Income by industry and gender after taxes in May 2018 according to ANZSIC 2006 from the Australian Bureau of Statistics. Retirees' pre-retirement industries are obtained from the 2001 to 2018 surveys. Pre-retirement industry and gender are combined to match median gender earnings in each industry in Australia in May 2018, and these earnings were taxed under 2018 Australian income tax rules	2477
Annuitised Net Wealth (following Love et al., 2009)	Household's overall net wealth multiplied by the annualising factors. The natural logarithm of the annuitised net wealth is the final value for this variable	3522
Annuitised Net Wealth2 (following Haveman et al., 2006; Haveman, Holden, Romanov, & Wolfe, 2007; Haveman, Holden, Wolfe, & Romanov, 2007)	Individual's overall net wealth annuitised based on the remaining life expectancy and the discount rate (inflation-adjusted *T*-bill rate in 2018). The natural logarithm of the annuitised net wealth is the final value for this variable	3521
Financial Market Participation	Dummy variable, direct financial market participation = 1, non-participation = 0 Survey question: During the last financial year (from July 1, 2017, to June 30, 2018), did you receive any income or dividends from these types of investments? (Investment type: company shares, managed funds, property trusts)	3333
Financial Market Amount	The amount of investment in company shares, managed funds and property trust	960
Subjective Financial Wellbeing (measure 1)	Retirees' self-rated level of satisfaction toward their financial situation, ranging from 0 (totally dissatisfied) to 10 (totally satisfied)	3351
Subjective Financial Wellbeing (measure 2)	Survey question: Given your current needs and financial responsibilities, would you say that you and your family are very poor = 1, poor = 2, just getting along = 3, reasonably comfortable = 4, very comfortable = 5, or prosperous = 6	3100
Age	Individuals were 65 years or older on June 30, 2018	3527
Gender	Dummy variable, male = 1, female = 0	3527
Living Area	Living in a major city = 1, living in other cities = 0 Classified according to the 2001 Australian Statistical Geographical Classification	3527

TABLE A1 (Continued)

Variable	Description	Observations
Employment Status	Not working = 1, working less than 35 hours per week = 2, working more than 35 hours per week = 3	3524
Self-rated Health	Survey question: In general, would you say your health is poor = 1, fair = 2, good = 3, very good = 4, or excellent = 5	3084
Highest Education	The highest education level achieved by 2018, with year 12 or below = 1, certificate or diploma = 2, and university degree = 3	3360
Financial Literacy	The number of correct answers for five typical financial literacy questions regarding inflation, compounding, and diversification, ranging from 0 to 5 in the 2016 financial literacy section. These five questions are the following: 1. An investment with a high return is likely to be high risk. (True or false?) 2. Buying shares in a single company usually provides a safer return than buying shares in a number of different companies. (True or false?) 3. Suppose you put A$100 into a no-fee savings account with a guaranteed interest rate of 2% per year. You don't make any further payments into this account and you don't withdraw any money. How much would be in the account at the end of the first year, once the interest payment is made? 4. Imagine now that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, would you be able to buy more than today, exactly the same as today, or less than today with the money in this account? 5. Suppose that by the year 2020 your income has doubled, but the prices of all of the things you buy have also doubled. In 2020, will you be able to buy more than today, exactly the same as today, or less than today with your income?	3193
Living Status	Dummy variable, living with a partner = 1, otherwise = 0 This variable is from the following three survey questions: 1. Which of these bests describes your current marital status? And by "married", we mean in a registered marriage [1] Married (in a registered marriage), [2] separated, but not divorced, [3] divorced, [4] widowed, [5] never married but living with someone in a relationship, [6] never married and not living with someone in a relationship If the answer is 1, the next question is asked. If the answer is 2, 3, or 4, the third question is asked 2. Which of the following best describes your current living circumstances? [1] Married and living with spouse, [2] married, but spouse is in an institution (e.g. nursing home, goal), [3] married, but living with spouse less than half the time owing to work/other commitments 3. Are you currently living with someone in a relationship? [1] Yes [2] No If the answer for the first question is 1 and the second question is 1 or 3, the value for "living status" is assigned as 1. If the first question is 5, this value is assigned as 1 as well. If the answer in the first question is 2, 3, or 4 and the answer for the third question is 1, this value is assigned as 1. All the remaining answers are assigned as 0	3359

(Continues)

TABLE A1 (Continued)

