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Gender, Financial Literacy and Pension Savings*

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The relationship between the gender gap in financial literacy and pension savings is examined in this paper. In Australia, individuals have considerable discretion with respect to how their pension savings are managed. We argue that financial literacy should have a positive impact on the profitability of these decisions. Analysis based on micro-data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey suggests that a sizable share of the gender gap in pension savings can be attributed to the gender gap in financial literacy. Therefore, policies aimed at improving the financial literacy of women should help improve the living standards of women in retirement.

I Introduction

In high-income countries, population ageing and rising dependency ratios have brought into question the sustainability of public pension systems and private-sector defined-benefit pension schemes (European Commission, 2018; Feng, 2018). One partial response to this has been the introduction of, and shift to, defined-contribution pension plans, where individuals are responsible for ensuring they have sufficient pension savings for their retirement. In countries such as the UK, the US and Australia most pension savings are now held in defined-contribution plans. In such plans, savings are predominantly driven by employee and employer contributions as well as investment returns and investment shocks.

The consensus is that the growth in the coverage of defined-contribution pension plans has the potential to improve income adequacy in retirement. The growth in such arrangements may, however, exacerbate gender differences in retirement incomes as, relative to men, women (on average) have lower lifetime earnings and, therefore, make lower contributions over their working life (Jefferson & Preston, 2005; Bardasi & Jenkins, 2010; Austen & Mavisakalyan, 2018; Dobrescu *et al.*, 2018; Feng *et al.*, 2019). Of particular concern is the size of the gender gap in pension savings amongst non-retired adults. In Australia, for example, the latter was 62 per cent in 2018 (Preston & Wright, 2022) (Table 1). A large gender gap in pension savings and

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[Correction added on 19 December 2022, after first online publication: The percentage numbers has been changed]

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retirement benefits is observed in higher income countries (OECD, 2019). There is, accordingly, growing interest in the extent and cause of such a gap. Understanding the source is important for the design of policy aimed at improving women's economic and financial well-being in retirement.

This paper explores the potential role that financial literacy plays in understanding the gender gap in pension savings. Financial literacy may affect pension savings through decisions such as choice of fund, portfolio allocations, the purchase of health and life insurance products, contribution rates and drawdown decisions. As a mechanism, financial literacy is of particular interest since, in most countries, there is a sizeable gender gap in financial literacy with women (on average) less financially literate than men (Hasler & Lusardi, 2017). It is reasonable to hypothesise that the gender gap in financial literacy may be a potential determinant of the gender gap in pension savings, with empirical analysis needed to establish its importance.

To empirically examine this hypothesis, individual-level data are used that were collected in the Household, Income and Labour Dynamics in Australia (HILDA) survey for a sample of adults aged 18–64 years in 2018. As a case study Australia is of considerable international interest for several reasons. The first is that, within Australia, around 90 per cent of adults aged 18–64 years have some pension (superannuation) savings (mostly in defined-contribution accounts), largely because of a system that mandates that employers contribute to pension accounts on behalf of employees. The second is that, compared with pension systems elsewhere, there are a multitude of decisions that individuals may make within Australia's pension (superannuation) system that may affect their pension savings and total accumulation (savings) at retirement. The third is that there is a large gender gap in the pension savings of non-retirees in Australia. The fourth is that, in international comparisons, Australia has a high level of

TABLE 1
Financial Literacy of Adults Who Are Not Retired, Australia, 2018

	(1) Males	(2) Females	(3) Gap (1)–(2)	(4) %Gap (3)/(2) × 100
Q1: Interest rate: Suppose you put $100 into a no-fee savings account with a guaranteed interest rate of 2 per cent per year. You do not make any further payments into this account and you do not withdraw any money. How much would be in the account at the end of the first year, once the interest payment is made?	91.6%	82.3%	9.3% points	11.3%
Q2: Inflation: Imagine now that the interest rate on your savings account was 1 per cent per year and inflation was 2 per cent 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?	76.0%	61.4%	14.6% points	23.8%
Q3: Diversification: Buying shares in a single company usually provides a safer return than buying shares in a number of different companies. [True, False]	77.4%	74.5%	2.9% points	3.9%
Q4: Risk: An investment with a high return is likely to be high risk. [True, False]	87.7%	78.3%	9.4% points	12.0%
Q5: Money Illusion: 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?	80.8%	80.2%	0.6% points	0.7%

Notes: Sample is aged 18–64 years, not retired, living in private dwellings. $N = 11{,}217$ ($N_M = 5{,}410$ males and $N_F = 5{,}807$ females). Estimates are weighted to reflect population totals.
Source: Household, Income and Labour Dynamics in Australia (HILDA) Survey.

financial literacy. However, it also has a large gender gap in financial literacy (Preston & Wright, 2019). The fifth is that HILDA is a large sample, nationally representative, individual-level data set that contains detailed information relating to pension savings, financial literacy and socio-economic/demographic characteristics.

The remainder of this paper is organised as follows. Section II reviews the studies concerned with the relationship between financial literacy and pension savings. Much of this research has been concerned with financial literacy and pension planning, with few studies focusing on financial literacy and actual pension savings. Section III provides a brief overview of the Australian pension system. Section IV presents a theoretical model aimed at guiding the empirical analysis. The model implies two empirical specifications that may be estimated as regression equations with individual-level data. The first is a reduced-form specification where financial literacy is included as an explanatory factor. The second is a more structural specification, where financial literacy is related to the 'pension return', measured as the ratio of pension savings to cumulative earnings. Section V describes the data and outlines the econometric approach. Results are presented in Section VI. Conclusions follow in Section VII.

The analysis suggests that there is a positive, statistically significant and robust relationship between financial literacy and pension savings for both males and females. In addition, a positive relationship is found between financial literacy and the pension return for both males and females. We interpret this as support for the mechanism that more financially literate individuals (regardless of sex) make more profitable decisions relating to the management of their pensions. Most importantly, an Oaxaca–Blinder decomposition indicates that a sizable share (around 8.5 per cent) of the gender gap in pension savings may be attributed to the gender gap in financial literacy. The analysis suggests that policies that close the gender gap in financial literacy, by improving the financial literacy of women, will likely close the gender gap in pension savings, and subsequently improve the income and living standard of women in retirement.

II Previous Research

A key characteristic of pension reforms around the world is the shifting of responsibility for retirement saving from the state to the individual. Globally this has seen a growth in defined-contribution plans and, in some countries, an extension of pension coverage through legal mandates whereby employees (employers) are required to contribute a portion of wages received (paid) into a pension account. While the growth in defined-contribution arrangements may improve income adequacy in retirement, a particular concern with such developments is that those with discontinuous work histories, atypical employment (e.g., part-time, casual, self-employed) and low earnings power may be unable to accumulate sufficient funds for their retirement, and thus face poverty and income inequities in retirement. Given these concerns, there is a growing body of research examining the pension outcomes of at-risk groups. Considerations include the design of pension systems, coverage, taxation arrangements, replacement rates, relative pension benefits, well-being, *etc*. Examples of recent papers and reports include OECD (2019), PC (2018), Australian Government (2020), Della Giusta and Longhi (2021) and Evans and Pienknagura (2021).

Studies of the gender gap in the incomes of retirees suggest sizeable male–female differences in retirement benefits. In the EU, for example, the average pension income gap is around 25 per cent amongst 65-year-olds; in countries such as the Netherlands and Germany it is closer to 40 per cent (OECD, 2019). A number of studies attribute the gap to part-time work (linked to gendered division of market and care work), with mothers, in particular, facing a steep 'pension penalty' (Bettio *et al*., 2013; Möhring, 2015). However, the source of the gap extends beyond motherhood and part-time work. Kuivalainen *et al*. (2020) using Finnish administrative data from 2011 shows that much of the gender gap in the pensions of retirees' relates to earnings differences arising from occupational segregation during the accumulation phase. In Finland career breaks do not lead to breaks in pension accumulation rights and thus have less of an effect on the gender gap in retirement benefits.

As with Kuivalainen *et al*. (2020), Bonnet *et al*. (2022) using French administrative data (for 2012) also show that gender differences in wage levels and contribution periods predominantly drive the gender gap in retirees' pensions. Their distributional analysis by sector (private and public) points to particularly pronounced gender gaps in pensions at the bottom of the distribution

of private sector pensions. In Ireland the situation is different with gender gaps in retiree pension income largest at the top of the distribution (this study does not disaggregate by sector) (Nolan *et al*., 2019). The main factor explaining the latter appears to be gender differences in years of work experience. At the bottom of the Irish distribution the gender gap is also affected by factors such as living arrangements and migrant status (Nolan *et al*., 2019).

While much of the discussion thus far has focused on the gender gap in the income of retirees, analysis based on younger cohorts suggests that the drivers of pension gaps during the accumulation phase are similar. Feng *et al*. (2019), for example, use administrative data from a pension fund in Australia to track age cohorts over time and examine the cumulative effects of labour market status on retirement savings. They show that substantial gender gaps in pension savings occur in the early phase of paid working life (due to career breaks, part-time work and gaps in contribution records) and that this affects future income in an adverse way. They also show that while a return to full-time paid work in later life may have a positive effect on savings, the '. . .damage in terms of foregone wages and associated retirement savings in their own account has already been done, and women's balances are much lower' (p. 166). Best and Saba (2021) also emphasise the enduring effect of the gender gap in pension savings over the accumulation phase.

The extensive literature on savings behaviour also suggests that decisions about pension savings may be affected by factors such as framing effects, the design of the pension system and default settings (Card & Ransom, 2011; Dobrescu *et al*., 2018; Hastings & Mitchell, 2020; Clark & Pelletier, 2022), interest in pension affairs (Bateman *et al*., 2014; Debets *et al*., 2022), risk, time preferences and patience (Charness & Gneezy, 2012; Arrondel *et al*., 2013; Choi *et al*., 2014; Fernández-López *et al*., 2015; Hastings & Mitchell, 2020; Best & Saba, 2021), locus of control (Cobb-Clark *et al*., 2016), confidence levels (Angrisani & Casanova, 2021); household decision-making roles (Bucher-Koenen *et al*., 2017), cognitive and decision-making abilities (Bateman *et al*., 2012; Choi *et al*., 2014), financial literacy (Lusardi & Mitchell, 2007, 2011; Behrman *et al*., 2012; Agnew *et al*., 2013; Brown & Graf, 2013; Boisclair *et al*., 2017; Dahlquist *et al*., 2017; Hastings & Mitchell, 2020) and trust (e.g. in financial institutions) (Burke & Hung, 2021). Gender differences in pension savings may, therefore, stem from gender differences in one or more of these characteristics.

A consistent finding in the literature is that women, on average, are less financially literate than men (Fonseca *et al*., 2012; Lusardi & Mitchell, 2014; Hasler & Lusardi, 2017; Cupák *et al*., 2018; Preston & Wright, 2019). In most countries financial literacy is shown to have an inverse 'U'-shape, suggesting that it is lower amongst the young and the old than it is amongst prime aged adults. Gender gaps in financial literacy prevail across the life-course and have been shown to be particularly large amongst young adults (Preston & Wright, 2019). Gender differences in pension savings may, therefore, stem from gender differences in financial literacy. During the accumulation phase of a defined-contribution pension plan, financial literacy may affect the gender gap in pension savings through several channels, including decisions relating to: the choice of pension fund; choice of investment strategy (e.g., balanced, high growth *etc*.) within the pension fund (assuming choice permitted); contributions; life insurance *etc*. Moreover, if gender gaps in financial literacy contribute to gender differences in choice of fund, investment strategy, contributions *etc*. when young, it could be that these decisions serve to magnify the gender gap in pension savings in later years. Empirical research is required to examine these considerations.

