Retirement Savings: A Tale of Decisions and Defaults*

L.I. Dobrescu,† X. Fan,‡ H. Bateman,§ B.R. Newell,¶ A. Ortmann,‖ S. Thorp**

Abstract

This paper examines the default behaviour of the members of an industry-wide pension fund to assess both the prevalence of defaults and their impact on retirement accumulation. Preliminary empirical investigations indicate that preferences, demographic characteristics, and labor mobility can go a long way towards explaining the low active plan choice (or high defaulting) and overall level of savings. Using a structural dynamic life-cycle model, we then assess the ability of these different, empirically motivated, decision drivers to explain the data. In our model, individuals decide how much to save for retirement in a setting that combines an irreversible automatic enrolment with an active decision regime. Under automatic enrolment, there is an initial choice between two pension plans (defined benefit vs. defined contribution) into which employer contributions are paid, and then each period individuals decide on the personal voluntary contribution to the selected plan, and the type of investment allocation. We estimate the model using simulated method of moments on administrative data from an Australian pension fund. Our results show that the default structure, which specifies individual's outcomes when no choices are made, strongly influences wealth accumulation. We also find that defaults tend to be quite sticky, both over time and across decisions. Overall, our findings suggest that if defaults are not carefully chosen, retirement savings can be severely affected.

Key Words: pension defaults, retirement savings, method of moments.

JEL Classification: H8, J26, J32.

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†Corresponding author. School of Economics, University of New South Wales, Sydney 2052, Australia. Email: obrescu@unsw.edu.au

‡CEPAR, University of New South Wales, Australia

§School of Risk and Actuarial Studies, University of New South Wales, Australia

¶School of Psychology, University of New South Wales, Australia

‖School of Economics, University of New South Wales, Australia

**Finance Discipline Group, University of Technology, Sydney, Australia

1 Introduction

Recent reforms of social security systems around the world have put individuals more and more in charge of their own financial security after retirement. At the same time, many of the financial decisions that households must make (i.e., savings rate, portfolio allocation, buying health or life insurance, etc.) are becoming increasingly complex. One potential consequence of these contrasting forces is that individuals delay making these decisions, possibly incurring substantial reductions in their long-run wealth accumulation (Madrian and Shea, 2001; Iyengar, Huberman and Jiang, 2004). Or, they can rely on default options that specify an individual's outcome when no choice is made. In theory, defaults should not matter as long as individuals can easily opt out. In practice, however, defaults tend to be sticky (Madrian and Shea, 2001; Choi et al. 2002, 2004; Cronqvist and Thaler, 2004), even if they lead to inferior outcomes (Choi, Laibson and Madrian, 2011).[1] Hence, if individuals remain passive and defaults are not carefully chosen, suboptimal retirement outcomes may result (Goda and Manchester, 2013; Carroll et al., 2009).

To address this problem we first must ask why individuals rely so often on default options in their pension choices. Is it preferences, demographic characteristics, or labor mobility? And given the low participation in pension decisions, what is the impact of default provisions on retirement savings?

To answer these questions, we first identify the empirical elements of the choices related to pension plan and voluntary contributions. Using a structural dynamic life-cycle model, we then assess the ability of different, empirically motivated, decision drivers to explain the data. Overall, both our reduced form and structural model aim to shed light on what drives the low active plan choice (or high plan defaulting) and savings inadequacy.

We focus on one of Australia's largest pension funds, UniSuper, which covers all employees of the higher education and research sector. UniSuper is a hybrid fund that offers both defined benefit (DB) and accumulation or defined contribution (DC) plans. The DB plan provides retirement benefits calculated according to a set of formulae based on indi-

[1] See Sunstein (2013) for a review of the recent literature on defaults and DellaVigna (2009) for studies documenting their effects and the way they challenge the economic assumption of rational decision-making.

vidual earnings and service (i.e., contribution years). The DC plan provides benefits based on contributions and subsequent investment market performance. Initially, all *permanent employees* (i.e., individuals employed on contracts of two years or more) are enrolled by default in the DB plan, and have one year to make an irreversible change to the DC option. Those who do not actively choose a DC retirement plan by the end of the first year of tenure, remain permanently in the default (DB) plan. Additionally, individuals must also choose an initial level of voluntary contributions, which can be actively changed in subsequent periods. In contrast, *casual employees* (i.e., individuals employed on contracts of less than two years) have access only to a DC plan (henceforth DC-casual plan). Yet, they can choose the level of voluntary contributions just like their permanent counterparts. Unlike the latter though, the level of employer contributions for casuals is significantly lower (9% instead of 17% for permanent staff). Finally, all employees can choose the investment allocation (for their DC balance) from a menu of options (or stay with the default one).