Variable	Description	Observations
Risk Preference	A value of 1 to 4 is assigned, depending on two questions in the survey, where no risk = 1, average risk = 2, above-average risk = 3, and substantial risk = 4. These two survey questions are as follows 1. Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash, that is, cash used for savings or investment? [1] I take substantial financial risks, expecting to earn substantial returns, [2] I take above-average financial risks, expecting to earn above-average returns, [3] I take average financial risks, expecting to earn average returns, [4] I am not willing to take any financial risk, or [5] I never have any spare cash If the answer is 5 or missing for the first question, then the answer to the next question is the final answer 2. Assume you had some spare cash that could be used for savings or investment. Which of the following statements comes closest to describing the amount of financial risk that you would be willing to take with this money? [1] I take substantial financial risks, expecting to earn substantial returns, [2] I take above-average financial risks, expecting to earn above-average returns, [3] I take average financial risks, expecting to earn average returns, or [4] I am not willing to take any financial risks	3038
Household Net Wealth	Household Net Wealth = Total Household Assets – Total Household Debts Total household assets: balances on joint, individual, and children's bank accounts and the value of superannuation, business assets, cash and equity investments, collectibles, home assets and other property assets, life insurance, trust funds, and vehicles Total household debts: student loans, joint credit cards, individual credit cards, other personal debt, business debt, home debt, other property debt, and overdue household bills	3527
Age Pension Eligibility	Dummy variable, Age Pension receiver = 1, non-Age Pension receiver = 0	3359
Instrumental Variable: *Neighbourhood_Relationship*	Survey question: people in this neighbourhood generally do not get along with each other. Rank from strongly disagree to strongly agree from 1 to 7	3079

Note: This table presents the descriptions of each variable and related questions in the 2018 HILDA survey. The sample comprises retirees aged 65 years and above, and there are 3527 observations overall.

TABLE A2 Annualising factors for singles and couples.

	Annualising factors		
Age of head	**Couple**	**Single male**	**Single female**
65	0.0349	0.0559	0.0509
66	0.0364	0.0583	0.0529
67	0.0370	0.0587	0.0550
68	0.0392	0.0614	0.0573
69	0.0404	0.0644	0.0579
70	0.0423	0.0678	0.0605
71	0.0439	0.0683	0.0633
72	0.0462	0.0721	0.0664
73	0.0488	0.0764	0.0699
74	0.0517	0.0813	0.0738
75	0.0529	0.0821	0.0749
76	0.0562	0.0878	0.0794
77	0.0601	0.0944	0.0845
78	0.0632	0.0955	0.0903
79	0.0663	0.1033	0.0920
80	0.0716	0.1127	0.0988
81	0.0759	0.1143	0.1068
82	0.0801	0.1256	0.1091
83	0.0853	0.1278	0.1188
84	0.0938	0.1418	0.1304
85	0.0952	0.1446	0.1336
86	0.1075	0.1625	0.1479
87	0.1114	0.1658	0.1518
88	0.1248	0.1893	0.1699
89	0.1294	0.1934	0.1746
90	0.1469	0.2255	0.1981
91	0.1519	0.2300	0.2034
92	0.1662	0.2348	0.2348
93	0.1714	0.2403	0.2403
94	0.1863	0.2860	0.2464
95	0.2052	0.2915	0.2915
96	0.2112	0.2980	0.2980
97	0.2177	0.3052	0.3052
98	0.2247	0.3132	0.3132
99	0.2674	0.3845	0.3845
100	0.3502	0.5309	0.5309

TABLE A3 First-stage results – financial market participation versus retirement income sufficiency.

	Stage 1 results for the replacement ratio *Financial_Market_Participation*	**Stage 1 results for annuitised net wealth *Financial_Market_Participation***
Financial_Market_Participation_IV	−0.036* (−1.66)	−0.013** (−2.45)
Age	0.027*** (4.90)	0.006*** (4.76)
Gender	−0.063 (−0.98)	−0.048*** (−2.66)
Living_Area	−0.037 (−0.61)	0.032* (1.92)
Employment_Status	−0.103* (−1.77)	−0.046** (−2.40)
Self-Rated_Health	0.030 (0.90)	0.028*** (3.03)
Highest_Education	−0.026 (−0.65)	0.015 (1.23)
Financial_Literacy	0.072** (2.56)	0.029*** (4.54)
Living_Status	−0.122* (−1.78)	0.053*** (2.91)
Risk_Preference	0.286*** (5.17)	0.140*** (7.70)
Regular_Disposable_Retirement_Income		0.085*** (3.84)
Household_Net_Wealth	0.244*** (8.95)	
Constant	−3.188*** (−6.80)	−0.562*** (−4.95)
Observations	2110	2791

Note: This table reports the first-stage relation between the *Financial_Market_Participation* and the *Financial_Market_Participation_IV* (neighbourhood relationship) for the main results in Table 2. All the control variables are the same as in the baseline analysis. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE A4 First-stage results – financial market investment versus retirement income sufficiency.