III Australian Retirement Income System

The Australian retirement income system has been described in detail elsewhere (Gerrans, 2012; Bateman *et al*., 2014; Dobrescu *et al*., 2018; Feng *et al*., 2019; Kingston & Thorp, 2019; Preston & Wright, 2022). In brief, it is comprised of three pillars: (1) a means tested, universal, public pension (Age Pension) safety net; (2) a system of mandatory employer pension contributions (known as Superannuation Guarantee (SG) contributions); and (3) pre- and post-tax voluntary contributions into pension funds and other private savings. Most contributions within the system are under the second pillar and most are into defined-contribution accumulation funds. Pillar (2) is underpinned by the 1992 Superannuation Guarantee Act which mandates that employers

contribute a portion of each employee's ordinary time earnings into a pension account. Those not covered by the mandatory provisions include workers on government funded paid parental leave payments, those under 18 years of age and those not classified as employees (e.g., independent contractors and the self-employed). The preservation age in most pension plans is 60 years if born after 1 July 1964 (and between 55 and 60 years for those born earlier). Pension coverage in Australia is high. Around 92 per cent of adult males and 90 per cent of adult females have some pension savings (Preston & Wright, 2022).

When compared with pension arrangements in other countries, the Australian pension system offers considerable choice. Indeed, it is the scope of decisions that individuals may make which makes the Australian system somewhat unique. Also of note is the relative ease with which these decisions may be made – most may be made online without prior agreement or permission by the fund and with minimal cooling off time. Individuals may make decisions with respect to the type of fund (retail, industry, *etc*.) and, having made this decision, may then choose which specific fund to save with (e.g., out of a set of 63 industry funds, 48 are open; Ooi, 2021) and the product option (e.g., whether or not to invest in a product with default settings). Decisions may also be required with respect to account consolidation following a change of jobs, although going forward this may reduce. Recent reforms now enable accounts to follow individuals as they change jobs.

Other decisions include the purchase of linked products (e.g., health and life insurance) and the frequency and level of voluntary contributions. In deciding on voluntary contributions individuals must decide whether to make them pre- or post-tax. Related decisions concern contribution limits and how to optimise tax concessions and incentives (if eligible). Decisions may also be made with respect to early drawdowns. The grounds for early access include incapacity, terminal medical condition, compassionate grounds for the individual or a dependant, and financial hardship. First home buyers may access their pension savings (limited to their voluntary contributions) to assist with the purchase of their first home. Older individuals may use their pension savings to fund a phased retirement, where the final years of employment are a mix of pension payments and earnings from employment. Individuals also have the option privately managing their retirement savings through a 'self-managed super fund' (SMSF).

Allowing people discretion with respect to financial decisions does not mean that they will necessarily make sound financial decisions (Gerrans, 2012). The direction and magnitude of the relationship between financial literacy and pension savings is, therefore, an empirical question. It may be the case that more financially literate individuals make more decisions and that these decisions are, on average, profitable decisions. Dobrescu *et al*. (2018), for example, demonstrate that those making an active choice (i.e., not remaining with the default option) achieve substantial increases in pension savings. Likewise, it may be that more financially literate individuals make fewer decisions and hence lower the risk of making a bad decision.

IV Model

In order to inform the specification of the empirical analysis, a simple theoretical model, relevant to Australian retirement income system is outlined in this section. At the centre of this system is a defined-contribution component, which may be expressed as:

$$S_s = \rho(w \cdot t) \tag{1}$$

where S_s is an individual's pension (superannuation) savings after t years of work; w is average (employment) earnings after t years of work; and $w{\cdot}t$ is cumulative earnings after t years of work. This expression states that an individual's pension savings is proportional to their average earnings weighted by the number of years worked. The parameter ρ is the ratio of pension savings to cumulative earnings: $\rho = S_s/(w{\cdot}t)$. This may be thought of as a summary measure of the financial 'return' to the individual of the fund measured relative to their earnings. It is an estimate of the change in pensions savings associated with a change in cumulative earnings: $dS_s/d(w{\cdot}t) = \rho$. What determines the value of ρ is discussed below. It is important to note that in this model, for an individual to have pension savings ($S_s > 0$), they must have been employed at some point in time ($t > 0$) and received positive earnings ($w > 0$). Therefore, if $t = 0$ then $S_s = 0$.

Initially it is useful to think about the model *ex post*. This refers to the pension savings of individuals who have already retired:

$$S_s^* = \rho^*(w^* \cdot t^*) \quad (2)$$

The superscript '*' is used to denote that the individual is retired. For a such individuals, the number of years worked is known, t^*, and since the individual is retired (not working), future earnings are zero. For this individual, w^* is average 'life-time' earnings and $w^* \cdot t^*$ is 'life-time' earnings. Pension savings at retirement are S_s^*. For retired individuals, S_s^*, w^* and t^* are known. Therefore, the return to the defined-contribution plan is also known: $\rho^* = Ss^*/(w^* \cdot t^*)$. It is important to recognise that individuals may continue to work after they 'retire'. For example, a person may retire from their main job but continue to work on a part-time basis. The assumption made in this respect is that the system is closed to the individual once they retire and no further contributions can be made.

Application of the model is more problematic *ex ante*. This refers to the pension savings of individuals who are not retired:

$$S_{st} = \rho_t(w_t \cdot t) \quad (3)$$

The subscript t is used to denote that the individual is not retired. For non-retired individuals: $t < t^*$. Pension savings after t years of work is S_{st}. Average earnings after t years of work is w_t. The issue with applying this model to non-retired individuals is that (by definition), their working lives are not complete: $t^* - t > 0$. More importantly, given the role it plays in this model, average earnings after t years of work are not likely to equal average life-time earnings: $w_t \neq w^*$. As the future relating to t and w are not known with certainty, there is no guarantee that the return (ρ) after t years of work will equal the return at retirement: $\rho_t = \rho^*$. This uncertainty becomes less of a concern the closer the individual is to retirement: $t \to t^*$; $w_t \to w^*$; and $\rho_t \to \rho^*$.

It is important to recognise that Equation (3) holds at *all* points before retirement. To illustrate, consider an individual who has worked for 20 years. Their pension savings at $t = 20$ is: $S_{s20} = \rho_{20}(w_{20} \cdot 20)$. If this individual retires after 20 years of work ($t = 20$) then $\rho^* = \rho_{20}$. Assume this individual works a further 20 years. After 40 years of work ($t = 40$), their pension savings is: $S_{s40} = \rho_{40}(w_{40} \cdot 40)$. If this individual retires after 40 years of work $\rho^* = \rho_{40}$. However, if the individual has only worked 20 years ρ^* is not observed. As mentioned above there is no reason to assume that $\rho_{20} = \rho_{40} = \rho^*$. However, there is no reason assume that it will be vastly different either. If $\rho_t = \rho^*$ at any t, then the return is fixed. If ρ *is* fixed, then the only way pension savings can increase is if cumulative earnings increase and/or the number of years worked increases. If earnings, w, and years worked, t, are both measured without error, and ρ is fixed, then pensions savings is deterministic, with the value of S_s simply being a matter of arithmetic.

It is likely ρ is not fixed over t. If this is the case, it is necessary to understand the determinants of ρ, that is, the deterministic component of ρ. Central to this component are the contribution 'rules' governing the pension fund, with the contribution rate of employees (how much the employee pays in from their earnings) and the contribution rate of employers (how much the employer pays in on behalf of their employees) being fundamental. Contribution rates can, and do, change. Another part of the deterministic component, which is of specific relevance in this paper, is the extent to which individuals may 'manage' their pension savings themselves (i.e., not necessarily rely on pension defaults). There is also a stochastic component. Investment decisions are inherently risky. This includes both 'good' and 'bad' decisions made by managers of pension funds. It also includes positive and negative shocks that impact on the value of the assets held by the pension fund. Given the stochastic component is random, it cannot be modelled econometrically. Even if it is important, it not of much relevance, because such variation cannot be modelled. We are only interested in factors that impact on the deterministic component, with the role played by individual decision-making being of most interest.

A more realistic model, for non-retired individuals, that allows for decision-making that potentially affects the return, is:

$$S_t = S_{0t} + S_{st} = S_{ot} + \rho_t(w_t \cdot t)D \quad (4)$$

As above, the subscript 't' indicates the model refers to non-retired individuals ($t < t^*$). In this model, S_t is 'total' pension savings. It consists of two components. The first is an 'other forms of pension savings' component, S_{0t}. The second is the defined-contribution component, S_{st}. One example of the former is savings accounts at

private banks or financial institutions. Evidence suggests that in Australia S_{0t} is small relative to S_{st}. In fact, it is likely so small that it is effectively zero: $S_{0t}/S \approx 0$. However, this is not necessarily the case in other countries. For this reason, there is value in including it in the model. S_{0t} is assumed to be independent of S_{st}. D is a parameter that influences mandatory pension savings by impacting on the return to pension savings independent of any impact on w_t and t. Since S_{ot} is independent of S_{st}, it is assumed not to be influenced by D. More generally, D can be thought of as the mechanism or channel by which individual decision-making can affect the return.

The key condition is the impact of D on the slope of the (defined-contribution component) pension savings relationship:

$$dS_{st}/d(w_t \cdot t) = \rho_t D \tag{5}$$

This condition suggests (not surprisingly) that there are three possible outcomes resulting from individuals making decisions relating to their own pension savings: (1) if $D = 1$ then the return is not influenced by decisions made by the individual: $\rho_t D = \rho_t$; (2) if $D < 1$ then decisions made by the individual result in pension savings less than would have been the case in the absence of such decisions: $\rho_t D < \rho_t$; and (3) if $D > 1$ then decisions made by the individual result in pension savings more than would have been the case in the absence of such decisions: $\rho_t D > \rho_t$.

Figure 1 shows a stylised version of this pension savings model with individual decision-making. This figure shows the pension savings profile for a non-retired individual who has worked for 30 years ($t = 30$). It is assumed that the individual will retire after 40 years of work. If this individual made no decisions relating to the management of their pension savings ($D = 1$), at $t = 30$, the return would have been $\rho 1$ with pension savings of S_S (30: $D = 1$). However, this individual, after 15 years of work ($t = 15$), makes a pension investment decision ($D < 1$) that leads to a lower return (e.g., vis-à-vis staying with the default) in the period $t = 15$ to $t = 30$ of $\rho 2$. Pension savings after $t = 15$ is S_S (15) with return $\rho 1$. The pension loss from this decision is S_S (30: $D = 1$) – S_S (30: $D < 1$) > 0. The observed return at $t = 30$ is $\rho 3$. This return will be a combination of $\rho 1$ and $\rho 2$, both of which are unobserved. Since the period $t = 30$ to $t^* = 40$ is in the future, the return associated with this additional 10 years of work is not known. It is only observed after the individual retires.