A distinctive feature of UniSuper is that the permanent employees' choice to opt out of the DB plan is limited to a specific time period. Previously, only Goda and Manchester (2013) included a choice deadline in their setting, but they did not allow individuals to simultaneously choose the plan and the level of contribution rates to the selected plan.[2] The presence of a 'deadline' on the choice between the two plans is crucial. On the one hand, decisions regarding portfolio allocations, contributions or savings rate can be made each pay period and so can be corrected if mistakes are believed to have been made. The non-reversible choice between two pension plans (DB vs. DC), on the other hand, can lead to substantially different retirement savings profiles because these plans differ radically in their accrual patterns and risk characteristics.

Our empirical analysis shows that the default (DB) plan is highly predominant. Indeed, less than 25% of the permanent employees in our sample are actually enrolled in the DC plan. The DB members tend to be middle-aged, married, with 1.8 children on average, and roughly 11 years of service. Permanent staff who are DC members, on the other hand, are

[2] Additionally, the results in Goda and Manchester (2013) are valid only for ages around 45 where they utilize the policy discontinuity. Our results are more general, covering the entire life-cycle.

slightly older than the DB members, married, with roughly 15 years of service.[3] Finally, DC-casuals are typically in their 30s, with one child, and roughly 4 years of contributions. In terms of voluntary contributions, only around 15%, 21% and 6% of the individuals in DB, DC and DC-casual plan, respectively, take advantage of this option.

For our multivariate empirical analysis, we separate the sample by: i) employment type, based on the employee being permanent or casual, and ii) risk attitude, as shown by whether the pension balance is invested in a balanced portfolio (the default option) or not. We split the sample this way for two reasons. First, we need to account for the employment type since the corresponding plan options are different. Second, choosing an investment allocation other than the default implies at least some understanding of the various options available. This understanding might translate into active choices regarding other financial decisions, like plan selection or voluntary contributions. For instance, 72% of those who opted for the non-default (DC) plan also have non-default investment allocations. Casuals, on the other hand, who cannot choose their plan, mostly do not opt out of the default allocation either, with 82% remaining in this option.

Overall, we find that the factors determining plan selection and contribution rates are broadly the same for the two groups. For permanent employees, the likelihood of selecting the DC plan increases with age, wage and years of contribution and is lower for those less educated and those who chose a default investment allocation. Married people are both more likely to opt for a DC plan and have a higher account balance. Females, who are more likely to face career interruptions due to maternity leave for instance, have lower pension balances, but are more likely to voluntarily contribute. Unsurprisingly, being highly educated is positively associated with both higher probability to voluntarily contribute and higher account balances, while having children has a negative effect on both. Opting for a default investment allocation is associated with worse outcomes along all three dimensions (i.e., selecting a DC plan, voluntarily contributing and overall pension balance), regardless of the type of employment contract. For casuals, job-related factors like wage, years of

[3] This might be related UniSuper being a DB-only plan prior to around 1998, when all (DB) members were given a one-off opportunity to switch to DC.

contribution, and the number of employers contributing also play an important role, as does holding insurance. All this points to these members (i.e., casuals) being more actively involved in supplementing their account balance.