	Stage 1 results for the replacement ratio *Financial_Market_Amount*	**Stage 1 results for annuitised net wealth *Financial_Market_Amount***
Financial_Market_Amount_IV	−0.977* (−1.88)	−0.725** (−1.98)
Age	6.403*** (2.59)	3.282*** (5.13)
Gender	12.388 (0.46)	−27.877*** (−2.91)
Living_Area	−48.063* (−1.72)	−3.819 (−0.42)
Employment_Status	−79.322*** (−2.83)	−55.607*** (−4.02)
Self-Rated_Health	2.681 (0.18)	−5.061 (−0.99)
Highest_Education	6.168 (0.30)	5.467 (0.69)
Financial_Literacy	8.998 (0.64)	6.638** (2.50)
Living_Status	−117.922*** (−2.92)	0.903 (0.09)
Risk_Preference	78.179*** (2.61)	46.165*** (3.66)
Regular_Disposable_Retirement_Income		126.897*** (4.06)
Household_Net_Wealth	101.171*** (8.17)	
Constant	−504.434*** (−2.35)	−278.524*** (−4.94)
Observations	665	819

Note: This table reports the first-stage relation between the *Financial_Market_Amount* and the *Financial_Market_ Participation_IV* (neighbourhood relationship) for the main results in Table 3. All the control variables are the same as in the baseline analysis. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE A5 First-stage results – alternative measures for income sufficiency.

	Stage 1 results for the replacement ratio *Financial_Market_Participation*	**Stage 1 results for annuitised net wealth *Financial_Market_Participation***
Financial_Market_Participation_IV	−0.035 (−1.64)	−0.013*** (−2.45)
Age	0.027*** (4.90)	0.006*** (4.77)
Gender	−0.063 (−0.98)	−0.048*** (−2.68)
Living_Area	−0.038 (−0.63)	0.033* (1.93)
Employment_Status	−0.103* (−1.77)	−0.047** (−2.40)
Self-Rated_Health	0.031 (0.91)	0.028*** (3.03)
Highest_Education	−0.027 (−0.66)	0.015 (1.26)
Financial_Literacy	0.071** (2.55)	0.029*** (4.53)
Living_Status	−0.122* (−1.78)	0.053*** (2.92)
Risk_Preference	0.286*** (5.17)	0.140*** (7.71)
Regular_Dispasable_Retirement_Income		0.085*** (3.84)
Household_Net_Wealth	0.244*** (8.91)	
Constant	−3.187*** (−6.81)	−0.564*** (−4.97)
Observations	2110	2790

Note: This table reports the first-stage relation between the *Financial_Market_Participation* and the *Financial_Market_Participation_IV* (neighbourhood relationship) for the alternative measures in Table 8. All the control variables are the same as in the main analysis. The *t*-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE A6 First-stage results – subjective financial wellbeing measures.

	Stage 1 results for Measure 1 *Financial_Market_Participation*	**Stage 1 results for Measure 2 *Financial_Market_Participation***
Financial_Market_Participation_IV	−0.065*** (−4.13)	−0.062*** (−3.72)
Age	0.019*** (4.76)	0.018*** (4.59)
Gender	−0.069 (−1.24)	−0.074 (−1.31)
Living_Area	0.021 (0.42)	0.027 (0.51)
Employment_Status	−0.130** (−2.22)	−0.146** (−2.44)
Self-Rated_Health	0.071** (2.48)	0.070** (2.43)
Highest_Education	−0.018 (−0.50)	−0.020 (−0.54)
Financial_Literacy	0.070*** (3.17)	0.088*** (3.91)
Living_Status	−0.009 (−0.15)	−0.014 (−0.24)
Risk_Preference	0.306*** (6.20)	0.286*** (5.61)
Regular_Disposable_Retirement_Income	0.061 (1.14)	0.063 (1.08)
Household_Net_Wealth	0.233*** (8.63)	0.245*** (8.11)
Constant	−2.840*** (−7.78)	−2.848*** (−7.69)
Observations	2795	2771

Note: This table reports the first-stage relation between *Financial_Market_Participation* and the *Financial_Market_Participation_IV* for the subjective financial wellbeing measures in Table 9. Measure 1 is the retiree's level of satisfaction toward his or her financial situation, and measure 2 is the retiree's self-rated financial situation satisfaction considering financial needs and responsibilities. All the control variables are the same as in the main analysis. The *t*-statistics are in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.