The magnitude of D is an empirical question. One way to move forward empirically is to make D a function of a set of observable variables, $\mathbf{X}$, relating to the individual: $D = f(\boldsymbol{X})$. Linearising the model by taking natural logarithms gives:

$$\ln S_t = \ln S_{0t} + \ln \rho_t + \ln w_t + \ln t + \ln D \tag{6}$$

If $D = 1$, Equation (6) reduces to:

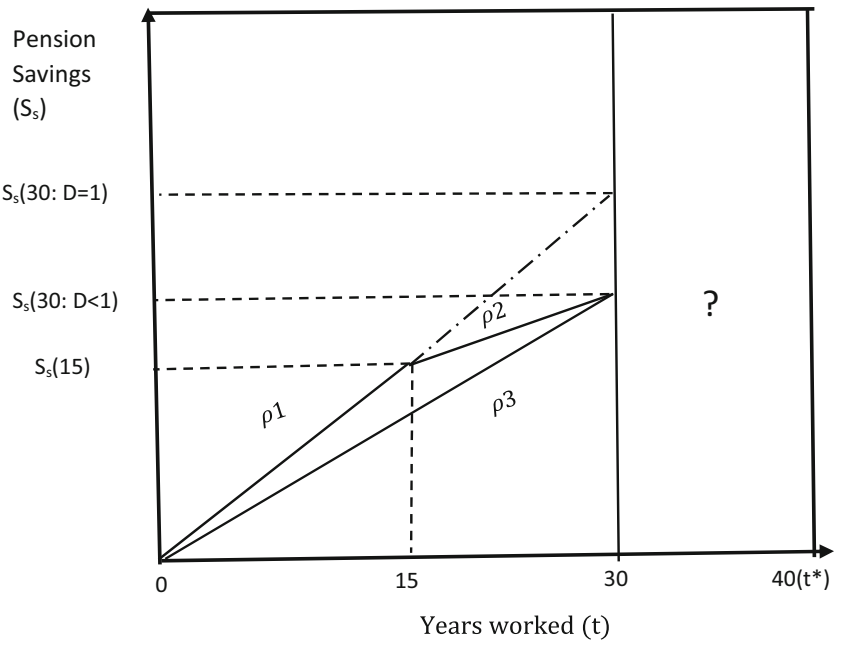
$$\ln S_t = \ln S_{0t} + \ln \rho_t + \ln w_t + \ln t \tag{7}$$

since $\ln(1) = 0$. From Equation (6) the elasticities of S_{0t}, ρ_t, w_t, t and D are all 1. The condition that $D \neq 1$ is fundamental since, if this is the not the case, individual decision-making has no impact on the return. The problem is that D (or $\ln D$) and ρ_t (or $\ln \rho_t$) are not observed separately. What is observed is: $\rho_t D$. Our contention is that Equation (6) can be operationalised with individual-level survey data. Given survey data are being used in the empirical analysis, it is unlikely that S_{0t}, w_t, t and X are measured without error. An approximation to the empirical identity in Equation (6) that is empirically tractable, in the sense that it may be estimated with survey data and econometric (regression) methods, is:

$$\ln S_{ti} = a_o + a_1(\ln w_{ti}) + a_2(\ln t_i) + \boldsymbol{B}'\boldsymbol{X}_i + e_i \tag{8}$$

where $i = 1, 2, \ldots, N$ is a sample of non-retired individuals; a_0, a_1, a_2 and $\boldsymbol{B}$ (b_1, b_2, …, b_k) set of parameters to be estimated; $\ln w_{ti}$, $\ln t_i$ and $\boldsymbol{X}_i$ (X_1, X_2, …, X_k) are individual-specific variables; and e is a stochastic error term. The constant term, a_0, is no longer exclusively pension savings from 'other forms of pension savings', S_{0t}. For example, it also captures measurement error, so the model property of $S_{st} = 0$ when $S_t = S_{0t}$ likely does not hold. This equation is a reduced-form equation since all the right-side variables are assumed to be exogenous. As is discussed below, this is questionable when it comes to financial literacy. In addition, it does not provide evidence that, for example, financial literacy impacts on pension savings through the return. In this sense it is not a test of any specific mechanism or channel. This is worrying because what is observed (e.g., a correlation between financial literacy and pension savings) may be spurious.

FIGURE 1
Stylised Pension Savings Model with Individual Decision-Making



A more structural approach involves a two-step estimation strategy. As indicated above, it is not possible with individual survey data to separate out ρ_t from $\rho_t D$ if individuals are making decisions that impact on the return to their pension savings (unless of course their decisions have no impact on the return). However, it is possible to obtain an estimate of $\rho_t D$ using the same data as use in the reduced-form analysis. The first step involves backing out $\rho_t D$ for each individual i in the sample of non-retired individuals, from the following expression:

$$[\rho_t D]_i = S_{sti}/(w_{ti} \cdot t_i) \tag{9}$$

The operator $[\cdot]$ is used to reinforce that D cannot be separated from $\rho_t D$ in observational survey data. The next step is to relate this value to the same set of **X** variables included in the reduced-form analysis:

$$[\rho_t D]_i = c_0 + \mathbf{C'X}_i + u_i \tag{10}$$

where c_0 is a constant; $\boldsymbol{C}$ $(c_1, c_2, \ldots, c_k)$ is a set of parameters to be estimated and u is stochastic error term. This specification provides a direct test of the variables included in **X** on the return. It is also a more direct test of the proposed mechanism that individual decision-making impacts on pension savings through the return than the reduced-form approach. Given financial literacy is included in **X**, the specification also provides an opportunity to test if financial literacy improves the profitability of such decisions.

Several caveats about this empirical strategy are worth stressing here. Additional issues are discussed in the next section. The first is that it requires accurate information relating to pensions saving. There is some concern in the literature that self-reported pension data (such as that using in this study) may be poorly measured, hence a preference for administrative data. Notwithstanding the potential for measurement error, self-reported pension data has its benefits for the purpose of studying pension savings decisions

(Chan & Stevens, 2008). The second concern is that cumulative earnings data are rarely collected in surveys. What is usually collected is some measure of earnings around the date of the interview (e.g., the month or previous financial year). This necessitates the estimation of cumulative earnings and average labour earnings. As is discussed below, the approach that we follow with respect to the latter is the widely used econometric approach pioneered by Mincer (1974). The third concern relates to endogeneity. The empirical strategy that we follow (both the reduced-form and the more structural specification) assumes a specific direction of causality. There are several variables that we include in X that are potentially endogenous, including financial literacy.

V Methodology

(i) Data

The data employed in this study are from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. HILDA is a nationally representative longitudinal household survey that, at the time of writing, is comprised of 19 waves covering the period 2001–19. The data are mostly collected *via* face-to-face surveys. All household members aged 15 years and older are interviewed, which is not usually the case in surveys of this type. Our analysis makes particular use of data from two special modules. The first, which was conducted in Wave 16 (2016), relates to financial literacy. The second, which was conducted in Wave 18 (2018), relates to wealth (including pension savings). Further detail relating to the specifics of these two modules is contained in Preston and Wright (2022).

(ii) Sample

The main sample for analysis purposes is comprised of individuals aged between 18 and 64 years in 2018 (i.e., born between 1954 and 2000) who are not retired and reside in a private dwelling. Persons born in 1974 (and, therefore, aged 18 in 1992) have a high probability of being covered by the mandatory pension system during their working life. This, of course, does not necessarily apply to immigrants. Therefore, in our analysis, we control for 'place of birth'. Further research relating to the pension savings of immigrants is needed.

In Wave 18, there are 12,374 persons who meet our selection conditions. As the financial literacy information is collected in Wave 16, and the pension savings information is collected Wave 18, financial literacy information is only available for 11,217 individuals (due to attrition). This is a sample size reduction of 1,157 individuals or 9 per cent. A further 726 individuals, or 6.5 per cent, were lost because of missing information on variables needed to calculate the number of years worked. This further reduced the sample size to 10,491 with the latter comprised of 5,058 men and 5,433 women. It is important to note, that 695 individuals, or 6.6 per cent report having no pension savings. The majority of our analysis focuses on individuals with positive pension savings, that is, a sample of 9,796 observations (4,765 men and 5,031 women). In Section VI we carry out analysis concerned with the consequences of excluding individuals with zero pension savings.

(iii) Econometric Model

The main hypothesis of this paper is that the male–female gap in financial literacy is a potential determinant of the male–female gap in pension savings: $S_m/S_f = f(FL_m/FL_f)$, $f > 0$. In the previous section a theoretical model was outlined aimed at guiding the empirical testing of this hypothesis with individual-level data. The model suggests that there are two empirical specifications that may be estimated with HILDA data relevant to this hypothesis (see Eqs. 8 and 10). The first is a reduced-form specification, where pension savings is related to average cumulative earnings, years worked and a set of 'other' variables (**X**) thought to potentially affect pension savings including financial literacy: $S = f(w, t, \boldsymbol{X})$. The second is a (more) structural specification, where the pension-to-earnings return (measured as the ratio of cumulative pension savings to cumulative earnings) is related to the same set of 'other' variables (**X**) included in the reduced-form specification: $\rho D = f(\boldsymbol{X})$. Since the sample is initially restricted to individuals who have positive pension savings, both these models can be estimated with ordinary least squares (OLS) regression.

(iv) Variables

Pension savings, *S*, in HILDA is the respondent's self-assessed estimate of total pension savings. It is not a variable 'matched into' the survey from administrative pension data. The specific HILDA variable that is employed is '*pwsupwi*'. This includes savings for retirement

from all pension funds, measured in 2018 Australian dollars (AUD). It is not possible to measure pension savings within different accounts separately (if the individual has multiple pension accounts). This is less than ideal, but likely not problematic. The variable is a HILDA 'derived' variable, with a considerable amount of imputation and top-coding being used in its construction. More specifically, 20 per cent of our sample (N = 1,929) have had their pension savings imputed (8 per cent; 822 sample members) 'did not know' how much pension savings they had, 25 sample members refused to answer the question and the remaining 1,107 members could only provide an estimate within a broad range (for further details on the HILDA imputation approach, see Summerfield *et al*., 2020).

The *pension return*, ρD, is measured as the ratio of pension savings, S, to cumulative earnings, $(w{\cdot}t)$ $\rho D = S/(w{\cdot}t)$. 't' is number of years worked and 'w' is average cumulative earnings. Expressing cumulative earnings as the product of average cumulative earnings and number of years work is preferred since (as discussed in the previous section) it allows one to obtain an estimate of how each variable impacts on pension savings separately. Both S and t are known in the sense that information relating to both is collected in HILDA. However, this is not the case for w. In each wave of HILDA, gross wages and salary in the previous financial year is collected. Since HILDA is a panel survey it is possible to estimate cumulative earnings for some of the individuals included in our analysis by summating earnings from previous waves (Austen & Mavisakalyan, 2018). However, our analysis includes individuals with number of years of work greater than 18, which is the number of years that the HILDA survey has been in existence at Wave 18. In addition, attrition is a problem. Of sample members with the potential for 18 years of HILDA data (i.e., aged 36 or more in 2018), only 9 per cent were interviewed in all previous waves. It is our view that trying to calculate 'actual' cumulative earnings using the panel dimension of HILDA is not feasible for the sample that we are interested in. As an alternative, we estimate cumulative earnings based on the life-time earnings approach pioneered by Mincer (1974).

The first step involves estimating an earnings equation that includes schooling and work experience as the main explanatory factors. This equation is estimated separately for males and females. These equations are then used to 'predict' the individual's annual earnings at each year of work (i.e., for t, $t-1$, $t-2$, *etc*.). These predicted 'each year of work' earnings are then cumulated to generate cumulative earnings after t years of work. In turn, these cumulative earnings are divided by t to create *average cumulative earnings*, 'w', which is the variable included in the regression equations estimated in the next section. The gender gap in 'w' is 47.5 per cent. (We note that this is on par with the 49.6 per cent gender gap in median long-term earnings estimated by Austen and Mavisakalyan (2018) who did sum up 15 years of HILDA data to examine gender gaps in long-term earnings.) Further details relating as to how 'w' was created, including the full earnings equations estimates, are contained the appendix of Preston and Wright (2022). Given we now have an estimate of cumulative earnings, it is straightforward to calculate the *pension return*, 'ρD'.

In addition to w and t, there are a set of other variables included in the analysis. These variables are denoted by the vector $\mathbf{X}$ of which financial literacy, FL, is of particular importance to us. In HILDA, information relating to financial literacy is obtained by asking five questions relating to their understanding of interest rates, inflation and risk. These questions are factual with 'right and wrong' answers. They are not questions concerned with the respondent's self-assessed view of their financial understanding. It is important to note that these questions also contain the so-called 'Big 3' financial literacy questions popularised by Lusardi and her numerous collaborators (Lusardi & Mitchell, 2014). A summary of these questions is given in Table 1.