Next, we construct a quantitative model to replicate these findings. In our model, individuals make decisions on consumption and on how much they save for retirement. A novel feature of our model is that it captures the impact of default provisions in a setting that combines an irreversible automatic enrolment decision with an active decision regime. Under automatic enrolment, permanent employees initially choose between two pension plans (DB vs. DC), and then each period they actively decide i) the rate of voluntary contributions to the plan they selected, and ii) whether to opt out of the default (balanced) investment allocation or not. For casuals, the decisions are restricted to choosing the investment allocation and the level of voluntary contributions they make to their pre-defined DC-casual plan. We assume that individuals will select the policy (i.e., the plan and contribution schedule) that maximizes their expected lifetime utility. We use simulated method of moments (SMM) to estimate the model separately by gender and employment type.[4]

Our life-cycle models are consistent with the empirical findings for both permanent and casual employees. First, we find that defaults are sticky, both over time and across decisions. For instance, only a few people opt out of the default (DB) plan and more than half remain in the default (balanced) investment allocation. We also find an increasing incidence and level of voluntary contributions with age, in line with the data.

Finally, we measure the effect of default stickiness on retirement savings by performing-ing several counterfactual experiments to study what would have happened to a member's retirement wealth had the default structure been different. Specifically, changing the default plan for permanent employees from DB to DC, leads to a 9.5% and 18.0% net increase in total pension wealth for males and females, respectively. This is not surprising given the investment performance reported by UniSuper. And replacing the formula-based DB benefit with a market-contingent DC benefit is even more beneficial for women, who have shorter

[4]We opt for this strategy because of computational time reasons. Note that these categories are completely separate, i.e., there are no interactions or cross-effects between them.

job tenure and lower wages on average. Additionally, defaults continue to be sticky when the standard investment option is either the alternative low or high risk allocations, with the former leading to less accumulated wealth and the latter to more retirement savings. In both cases, however, the loss (or gain) is quite small. Allowing permanent employees to freely switch between DB and DC brings by far the highest pension wealth gains (5.5% for men and 9.3% for women). Conversely, eliminating only the cost of switching out of the default investment option leaves wealth roughly unchanged, for both permanent and casual staff.

Our analysis contributes to understanding both the determinants of retirement plan selection and the role of default provisions on retirement savings behavior. So far, the consensus from studies of plan selection has been that the main drivers of retirement wealth are individual risk preferences, demographic characteristics, and job tenure (Clark and Pitts 1999; Clark, Ghent and McDermed 2006; Manchester, 2010; Brown and Weisbenner, forthcoming).[5] Our empirical results are consistent with these findings. Some international evidence, however, also supports the notion that a large number of choice options causes confusion, which leads to high rates of default (Tapia and Yermo, 2007).[6] Our simulations replicate these facts in the context of the Australian higher education sector and quantify the large impact of default provisions on savings. In this respect, our paper is closely related to studies of pension plan choice (e.g., Bodie et al., 1988; Blake, 2000; Gerrans and Clark-Murphy, 2004; Brown et al., 2004; Cocco and Lopes, 2011; Gerrans and Clark, 2013) and on the role of defaults in decisions regarding participation (e.g., Madrian and Shea, 2001), contribution rates (e.g., Choi, Laibson, Madrian and Metrick, 2004), asset allocation (e.g., Choi, Laibson and Madrian, 2005; Hedesstrom, Svedsater and Garling, 2004), and distributions from DC plans (Mitchell, Mottola, Utkus and Yamaguchi 2009). Additionally, by allowing for 'active choices' (i.e., voluntary contributions and investment allocations), we also contribute to the recent literature investigating the relevance of individual heterogeneity in designing and implementing default provisions in the context of plan enrolment (Carrol et al., 2009; Handel,

[5] Similar to our paper, these studies use data from various institutions, such as universities, that offer individuals a choice between enrolling in either a DC or a DB plan.

[6] Hence, countries offering a wide choice of pension funds, such as U.S., Sweden or Australia tend to have fewer people making active choices and so, higher proportions of people enrolled in default options (Benartzi et al, 2012; Choi et al., 2004; Vanguard, 2008; Tapia and Yermo, 2007; Bateman et al., 2014).

2009; Chetty et al., 2013; Sunstein, 2013).

We present three new sets of results using higher-education sector data from Australia. First, we document the relation between defaults and risk attitudes (i.e., investment choices), pension plan choice, and the level of voluntary contributions. Second, we examine the association between demographics, preferences and job variables, and the likelihood of being a member of a DC plan, the level of voluntary contributions and retirement savings. Third, we quantify the effect of default settings on retirement savings in a context that includes both automatic enrolment and two 'active choices'. We do so by: i) providing a quantitative framework to solve for the optimal choice of pension plan and contribution scheme, and ii) assessing the welfare gains or losses from changing the default structure.