The mean number of correct responses is 4.2 for males and 3.8 for females for the sample employed Table 1. This implies a gender gap in financial literacy of 9.8 per cent. It would appear that the questions vary with respect to degree of difficulty, with 91.6 per cent of males and 82.3 per cent of females able to correctly answer (Q1) on interest rates and only 76.0 per cent of males and 61.4 per cent of females able to correctly answer (Q2) on inflation. It is interesting to note that the gender gap is largest for the most difficult question (Q2), although it is not the smallest for the easiest question (Q1). For all questions, and regardless of difficulty, the incidence of returning a correct answer is lower for females when compared with males. In other words, there is a sizeable gender gap in all types of financial

understandings that these questions are intended to capture. The same pattern of gender gaps in financial literacy is observed for other characteristics including place of birth, highest educational qualification obtained, rural–urban residence and a host of labour market related characteristics (Preston & Wright, 2022) (Table 3). For a recent analysis of the gender gap in financial literacy in Australia see Preston and Wright (2019).

With observational survey data such as HILDA, variables are usually measured at the time of the survey. There is, therefore, always some concern about simultaneity bias. In the case of financial literacy and pension savings, the causal direction that we assume in our empirical work is that financial literacy affects pension savings: $FL \rightarrow S$. More specifically, the mechanism or channel that we promote is that individuals with higher financial literacy make more profitable decisions relating to the management of their pension savings. This results in higher pension savings than they would otherwise have had in the absence of such decisions. While such a causal direction is sensible, the reverse causal direction that pension savings affects financial literacy is equally relevant: $S \rightarrow FL$. It may very well be the case that individuals who make decisions relating to the management of their pension savings become more financially literate. In otherwards, the mechanism or channel is a type of financial 'learn-by-doing', where the decisions individuals make relating to their pension savings improves their financial understanding.

With observational data it is difficult (if not impossible) to determine which is the dominant causal direction. Establishing the appropriate causal direction is complicated even further if individuals with high levels of financial literacy remove pension savings from the system and make alternative investments targeted at their retirement. If the share of individuals doing this is large, then one would observe lower pension savings for individuals with high levels of financial literacy. However, we believe that this share would need to be very large for this effect to be observed. In addition, we are aware of no published evidence that suggest that individuals in large numbers (regardless of their level of financial literacy) are making investments of this type in Australia. We comment further on the importance of this mechanism below.

It would be beneficial if we had measures of financial literacy when individuals were young. This would provide a more convincing check of the assumed causal direction since time is central in the evaluation of 'cause and effect'. However, HILDA does not collect 'early-life' information of this type. The financial literacy information used in this paper was collected in Wave 16, while the pension savings information was collected in Wave 18. This means that our financial literacy variable is effectively lagged two years. While this no doubt helps reduce simultaneity bias, we believe that two years is not long enough to provide a reliable check. It seems unlikely that the level of financial literacy of someone who is aged 47 is much different to when they were aged 45. We, therefore, adopt an alternative approach in an attempt to address this issue.

Research has established that there are three main correlates of financial literacy: education, age and sex (Lusardi & Mitchell, 2014). It is a near empirical fact that the relationship between age and financial literacy is an inverted 'J'-shape. Given this functional form assumption, it is possible to remove the effect of age on financial literacy by regressing financial literacy on age and age squared. The residual from this regression, *FLres*, is an age-independent measure of financial literacy. It can be thought of being a more likely value of financial literacy when the individual was young than the value collected at the time of the survey (or in our analysis, collected two years before the pension savings information was collected). This, of course, is more likely to be true the older the individual is at the time the financial literacy information was collected. Therefore, *FLres*, and not *FL*, is included as the financial literacy variable in our empirical analysis. We present empirical evidence in support in of this approach in the next section.

Before discussing the remaining variables included in the analysis, consider Table 2. It summarises information, collected in HILDA, relating to individuals who report making voluntary contributions to their pension savings in 2018. The data suggest that 12.0 per cent of males and 11.5 per cent of females paid additional money into their pension savings in addition to their mandatory contributions based on their earnings. Table 2 also suggest that, for both sexes, individuals with higher earnings and higher schooling have a higher probability of making voluntary contributions. The pattern with respect to age is less clear. With respect to the main hypothesis of interest in this paper, there is a clear relationship with financial literacy. For

TABLE 2
Financial Literacy and Other Characteristics of Non-Retirees in Australia, 2018

Number of financial literacy questions correctly answered	Males						Females					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	% of Males	Mean age	Years schooling	Gross wages and salary, 2017/18	Mean pension savings	% Making voluntary contributions	% of Females	Mean age	Years schooling	Gross wages and salary, 2017/18	Mean pension savings	% Making voluntary contributions
0	1.6%	37.5 (12.1)	12.5 (1.4)	$30,626 ($41,740)	$42,670 ($96,425)	7.0%	2.3%	37.1 (12.4)	12.7 (1.8)	$17,952 ($23,732)	$26,573 ($62,026)	3.3%
1	1.3%	28.6 (10.1)	12.5 (1.0)	$30,871 ($26,089)	$21,040 ($55,545)	5.1%	4.4%	34.2 (13.8)	13.1 (1.8)	$25,043 ($26,292)	$23,688 ($50,686)	7.5%
2	5.2%	32.2 (13.0)	12.5 (1.6)	$31,769 ($38,532)	$49,632 ($238,313)	4.4%	8.5%	33.4 (11.4)	13.4 (1.9)	$27,459 ($29,814)	$30,526 ($81,152)	2.6%
3	13.1%	34.0 (11.8)	13.2 (1.9)	$48,253 ($41,489)	$59,280 ($106,861)	7.8%	17.0%	35.9 (12.6)	13.5 (2.0)	$35,575 ($40,763)	$55,556 ($188,478)	8.6%
4	25.9%	39.2 (12.2)	13.7 (2.2)	$66,715 ($56,894)	$117,34 ($195,983)	8.4%	28.7%	39.8 (12.3)	14.1 (2.3)	$42,469 ($38,372)	$75,615 ($132,779)	8.9%
5	52.9%	42.2 (12.4)	14.4 (2.3)	$82,578 ($75,881)	$184,078 ($288,754)	17%	39.1%	43.0 (12.2)	14.8 (2.5)	$57,059 ($56,467)	$127,944 ($222,662)	18.3%
All	–	39.4 (12.8)	13.9 (2.2)	$69,114 ($65,989)	$136,665 ($242,294)	12.0%	–	39.4 (12.8)	14.1 (2.3)	$43,809 ($46,197)	$83,558 ($177,143)	11.5%

Notes: Sample is aged 18–64 years, not retired, living in a private dwellings. $N = 11,217$ ($N_M = 5,410$ males and $N_F = 5,807$ females). Estimates are weighted to reflect population totals. Standard deviations are shown in parentheses. Pension savings includes those with zero pension savings.
Source: Household, Income and Labour Dynamics in Australia (HILDA) Survey.

both sexes, the probability of making contributions increases as financial literacy increases.

In order to understand the magnitude of this relationship, consider the two extremes of financial literacy: zero correct and all five questions correct. For individuals who answered none of the five financial literacy questions correctly, 7.0 per cent of males and 3.3 per cent of females made voluntary contributions in this period. For individuals who answered all five questions correctly, 17.0 per cent of males and 18.3 per cent of females made voluntary contributions. Although the relationship between financial literacy and making voluntary contributions needs to be more comprehensively modelled, the positive correlation provides some evidence in support of our proposed mechanisms linking financial literacy and pension savings. In addition, it provides evidence that there are a large number of individuals with high levels of financial literacy who are not withdrawing from the pension system to make alternative investments relating to their retirement. If high financial literacy individuals were making such investments by withdrawing from pension savings, one would not expect them to be making voluntary contributions to pension savings (assuming money is neutral).

It is recognised that pension savings in 2018 will be determined by activities, events and decisions made in the past. Although HILDA does contain some information of this type, detailed life and employment histories, based on retrospective questioning, have not (to date) been collected. This seriously limits what additional variables, relating to the past, may be included in the analysis. The approach that we, therefore, follow is to include a set of what may be termed 'ever variables' aimed at measuring activities, either current or in the past, that may affect pension savings. These include five dummy variables relating to marital status: married (and never *de-facto*, divorced or widowed) (*Married*); *de-facto* – either currently living in a *de-facto* relationship or, in the past, ever lived in a cohabiting relationship (*Ever-cohab*); current or previously divorced (*Ever-div*); currently or previously widowed (*Ever-wid*). Marital status variables may be expected to have an effect on pension savings that is separate from their effect on earnings. Legislative provision, for example, allows for the splitting of pension savings on divorce. In most states and territories, couples separating from a *de-facto* relationship may also seek access to a portion of their partner's pension savings (West & Mitchell, 2021). Likewise, there are various tax incentives in the Australian system that may see one partner make co-contributions into the pension savings of another partner. A variable capturing whether the respondent has ever had children is also included (*Ever-child*). The presence of a child (or children) might capture a break in contributions following time out on parental leave and/or see a diversion of resources away from saving for retirement towards children through, for example, reduced voluntary contributions and cash withdrawals.

Five dummy variables relating to the type of job the individual holds, or has held in the past, are included: ever employed part-time (*Ever-pt*); ever self-employed (*Ever-se*); ever unemployed (*Ever-unemp*); ever in a union (*Ever-union*); and ever employed in the public sector (*Ever-govt*). We believe these factors likely impact on pension savings in addition to the earnings differences they are correlated with. For example, union membership or government employment may affect pension savings arising from pension related information sessions provided to union member and public-sector employees. Public-sector employment also likely captures the greater incidence of pension coverage, especially historically, of public sector *versus* private sector employees. Unemployment almost certainly leads to a break in individual and employer contributions being made. A large spell of unemployment, especially when an individual is young, will lower pension savings. Compared with full-time employment, we believe that part-time employment is qualitatively different. For example, job turnover is higher for part-time employees compared with full-time employees and part-time employees are more likely than full-timers to be employed on a casual basis. We also believe that compared with paid employment, self-employment is qualitatively different. For example, there is much more churning from self-employment to paid employment than from paid employment to self-employment.

One would expect homeownership to affect pension savings. However, this relationship is complicated. As discussed in Section III, provisions exist for first-time homebuyers to withdraw pension savings to contribute to a down payment on a home. Owning or purchasing a property (a measure of wealth) may, therefore, lead to lower pension savings. In a similar manner, mortgage payments means that there is less money available to make additional voluntary contribution

(Feng, 2018). However, homeownership may lead to higher pension savings, particularly if pensions savings are used to cover housing debt (Kingston & Thorp, 2019). While it is not possible to sign the effect of home ownership *a priori* (it is an empirical question), we believe it is factor that should be included in our analysis. Therefore, a dummy variable capturing whether the respondent currently or ever owned their home (*Ever-home*) is included in the regressions.

The remaining variables in the analysis include a dummy variable that captures if the respondent has had a spell of non-employment since they left school (*Ever-gap*). This variable is equal to one if the number of years since leaving full-time education is greater than the time spent in paid employment (i.e., potential work experience > actual work experience). Our sample includes respondents who were in employment before the mandatory pension system was introduced in 1992. For example, someone aged 60 in 2018, would have been aged 34 in 1992. A significant share of their working life would, therefore, have elapsed before the introduction of the mandatory arrangements. In order to account for this discontinuity, we include a dummy variable coded 1 is the respondent was born before 1974 (*Born* < 1974). A person born in 1974 would be aged 18 in 1992 and therefore be 'just' of working age. For foreign-born individuals, their pension savings will be dependent on age at which they immigrated to Australia. In order to capture the effect of being foreign-born on pension savings, a dummy variable was included coded 1 is the respondent is foreign-born (*Foreign*). The final variable included in the analysis is measure of education, measured as the number of years of schooling completed (*Schooling*). Further variable definitions, and descriptive statistics, for all the variables included in the analysis is presented in Table 3.

(v) Decomposition

In order to formally test our key hypothesis of interest, a statistical decomposition, suggested by Oaxaca (1973) and Blinder (1973), is used. The approach involves partitioning the gender gap in pension savings in two components. The first is the so-called 'explained component', which is the share of the gender gap (usually expressed as percentage) that can be attributed to gender differences in measured characteristics (such as cumulative earnings, years worked, financial literacy, etc). The second is the so-called 'unexplained component', which is the share of the gender gap that can be attributed to gender differences in coefficients (sometimes referred to as the 'returns' to the measured characteristics).

More formally, the Oaxaca–Blinder decomposition may be written:

$$\ln S_M = \alpha_M + \boldsymbol{\beta}_M \mathbf{Z}_M + \epsilon_M \tag{11}$$

$$\ln S_F = \alpha_F + \boldsymbol{\beta}_F \mathbf{Z}_F + \epsilon_F \tag{12}$$

where the subscripts '*M*' and '*F*' denote male and female, respectively, the natural logarithm of pension savings (ln*S*) is the outcome variable of interest and the vector $\mathbf{Z}$ is a set of variables that, in our analysis, is comprised of w, t and $\mathbf{X}$ (where $\mathbf{X}$ denotes all other variables as previously described, including financial literacy). When the outcome variable is 'pD' we only include the vector $\mathbf{X}$ (i.e., we do not control for w and t); $\boldsymbol{\beta}$ is a set of coefficients to estimated; and α is a constant term (also to be estimated). After estimation, subtracting Equation (12) from Equation (11) and rearranging the terms, the gender gap in pension savings may be given as:

$$\begin{aligned} Gap &= \overline{\ln S_M} - \overline{\ln S_F} \\ &= \underbrace{(\overline{\mathbf{Z}}_M - \overline{\mathbf{Z}}_F)\hat{\boldsymbol{\beta}}_M}_{\text{Explained component}} \\ &\quad + \underbrace{\overline{\mathbf{Z}}_F\left(\hat{\boldsymbol{\beta}}_M - \hat{\boldsymbol{\beta}}_F\right) + (\hat{\alpha}_M - \hat{\alpha}_F)}_{\text{Unexplained component}} \end{aligned} \tag{13}$$

The explained and unexplained components may be easily expressed as percentage shares of the raw gap. Since financial literacy is one of the variables included in $\boldsymbol{X}$, the Oaxaca–Blinder decomposition provides an estimate of the share of the gender gap in pension savings (or the gender gap in pension return) that may be attributed to the gender gap in financial literacy. Hence, it is our view that the Oaxaca–Blinder decomposition provides a direct, meaningful and easy to interpret test of the key hypothesis of this paper.

VI Results

The main regression results are presented in Table 4. Columns (1) to (4) are for pension savings, *S*. Columns (5) and (6) are for the pension return, ρD. The results of the associated Oaxaca–Blinder decomposition of the gender gap in pension savings and pension return are

TABLE 3
Mnemonics, Variable Definitions and Descriptive Statistics of Regression Variables, Males and Females, Aged 18–64 Years, Australia, 2018

Mnemonics	Variable definition	(1) Males	(2) Females	(3) Gap (1)–(2)	(4) %Gap (3)/(2) × 100
S	Respondents pension savings (superannuation savings) in 2018 Australian dollars ($)	$154,519 ($254,975)	$97,317.2 ($190,364)	$57,202	58.8%
ρD	Ratio of pension savings to cumulative earnings (%)	10.4% (11.7%)	11.6% (18.9%)	−1.2% points	−10.3%
W	Average cumulative earnings in 2018 Australian dollars ($)	$57,185 ($21,167)	$38,776 ($14,026)	$18,409	47.5%
t	Number of years worked	20.9 (12.5)	18.0 (11.6)	2.9	16.1%
FL	Respondent's financial literacy (number of correct responses)	4.2 (1.0)	3.9 (1.2)	0.3	7.7%
FLres	Age standardised financial literacy	0.253 (1.0)	−0.102 (1.2)	0.355	−348.0%
Married	Dummy variable = 1 if the respondent is married and has never been separated, widowed, divorced or cohabitated	34.9%	35.6%	−0.7% points	−2.0%
Ever-cohab	Dummy variable = 1 if the respondent has ever been in a cohabitating relationship	36.3%	38.2%	−1.9% points	−5.0%
Ever-div	Dummy variable = 1 if the respondent has ever been divorced	5.9%	8.2%	−2.3% points	−28.0%
Ever-wid	Dummy variable = 1 if the respondent has ever been widowed	0.9%	1.2%	−0.3% points	−25.0%
Ever-child	Dummy variable = 1 if the respondent has ever had any children	59.3%	67.5%	−8.2% points	−12.1%
Ever-pt	Dummy variable = 1 if the respondent ever worked part-time in their main job	50.3%	82.0%	−31.7% points	−38.7%
Ever-se	Dummy variable = 1 if the respondent was ever self-employed in their main job	26.6%	17.8%	8.8% points	49.4%
Ever-unemp	Dummy variable = 1 if the respondent was ever unemployed	26.3%	26.7%	−0.4% points	−1.5%
Ever-union	Dummy variable = 1 if the respondent was ever a trade union member or member of an employee association	35.2%	34.4%	0.8% points	2.3%

TABLE 3
(continued)

Mnemonics	Variable definition	(1) Males	(2) Females	(3) Gap (1)–(2)	(4) %Gap (3)/(2) × 100
Ever-govt	Dummy variable = 1 if the respondent ever worked in the public sector in their main job	26.5%	41.1%	−14.6% points	−35.5%
Ever-home	Dummy variable = 1 if the respondent ever owned their own home	65.1%	66.2%	−1.1% points	−1.7%
Ever-gap	Dummy variable coded as 1 if the respondent's actual years of work experience is less than their potential years of work experience	70.1%	85.0%	−14.9% points	−17.5%
Born < 1974	Dummy variable = 1 if the respondent was born before 1974	41.0%	39.6%	1.4% points	3.5%
Foreign	Dummy variable = 1 if the respondent was born outside of Australia	28.7%	28.9%	−0.2% points	−0.7%
Schooling	Years of schooling	14.0 (2.3)	14.3 (2.4)	−0.3	−2.1%
N		4,765	5,031		

Note: Sample is aged 18–64 years, not retired, living in private dwellings. $N = 9{,}796$ ($N_M = 4{,}765$ males and $N_F = 5{,}031$ females). See the text for the approach used to estimate average cumulative earnings and age-standardised financial literacy. A continuous measure of years of schooling was derived from information on a respondent's highest qualification and information on years since leaving school and level of qualification currently enrolled in. Estimates are weighted to reflect population totals. Standard deviations are reported in parentheses.
Source: Household, Income and Labour Dynamics in Australia (HILDA) Survey.

presented in Table 5. The regression estimate, and results of the Oaxaca–Blinder decomposition, for pension savings will be considered first followed by the same for the pension return. The section concludes with some robustness testing, where the analysis is carried out on more homogenous samples. Tobit regressions that allow for the inclusion of respondents with zero pension savings into the analysis, are also estimated as a further form of robustness testing. It is important to note that since both *w* and *FLres* are predicted variables, the errors in the regressions will be heteroskedastic. Therefore, the standard errors have been corrected for heteroskedasticity following White (1980).

Columns (1) and (2) of Table 4 show the regression estimates for pension savings, separately for males and females, for the specification that only includes average cumulative earnings, *w*, and years worked, *t*. Three points about these estimates are worth stressing. First, it is clear for both males and females, that average cumulative earnings and years worked are strong predictors of pension savings. In terms of variance explained, the R^2 values are very high, with over half the variance in pension savings, for both males (58.9 per cent) and females (52.2 per cent), being 'explained' by these two variables. This is encouraging remembering that the regressions are estimated with individual-level data and R^2-values of over 50 per cent are not common with this type of data.

Second, since S, *w* and *t*, are all expressed in natural logarithms, the coefficients of *w* and *S* may be interpreted as elasticities. For both males and females, none of the elasticities are exactly equal one (1). That said, none of the elasticates are widely different to one. Therefore, they are not too different to the elasticities implied by the theoretical model outlined in Section IV (see

TABLE 4
Regression Estimates, Pension Savings (S) and Pension Return (ρD), Males and Females, Aged 18–64 Years, Australia, 2018

No.	(1)	(2)	(3)	(4)	(5)	(6)
	ln(S)				ρD (%)	
Outcome Sex	Males	Females	Males	Females	Male	Female
ln(*w*)	1.276***	0.938***	0.615***	0.352**	–	–
	(0.092)	(0.075)	(0.174)	(0.155)		
ln(*t*)	1.051***	1.338***	1.229***	1.353***	–	–
	(0.050)	(0.035)	(0.069)	(0.070)		
FLres	–	–	0.121***	0.107***	0.686***	0.874***
			(0.022)	(0.020)	(0.205)	(0.221)
Married	–	–	0.006	0.036	−0.867	0.309
			(0.084)	(0.082)	(0.651)	(0.916)
Ever-cohab	–	–	−0.011	0.141**	−1.026*	0.004
			(0.074)	(0.061)	(0.561)	(0.749)
Ever-div	–	–	−0.200***	−0.095	−1.765***	−1.717**
			(0.077)	(0.079)	(0.660)	(0.872)
Ever-wid	–	–	0.047	0.059	3.106	1.813
			(0.283)	(0.200)	(4.799)	(1.941)
Ever-child	–	–	−0.024	−0.175***	−0.205	−1.641***
			(0.057)	(0.060)	(0.491)	(0.594)
Ever-pt	–	–	−0.339***	−0.278***	−1.700***	−5.283***
			(0.045)	(0.079)	(0.431)	(0.986)
Ever-se	–	–	−0.408***	−0.360***	−1.390***	0.426
			(0.054)	(0.074)	(0.471)	(0.867)
Ever-unemp	–	–	−0.084	−0.240***	−0.683	−1.669***
			(0.052)	(0.057)	(0.436)	(0.575)
Ever-union	–	–	0.231***	0.101*	1.554***	0.461
			(0.042)	(0.058)	(0.412)	(0.568)
Ever-govt	–	–	0.246***	0.330***	2.780***	2.720***
			(0.047)	(0.050)	(0.531)	(0.565)
Ever-home	–	–	0.361***	0.362***	2.423***	2.877***
			(0.067)	(0.069)	(0.488)	(0.473)
Ever-gap	–	–	−0.212***	−0.099	−1.761***	−1.371**
			(0.046)	(0.064)	(0.452)	(0.690)
Born < 1974	–	–	−0.242***	−0.086	−0.082	3.647***
			(0.060)	(0.083)	(0.421)	(0.602)
Foreign	–	–	−0.243***	−0.236***	−2.048***	−2.882***
			(0.055)	(0.063)	(0.504)	(0.619)
Schooling	–	–	0.044**	0.044**	0.119	−0.457***
			(0.019)	(0.021)	(0.095)	(0.123)
Constant	−5.904***	−2.999***	0.403	2.692**	9.766***	21.418***
	(0.884)	(0.755)	(1.503)	(1.271)	(1.442)	(2.559)
R^2 (%)	58.9%	52.2%	64.9%	57.3%	6.6%	5.6%
N	4,765	5,031	4,765	5,031	4,765	5,031

Notes: Sample is aged 18–64 years, not retired, living in private dwellings. Estimates are weighted to reflect population totals. Standard errors are corrected for heteroskedasticity following White (1980). Significance levels given by: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.

Eqs. 6 and 7). This close to one is also encouraging given that *S*, *w* and *t* are all likely measured with considerable error. Third, it is interesting to note that male pension savings are more responsive to average cumulative earnings [$\eta(S, w)_M = +1.3$] compared with years worked [$\eta(S,$

TABLE 5
Oaxaca–Blinder Gender Gap Decomposition, Pension Savings (S) and Return (ρD), Males and Females, Aged 18–64 Years, Australia, 2018

No.	(1)	(2)	(3)	(4)
	Pension savings ln(S)		Pension return (ρD)	
Decomposition of gap in ... Component		% of Raw gap		% of Raw gap
(A) Explained component	0.498***	98.4%	0.538**	−42.9%
	(0.081)		(0.2117)	
(B) Unexplained component	0.008	1.6%	−1.793***	142.9%
	(0.076)		(0.391)	
(C) Raw gap (C = A + B)	0.506***	100.0%	−1.255***	100.0%
	(0.054)		(0.346)	
Decomposition of explained component ...		% of Explained component		% of Explained component
(D) ln(*w*)	0.227***	45.6%	–	–
	(0.064)			
(E) ln(*t*)	0.174***	34.9%	–	–
	(0.034)			
(F) *X* variables not including financial literacy	0.055**	11.0%	0.294	54.6%
	(0.022)		(0.199)	
(G) Financial literacy	0.043***	8.6%	0.243***	45.2%
	(0.009)		(0.076)	
Explained component (A)	0.498	100.0%	0.538**	100.0%
	(0.081)		(0.217)	
Component of gap explained by FL (G/C)	0.043***	8.5%	0.243***	−19.4%
	(0.009)		(0.076)	

Notes: $N = 9{,}796$. Estimates are weighted to reflect population totals. Standard errors are shown in parentheses. Significance levels given by: $^{***}p < 0.01$; $^{**}p < 0.05$; and $^{*}p < 0.1$.

$t)_M = +1.1]$. However, the opposite is case for females, with pension saving being more responsive to years worked $[\eta(S,t)_F = +1.4]$ than average cumulative earnings $[\eta(S,w)_F = +0.94]$. It is not clear why this is the case. It could be the case that measurement error is a more serious problem for females compared with males since the employment experience of females is, on average, is more intermittent. If this is true, then years worked (and work experience used in the estimation of average cumulative earnings) is likely less accurately measured for females.

Columns (3) and (4) of Table 4 show the estimates for the reduced-form specification of pension savings, again separately for males and females. The inclusion of the ***X***-variables (Table 3) increases the variance explained (R^2 totals) from 58.9 per cent to 64.9 per cent for males and from 52.2 per cent to 57.3 per cent for females. For both sexes, this is a statistically significant improvement in goodness of fit ($p < 1$ per cent). The elasticities of w and t remain positive, and statistically significant, for both males $[\eta(S,t)_M = +1.2]$ and females $[\eta(S, t)_M = +1.4]$ and are quite similar in magnitude. However, the elasticity of average cumulative earnings, for both males $[\eta(S,w)_M = +0.62]$ and females $[\eta(S,w)_F = +0.35]$ are considerably smaller than what was observed before adding in the ***X***-variables (i.e., when compared with the coefficients in columns 1 and 2).

With respect to financial literacy, *FLres*, its effect on pension savings is positive and highly statistically significant for both males and females ($p < 1$ per cent). The coefficient of the financial literacy variable is larger (more positive) for males $[\beta(FLres)_M = 0.121]$ than for females $[\beta(FLres)_M = 0.107]$. These point estimates imply that the marginal effect of financial literacy on pension savings is 12.9 per cent for

males and 11.2 per cent for females. These percentage marginal effects are calculated following Halvorsen and Palmquist (1980), where: Marginal effect (β) = (exp(β) – 1) · 100. The 95 per cent confidence interval for males is 12.7 per cent to 13.0 per cent and for females is 12.7 per cent to 13.0 per cent. Since the two 95 per cent confidence intervals do not overlap, the difference of 1.7 percentage points between males and females is statistically significant at the 5 per cent level. More generally, these findings suggest that financial literacy is an important correlate of pension savings for both males and females.

As for the other **X**-variables, several of the marital status variables are statistically significant (i.e., $p < 10$ per cent). There are two notable differences between males and females. For females, divorce (*Ever-div*) is not statistically significant. However, for males the effect of divorce is negative, large and statistically significant ($p < 1$ per cent). The point estimate suggests that divorce is associated with around 18 per cent lower pension savings. For females the effect of cohabitating (*Ever-cohab*) is positive, large and statistically significant ($p < 1$ per cent). The point estimate suggests that cohabitation for females is associated with around 15.1 per cent higher pension savings. The effect of having children (*Ever-child*) is negative, and only statistically significant for females, with the effect for females being sizeable (−16.1 per cent).

With respect to the included employment-related variables, pension savings are lower for individuals who have worked part-time (*Ever-pt*), with the effect being more negative for males (−28.8 per cent) compared with females (−24.3 per cent). Likewise, pension savings are lower for individuals who have been self-employed (*Ever-se*), with the effect being larger for males (−33.5 per cent) compared with females (−30.2 per cent). The effect of public sector employment (*Ever-govt*) and union membership (*Ever-union*) are both positive. The effect of public sector employment is considerably larger for females (39.1 per cent) compared with males (27.9 per cent). The effect of union membership is larger for males (26.0 per cent) compared with females (10.6 per cent). The effect of unemployment (*Ever-unemp*) is negative, and only statistically significant for females, with the marginal effect for females being sizeable (−21.3 per cent). The opposite pattern is observed for time out of employment (*Ever-gap*), with the effect being only statistically significant and sizeable for males (−19.1 per cent).

The effect of home ownership (*Ever-home*) is positive and very large for both males and females. In fact, the marginal effects for males (43.5 per cent) and females (43.6 per cent) are almost identical. As expected, being foreign-born (*Foreign*) is associated with lower pension savings. The effect is sizeable and nearly identical in magnitude for males (21.6 per cent) and females (−21.0 per cent). It is interesting to note that being of employment age before the superannuation system was introduced (*Born* < 1974) is negative with the effect being statistically significant, and large, only for males (−21.5 per cent). Finally, there is a positive relationship between education (*Schooling*) and pension savings, with the size of this effect being the same for males and females. For both sexes, an additional year of schooling is associated with 4.5 per cent higher pensions savings.

Turning to the Oaxaca–Blinder decomposition, columns (1) and (2) of Table 5 show the results of the decomposition for pension savings based on the reduced-form specification. The mean pension savings is around A$155 K for males and around A$97 K for females. This is a male–female gap of nearly 60 per cent (Table 3), which is a natural logarithm difference of +0.506 (row (C), column (1) of Table 5). As Table 5 shows, the 'explained component' is 98.4 per cent of the male–female gap, with the 'unexplained component' being very small at 1.6 per cent (and not statistically different to zero). In other words, almost all the difference in pension savings between males and females may be attributed to average cumulative earnings (w), years worked (t), financial literacy (*FLres*) and other included variables ($\boldsymbol{X}$, not including *FLres*). With respect to the explained component itself, over 80.5 per cent can be attributed to earnings (45.6 per cent) and years worked (34.9 per cent). Likewise, around 19.5 per cent can be attributed to financial literacy (8.6 per cent) and the other (15) variables included in $\boldsymbol{X}$ (11.0 per cent). Focussing on the variables other than earnings and years worked, financial literacy is by far the most important in explaining the male–female pension savings gap. In fact, almost half (43.6 per cent) of gap not attributed to earnings and years worked, can be attributed to financial literacy. Most importantly, the decomposition suggests that 8.5 per cent of the (raw) male–female pension gap is explained by financial literacy. We believe this is considerable

support for the main hypothesis of interest in this paper that the gender gap in financial literacy is an important determinant of the gender gap in pension savings.

Returning to Table 4, columns (5) and (6) report the regression estimates for the pension return. Column (5) is for males and column (6) is for females. It is important to note at the outset that the variance explained totals for the pension return are much lower than for pension savings. The R^2-value is 6.6 per cent for males and 5.6 per cent for females, which are around 1/10 of the R^2-values for pension savings. This is not surprising given the pension return combines pension savings, average cumulative earnings and years worked into a single variable. However, these R^2-values are statistically significant ($p < 1$ per cent), suggesting that the included variables do capture some of the systematic variation in the pension return.

Generally, the variables that are important in the pension return regressions are also important in the pension savings regressions. For both sexes, divorce (*Ever-div*), being foreign-born (*Foreign*), part-time employment (*Ever-PT*) and time out of employment (*Gap-Year*) are associated with a lower pension return. Public-sector (*Ever-govt*) and homeownership (*Ever-home*) are associated with a higher pension return for both males and females. For females (but not males), having children (*Ever-child*), unemployment (*Ever-unemp*) and very surprisingly education (*Schooling*) are associated with a lower pension return while being of labour force age before the superannuation scheme was introduced (*Born* < 1974) is associated with a higher pension return. For males (but not females), cohabitation (*Ever-cohab*) and self-employment are associated with a lower pension return and union membership (*Ever-union*) is associated with a higher pension return. The similarity in the importance of the included variables in both the pension savings and pension return regressions, remembering that there is a large difference in the variance explained totals, is encouraging since it is pointing to a common set of factors likely correlated with pension decision-making.

With respect to financial literacy, *FLres*, its effect on the pension return, as was found for pension savings, is positive and highly statistically significant for both males and females ($p < 1$ per cent). The coefficient of the financial literacy variable is larger (more positive) for females [$\beta(FLres)_M = 0.874$] than for males [$\beta(FLres)_M = 0.686$]. These point estimates imply that the effect of financial literacy on pension savings is 0.7 percentage points for males and 0.9 percentage points for females. These are large effects remembering that the mean pension return is 10.4 per cent for males and 11.6 per cent for females (Table 3). In percentage terms (and not percentage points), these are effects of 6.7 per cent for males 7.8 per cent for females. The 95 per cent confidence interval for the point estimates for males is 0.680 per cent to 0.692 per cent and for females it is 0.868 per cent to 0.880 per cent. Since the two 95 per cent confidence intervals do not overlap, the difference of about 1.255 percentage points between males and females is statistically significant at the 5 per cent level. In short, the estimates in columns (5) and (6) of Table 4 suggest that financial literacy is an important correlate of the pension return amongst males and females. The estimates also reinforce what was found for pension savings and, arguably, provide more direct evidence in support of the proposed mechanism, that is, that financial literacy impacts on pension savings through individual decision-making. Males and females with higher financial literacy have higher pension returns and higher pension savings.

Columns (1) and (2) of Table 5 shows the results of the Oaxaca–Blinder decomposition for the pension return. As mentioned above, the mean pension return is 10.4 per cent for males and 11.6 per cent for females (Table 3). Given the pension return is larger for females than males, the male–female gap is negative, around −1.255 percentage points. In percentage terms, this is a male–female gap of −10 per cent. Because the male–female gap is negative, the interpretation of the decomposition estimates becomes more complicated. The 'explained' component is 0.538 and 'unexplained' component is −1.793. Adding these two components together equals the gap of −1.255. The negative unexplained component is mainly an outcome of the large difference in constant terms between males (9.766) and females (21.418).

Fortunately, our main interest relates to the explained component, which is positive. With respect to this component, 45.2 per cent can be attributed to financial literacy (*FLres*) and 54.6 per cent can to the other included variables (***X***, not including *FLres*). In other words, financial literacy is almost as important as the collective effect of the other (15) variables included in the analysis. With respect to the (raw) male–female gap of −1.255, around −19 per cent of this can be

attributed to the male–female gap in financial literacy. To be clear, the estimates imply that the male–female gap in the pension return would become 'more negative' the smaller the male–female gap in financial literacy. We believe this is direct evidence supporting the main hypothesis of interest in this paper that the gender gap in financial literacy is an important determinant of the gender gap in pension savings.

(i) Sample with Individuals with Zero Pension Savings

The estimates presented so far in this section only include individuals who have positive pension savings and consequently a non-zero pension return. As was discussed in Section V, zero pension savings is not in any sense a 'data error'. In 2018 the share of males and females aged 18–64 and not-retired reporting zero pension savings was 2.2 per cent and 11.5 per cent, respectively. Individuals with zero pension savings are likely different to individuals with positive pension savings in terms of observable and unobservable characteristics. If this is the case, excluding individuals with zero pension savings from the analysis may be a source of 'selection', which could lead to biased estimates and incorrect inference.

In order to explore this issue, persons with zero pension savings were included in the sample and Tobit regressions were estimated. The key results from this analysis are given in row (2) of Table 6 (the detailed results associated with row (2) are provided in Table S1 in the additional supporting information). The associated baseline estimates are given in row (1) (taken from Table 5) for comparative purposes. The estimate of main interest is in column (10). This shows the percentage share of the raw gender gap in pension savings that may be attributed to the gender gap in financial literacy. For the baseline (with positive pension savings) this share is 8.5 per cent. When Tobit regression is used, the share is slightly smaller at 6.7 per cent. Both shares are similar in magnitude, and both use the same variable specification but are based on different regression methods. We, therefore, conclude that our key finding is robust to the exclusion of individuals with zero pension savings.

(ii) Estimates for More Age-Homogeneous Samples

The baseline analysis (Table 6, row 1) pertains to individuals aged 18–64 years. Including older individuals in the analysis may be problematic. Older individuals (e.g., between the ages of 55 and 64) in employment may not be representative of all individuals in this age group. With respect to 54-64-year-olds, Wave 18 of HILDA indicates that around 69 per cent of males and 56 per cent of females aged 55–64 are employed and 23 per cent of males and 34 per cent of females report are retired. Older employed individuals are, therefore, likely not representative of all individuals in this age group. This is a further source of selection that could bias estimates. Including younger individuals, between the ages of 18 and 24, into the analysis could also be problematic for a similar reason. With respect to 18–24-year-olds, Wave 18 of HILDA indicates that 73 per cent of males and 76 per cent of females report being employed and 34 per cent of males and 37 per cent of females in this age group report being a full-time student. Younger employed individuals are, therefore, likely not representative of all individuals in this age group.

To examine whether the inclusion of younger and older individual is problematic, the baseline specification was estimated for individuals aged 25–54. The key results are shown in Table 6, row (3) (detailed regression results associated with row (3) are provided in Table S4 in the additional supporting information). Using this sample, 9.3 per cent of the gender gap in pension savings may be attributed to the gender gap in financial literacy. This is not too different to the baseline value of 8.5 per cent (row 1). Row (4) shows the results when individuals aged 54–64 are excluded from the sample. Row (5) presents the results where individuals aged 18–24 are excluded from the sample. When older individuals are excluded, 9.4 per cent of male–female gap may be attributed to the male–female gap in financial literacy. When younger individuals are excluded, the share of the gender gap in pension savings explained by the gender gap in financial literacy is 8.6 per cent. In both cases, the share is not too different to the baseline share of 8.5 per cent. These estimates based on more age-homogenous samples suggest that selection bias resulting from the inclusion of younger and/or older individuals in the analysis is not problematic. Therefore, our main finding of a positive and sizeable relationship between the gender gap in pension savings and the gender gap in financial literacy is unchanged.

TABLE 6
Robustness Analysis, Oaxaca–Blinder Gender Gap Decomposition of Pension Savings (S), Australia, 2018

	(1) Sample	(2) N_M	(3) N_F	(4) Age group	(5) Estimator	(6) Raw gap	(7) Explained component (%)	(8) Unexplained component	(9) Percentage of explained component due to financial literacy	(10) Percentage of raw gap due to financial literacy
(1)	Baseline (see Table 5)	4,765	5,031	18–64	OLS	0.506***	98.4%***	1.6%	8.6% ***	8.5%***
(2)	Baseline	5,058	5,433	18–64	Tobit	$63,542***	99.2%***	0.8%	6.8%***	6.7%***
(3)	Older and younger individuals excluded	3,375	3,651	25–54	OLS	0.571**	89.7%***	10.3%	10.4%***	9.3%***
(4)	Older individuals excluded	3,933	4,206	18–54	OLS	0.477**	90.4%***	9.6%	10.4%***	9.4%***
(5)	Younger individuals excluded	4,207	4,474	25–64	OLS	0.584***	96.6%***	3.4%	8.9%***	8.6%***
(6)	Baseline + risk tolerance	4,272	4,622	18–64	OLS	0.554***	95.8%***	4.2%	6.8%***	6.5%***

Notes: The detailed regression results and decomposition results are included in Appendix in the additional supporting information. Significance levels given by: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.

(iii) Risk Tolerance

Row (6) of Table 6 shows the results for a specification that controls for financial risk tolerance. Attitudes towards financial risk may correlate with pension savings. For example, married individuals may be able to risk-share and allowing one partner to opt for higher risk/higher return investment strategies (Dobrescu *et al*., 2018). If women have lower risk tolerance than men they may be less inclined to opt out of default settings and less inclined to make higher risk/higher (potential) pension return decisions. In the HILDA survey information on attitudes to financial risk is captured *via* a self-completion questionnaire (SCQ). In Wave 18 (2018) 9 per cent of respondents did not submit their SCQ. Of those who did and who were aged 18–64 and not retired, HILDA estimates suggest a 16 per cent gap ($p < 1$ per cent) (higher for men) in the mean financial risk tolerance scores of men and women. We use this information to generate a *Z*-score and we then enter the latter into our regressions. Our sample is comprised of 4,272 males and 4,622 females (i.e., we have 10 per cent fewer observations than the baseline regression on account of missing SCQs). It is likely that this sample is affected by selection and therefore not representative. The summary estimates in column (10) of row (6) show that, even in the presence of a control for risk tolerance, the gender gap in financial literacy accounts for 6.5 per cent of the raw gender gap in pension savings. Note, when the baseline regression is estimated on the subsample in row (6) the share of the raw gender gap due to financial literacy is 7.3 per cent. In other words, the share of the gap due to financial literacy is only marginally smaller (7.3–6.5 = 0.8 percentage points) when controlling for risk tolerance. There is no statistical difference in the two estimates.

(iv) Endogeneity

In all the estimates presented so far, it is assumed that the causal order in financial literacy impacts on pension savings. As discussed above, the reverse causal order is also relevant. In order to address the potential endogeneity of financial literacy, an instrumental variables (IV) approach is adopted. The approach requires finding a least one variable (the so-called 'instrument') that is highly correlated with financial literacy and not correlated with pension savings. The empirical studies of Behrman *et al*. (2012) and Ćumurović and Hyll (2019) suggest that parental education is a suitable instrument for financial literacy in several applications. In this paper, we employ father's education (*FatherSch*) as the instrument, measured in terms of years of schooling completed.

The full IV estimates and associated Oaxaca–Blinder decomposition estimates are not reported here but may be found in Tables 9 and 10 of Preston and Wright (2022). Taken together, the first-stage and reduced-form estimates suggest that father's schooling is a good instrument. A Hausman test firmly rejects the endogeneity of financial literacy (Hausman, 1978). The Hausman test statistic, which is an *F*-test, is 1.2 males and 1.1 for females – both values are not statistically significant below the 10 per cent level. This suggests that our assumed causal direction of financial literacy on pension savings is appropriate, and the OLS is the appropriate estimator.

VII Conclusions

In this paper we use data on pension savings and financial literacy for a sample of non-retired adults in Australia to empirically examine whether the male–female gap in financial literacy is a determinant of the male–female gap in pension savings. This is an important research topic as research shows that in most countries there is a sizeable gender gap in the retirement savings of non-retired (working) individuals and in the incomes (and hence standard of living) of retired individuals. It is also a timely study given the increasing popularity of privately managed defined-contribution pension schemes aimed at supplementing (if not replacing) state-sponsored pay-as-you-go defined-benefit schemes. There is some evidence to suggest that defined-contribution schemes exacerbate the gender gap in pension savings and retirement benefits. Understanding the source of the gender gap in pension savings therefore matters, particularly for improving, if not ensuring, the economic and financial security of women in old age.

Our analysis draws on data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. In 2018 this data suggests that there is both a sizeable gender gap in pension savings and a sizeable gender gap in financial literacy. Put simply, relative to their male counterparts, women of working age have, on average, lower pension savings and lower financial literacy. Financial literacy is measured as the ability to understand important financial concepts such as interest rates, inflation, risk and diversification.

Consistent with expectations, our analysis shows that earnings and labour supply are the main correlates of pension savings. We also find that, for both males and females, higher financial literacy is associated with higher pension savings. In addition, we find that financial literacy is associated with a higher 'pension return' where the latter is measured as the ratio of pension savings to cumulative earnings. We offer this as empirical evidence in support of the mechanism that more financially literate individuals make more profitable decisions related to the management of their pension savings. We find that around 8.5 per cent of the gender gap in pension savings may be attributed to the gender gap in financial literacy. In other words, our analysis strongly suggests that the gender gap in financial literacy is an important determinant of the gender gap in pension savings.

Our findings should be of interest to policy makers, particularly those concerned with gender equality and the economic and financial security of women in retirement. Interventions aimed at improving the financial literacy of women (e.g., through educational programs) and/or supporting and assisting them (e.g., *via* financial counselling programs) as they make important pension saving decisions can be expected to reduce the gender gap in pension savings and the gender gap in retirement incomes in old age. Given marked differences in financial literacy skills by age, education and other characteristics, it is likely that such interventions will need to be tailored for different groups. Differentiation might be with respect to stage in life (e.g., commencing work, birth of first child, divorce and nearing retirement).

In Australia, much of the policy response aimed at addressing the gender gap in pension savings has been to encourage voluntary contributions through tax incentives and, more recently, to introduce 'MySuper' (low cost, default) pension savings accounts. While these initiatives may assist women at the margin, they are unlikely to see a substantive narrowing in the gender gap in pension savings. Indeed, studies show that default arrangements may be a constraint on the accumulation of pension savings (Dobrescu *et al*., 2018). As shown in this paper and noted above, the gender gap in pension savings is largely driven by gender differences in earnings and labour supply. While interventions such as financial literacy training/financial advice can be expected to narrow the gender gap in pension savings, it remains the case that the provision of an adequate safety net (e.g., the Age Pension in Australia) along with other support measures such as rent assistance will, for the foreseeable future, be the most effective way of minimising gender disparities in income in retirement.

Notwithstanding this conclusion, given the changing demographic landscape, the increasing expectation that individuals will save for their own retirement, the increased levels of debt holding amongst younger generations (e.g., student debt, mortgage debt) and stalled wages growth (PC, 2020), it is important that we better understand how younger individuals are planning and saving for their financial futures. This includes moving beyond individual analysis and examining how decisions related to the financial futures of women are made within couple households.

Additional research is also required to better understand the relationship between financial education, professional financial advice usage and pension savings. Recent work by Burke and Hung (2021), for example, show that, in the US, financial advice usage is low and that it correlates with trust in the financial sector. Their experimental work also shows that indiscriminately providing unsolicited financial advice has little impact on behaviour, even where there is high financial trust. We also required a better understanding of the impact of fund fee and fund performance information (including how the information is presented and the accessibility of dashboards) on pension savings decisions disaggregated by sex. Within Australia this has been the focus of some attention (PC, 2018) but further work is required.

Finally, given the rising importance of defined-contribution pension schemes, there is a need for more detailed and regular (e.g., annual) reporting on the pension savings of males and females. More frequent reporting of data (by sex and marital status) on pension coverage, savings (including zero savings), voluntary contributions (incidence, amount, pre/post-tax), drawdowns, default usage, advice seeking/ usage, *etc*. would enable a richer understanding of the pension saving behaviour and outcomes of males and females. The Australian Taxation Office 'ALife' (ATO Longitudinal Information Files) goes someway to meeting these data needs, although it has its limitations (for further information on the 'ALife' data and its usefulness for retirement policy research, see Polidano *et al*., 2020).

Conflict of interest

The authors declare that they have no conflicts of interest.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Supporting information S1 Supplementary material.

REFERENCES

Agnew, J.R., Bateman, H. and Thorp, S. (2013), 'Financial Literacy and Retirement Planning in Australia', *Numeracy: Advancing Education in Quantitative Literacy*, **6**, Article 7.

Angrisani, M. and Casanova, M. (2021), 'What you Think you Know Can Hurt you: Under/over Confidence in Financial Knowledge and Preparedness for Retirement', *Journal of Pension Economics and Finance*, **20**, 516–31.

Arrondel, L., Debbich, M. and Savignac, F. (2013), 'Financial Literacy and Financial Planning in France', *Numeracy*, **6**, Article 8.

Austen, S. and Mavisakalyan, A. (2018), 'Gender Gaps in Long-Term Earnings and Retirement Wealth: The Effects of Education and Parenthood', *Journal of Industrial Relations*, **60**, 492–516.

Australian Government (2020), 'Retirement Income Review: Final Report', *The Treasury*, July. Commonwealth of Australia.

Bardasi, E. and Jenkins, S.P. (2010), 'The Gender Gap in Private Pensions', *Bulletin of Economic Research*, **62**, 343–63.

Bateman, H., Eckert, C., Geweke, J., Louviere, J., Thorp, S. and Satchell, S. (2012), 'Financial Competence and Expectations Formation: Evidence from Australia', *The Economic Record*, **88**, 39–63.

Bateman, H., Deetlefs, J., Dobrescu, L.I., Newell, B.R., Ortmann, A. and Thorp, S. (2014), 'Just Interested or Getting Involved? An Analysis of Superannuation Attitudes and Actions', *The Economic Record*, **90**, 160–78.

Behrman, J.R., Mitchell, O.S., Soo, C. and Bravo, D. (2012), 'The Effects of Financial Education and Financial Literacy: How Financial Literacy Affects Household Wealth Accumulation', *American Economic Review*, **102**, 300–4.

Best, R. and Saba, N. (2021), 'Quantifying Australia's Gender Superannuation Gap', *The Economic Record*, **97**, 410–23.

Bettio, F., Tiniios, P., and Betti, G. (2013), 'The Gender Gap in Pensions in the EU', Report prepared for the European Commission, Directorate-General for Justice.

Blinder, A. (1973), 'Wage Discrimination: Reduced Form and Structural Estimates', *Journal of Human Resources*, **84**, 436–55.

Boisclair, D., Lusardi, A. and Michaud, P.C. (2017), 'Financial Literacy and Retirement Planning in Canada', *Journal of Pension Economics and Finance*, **16**, 277–95.

Bonnet, C., Meurs, D. and Rapoport, B. (2022), 'Gender Pension Gaps along the Distribution: An Application to the French Case', *Journal of Pension Economics and Finance*, **21**, 76–98.

Brown, M. and Graf, R. (2013), 'Financial Literacy and Retirement Planning in Switzerland', *Numeracy: Advancing Education in Quantitative Literacy*, **6**, Article 6.

Bucher-Koenen, T., Lusardi, A., Alessie, R. and Van Rooij, M. (2017), 'How Financially Literate Are Women? An Overview and New Insights', *Journal of Consumer Affairs*, **51**, 255–83.

Burke, J. and Hung, A. (2021), 'Trust and Financial Advice', *Journal of Pension Economics and Finance*, **20**, 9–26.

Card, D. and Ransom, M. (2011), 'Pension Plan Characteristics and Framing Effects in Employee Savings Behavior', *Review of Economics and Statistics*, **93**, 228–43.

Chan, S. and Stevens, A.H. (2008), 'What you Don't Know Can't Help you: Pension Knowledge and Retirement Decision-Making', *The Review of Economics and Statistics*, **90**, 253–66.

Charness, G. and Gneezy, U. (2012), 'Strong Evidence for Gender Differences in Risk Taking', *Journal of Economic Behavior & Organization*, **83**, 50–8.

Choi, S., Kariv, S., Müller, W. and Silverman, D. (2014), 'Who Is (More) Rational?', *American Economic Review*, **104**, 1518–50.

Clark, R.L. and Pelletier, D. (2022), 'Impact of Defaults on Participation in State Supplemental Retirement Savings Plans', *Journal of Pension Economics and Finance*, **21**, 22–37.

Cobb-Clark, D.A., Kassenboehmer, S.C. and Sinning, M.G. (2016), 'Locus of Control and Savings', *Journal of Banking and Finance*, **73**, 113–30.

Ćumurović, A. and Hyll, A. (2019), 'Financial Literacy and Self-Employment', *Journal of Consumer Affairs*, **53**, 455–87.

Cupák, A., Fessler, P., Schneebaum, A. and Silgoner, M. (2018), 'Decomposing Gender Gaps in Financial Literacy: New International Evidence', *Economic Letters*, **168**, 102–6.

Dahlquist, M., Martinez, J. and Söderlind, P. (2017), 'Individual Investor Activity and Performance', *Review of Financial Studies*, **30**, 866–99.

Debets, S., Prast, H., Rossi, M. and van Soest, A. (2022), 'Pension Communication, Knowledge, and Behaviour', *Journal of Pension Economics and Finance*, **21**, 99–118.

Della Giusta, M. and Longhi, S. (2021), 'Stung by Pension Reforms: The Unequal Impact of State

Pension Age on UK Women and their Parents', *Labour Economics*, **72**, 1–12.
Dobrescu, L.I., Fan, X., Bateman, H., Newell, B.R., Ortmann, A. and Thorp, S. (2018), 'Retirement Savings: A Tale of Decisions and Defaults', *Economic Journal*, **128**, 1047–94.
European Commission (2018), *Pension Adequacy Report 2018: Current and Future Adequacy in Old Age in the EU*, vol. **1**. European Commission, Directorate-General for Employment, Social Affairs and Inclusion, Brussels.
Evans, C. and Pienknagura, S. (2021), 'Assessing Chile's Pension System: Challenges and Reform Options', IMF Working Paper No. PW/21/232, International Monetary Fund, Washington.
Feng, J. (2018), 'Voluntary Retirement Savings: The Case of Australia', *Journal of Family and Economic Issues*, **39**, 2–18.
Feng, J., Gerrans, P., Moulang, C., Whiteside, N. and Strydom, M. (2019), 'Why Women Have Lower Retirement Savings: The Australian Case', *Feminist Economics*, **25**, 145–73.
Fernández-López, S., Vivel-Búa, M., Otero-González, L. and Durán-Santomil, P. (2015), ''Exploring the Gender Effect on Europeans' Retirement Savings', *Feminist Economics*, **21**, 118–50.
Fonseca, R., Mullen, K.J., Zamarro, G. and Zissimopoulos, J. (2012), 'What Explains the Gender Gap in Financial Literacy? The Role of Household Decision Making', *Journal of Consumer Affairs*, **46**, 90–106.
Gerrans, P. (2012), 'Retirement Savings Investment Choices in Response to the Global Financial Crisis: Australian Evidence', *Australian Journal of Management*, **37**, 415–39.
Halvorsen, R. and Palmquist, R. (1980), 'The Interpretation of Dummy Variables in Semilogarithmic Equations', *American Economic Review*, **70**, 474–5.
Hasler, A. and Lusardi, A. (2017), *The Gender Gap in Financial Literacy: A Global Perspective*. Global Financial Literacy Excellence Centre, The George Washington University School of Business, Washington, DC. https://gflec.org/research/?item=11053
Hastings, J.S. and Mitchell, O.S. (2020), 'How Financial Literacy and Impatience Shape Retirement Wealth and Investment Behaviors', *Journal of Pension Economics and Finance*, **19**, 1–20.
Hausman, J. (1978), 'Specification Tests in Econometrics', *Econometrica*, **46**, 1251–71.
Jefferson, T. and Preston, A. (2005), 'Australia's 'Other' Gender Wage Gap: Baby Boomers and Compulsory Superannuation Accounts', *Feminist Economics*, **11**, 79–101.
Kingston, G. and Thorp, S. (2019), 'Superannuation in Australia: A Survey of the Literature', *The Economic Record*, **95**, 141–60.
Kuivalainen, S., Nivalainen, S., Jarnefelt, N. and Kuitto, K. (2020), 'Length of Working Life and Pension Income: Empirical Evidence on Gender and Social Differences from Finland', *Journal of Pension Economics and Finance*, **19**, 126–46.
Lusardi, A. and Mitchell, O.S. (2007), 'Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy and Housing Wealth', *Journal of Monetary Economics*, **54**, 205–24.
Lusardi, A. and Mitchell, O.S. (2011), 'Financial Literacy around the World: An Overview', *Journal of Pension Economics and Finance*, **10**, 497–508.
Lusardi, A. and Mitchell, O.S. (2014), 'The Economic Importance of Financial Literacy: Theory and Evidence', *Journal of Economic Literature*, **52**, 5–44.
Mincer, J. (1974), *Schooling, Experience and Earnings, National Bureau of Economic Research*. Columbia University Press, New York.
Möhring, K. (2015), 'Employment Histories and Pension Incomes in Europe', *European Societies*, **17**, 3–26.
Nolan, A., Whelan, A., McGuinness, S. and Maitre, B. (2019), 'Gender, Pensions and Income in Retirement', Economic & Social Research Institute, Dublin, Research Series Number 87.
Oaxaca, R. (1973), 'Male–Female Wage Differentials in Urban Labor Markets', *International Economic Review*, **14**, 693–709.
OECD (2019), *Pensions at a Glance 2019: OECD and G20*. OECD Publishing, Paris.
Ooi, E. (2021), 'Directors Who Serve Multiple Pension Funds: Are they Conflicted or Skilled?', *Journal of Banking and Finance*, **113**, 105764.
Polidano, C., Carter, A., Chan, M., Chigavazira, A., To, H., Holland, J., Nguyen, S., Vu, H. and Wilkins, R. (2020), 'The ATO Longitudinal Information Files (Alife) A New Resource for Retirement Policy Research', *The Australian Economic Review*, **53**, 429–49.
Preston, A. and Wright, R.E. (2019), 'Understanding the Gender Gap in Financial Literacy: Evidence from Australia', *The Economic Record*, **95**, 1–29.
Preston, A. and Wright, R.E. (2022), 'Gender, Financial Literacy and Pension Savings', IZA Discussion Paper No. 15250.
Productivity Commission (PC) (2018), 'Superannuation: Assessing Efficiency and Competitiveness', Australian Government Productivity Commission Inquiry Report No. 91 (December), Commonwealth of Australia.
Productivity Commission (PC) (2020) 'Why Did Young People's Incomes Decline?', Productivity Commission Research Paper, Commonwealth of Australia.
Summerfield, M., Garrard, B., Hahn, M., Jin, Y., Kamath, R., Macalalad, N., Watson, N., Wilkins, R. and Wooden, M. (2020), *HILDA User Manual – Release 19*. Melbourne Institute for Applied Economic & Social Research, Melbourne, VIC. https://melbourneinstitute.unimelb.edu.au/hilda/for-data-users/user-manuals
West, T. and Mitchell, E. (2021), 'Australian Women with Good Financial Knowledge Fare Better in Divorce', *Australian Journal of Management*, **1–22**, 203–24.
White, H. (1980), 'A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test of Heteroskedasticity', *Econometrica*, **48**, 817–38.