The remainder of the paper is organized as follows: Section 2 gives an overview of the UniSuper pension scheme in Australia. In Section 3 we describe the data and present the reduced form results on the determinants of retirement plan selection and contribution level choices. Section 4 develops the dynamic model, and Section 5 presents the parameter calibration and the estimation method. Results from the structural model are illustrated in Section 6 and counterfactual experiments are reported in Section 7. Section 8 concludes.

2 The UniSuper Pension Scheme

Australia has roughly 200 large superannuation funds. Among these funds, UniSuper is the superannuation fund for employees of Australia's higher education and research sector. It is one of Australia's largest superannuation funds with around 460,000 members and roughly $30 billion in assets. UniSuper is a hybrid fund (i.e., it offers both DB and DC plans), with member arrangements dependent on employment status, earnings, and the workplace agreement between the employee and employer.[7]

The UniSuper pension plan features are summarised in the Appendix (see Table A.1). Casual employees and staff on short-term contracts (of less than two years) are enrolled in the DC plan offered by UniSuper (known as Accumulation 1). Members of this plan hold

[7]Industrial agreements mean that, unlike most workers in Australia, employees of universities may not elect to have their employer contribute to a pension plan other than UniSuper.

individual accounts with balances that depend on contributions and investment earnings, less taxes, administrative and investment management fees, and insurance premiums.[8] Under the Australian retirement savings regulations (known as Superannuation Guarantee), employers must contribute at least 9% of ordinary time earnings for any employee earning at least $450 per month.[9] Employees can make additional ('voluntary') contributions from either pre- or post-tax earnings. These contributions can be made regularly or irregularly, and for low income earners, they may attract an annual government co-contribution of up to $1,000. Individuals in this component of the pension plan may also select from a menu of 15 investment options varying by projected returns, risk, asset allocation and management fees. Limited movement between investment options is allowed. If new members do not select an investment option, their contributions go to a default investment option. The default is a diversified 'Balanced' investment option with 70%:30% allocation to growth:defensive assets.

Staff on longer-term (of two years or more) or continuing (tenured) contracts are offered a one-off choice between a DB and a DC plan (known as Accumulation 2). This choice is irreversible and must be made within the first 12 months of their contract. They receive employer contributions to their pension plan above the mandatory 9%, typically amounting to 17% of earnings.[10] In addition, individuals in this category are required to contribute a further percentage of their wage, labelled a 'standard member contribution'. The default rate of this standard contribution is 7% of (post-tax) earnings. Apart from the higher employer contribution rates and some additional insurance coverage, the features of the DC plan available to long-term staff are similar to those described above for short-term staff.

Standard DB plan benefits are based on an aggregate (employer plus employee) contribution of at least 21% of earnings after tax.[11] If employees who receive 17% employer contributions choose a standard contribution of 7%, then 3% of their employer contribution

[8] Members receive life, total and permanent disability insurance coverage by default, but may vary their level of coverage, elect to also receive income insurance or opt out entirely.

[9] Many casual employees earning less than $450 are automatically enrolled, receiving the 9% anyway.

[10] A very small minority of employees receive a 14% contribution.

[11] In the absence of this contribution rate, entitlements are reduced. Employees who receive a 14% employer contribution must make an additional 'standard member contribution' of 7% to achieve this 21%. The majority of employees, who receive a 17% employer contribution, must additionally contribute at least 4.45% of earnings after tax. The extra 0.45% is to cover the 15% contributions tax.

is allocated to a DC component, which leaves a contribution of 21% of earnings into the DB component. Any further voluntary contributions are also allocated to the DC component. Employees who elect to reduce their standard member contributions below the thresholds have their retirement and death entitlements reduced in proportion to the reduction in their standard member contribution and are not eligible for optional insurance cover. The decision to reduce standard contributions cannot be reversed. Since for most DB members, part of the standard contributions and any voluntary payments are allocated to the DC component (usually earning uncertain returns),[12] part of their final retirement benefit is also uncertain.

3 Data and Empirical Analysis

In our analysis we combine two datasets: (1) UniSuper administrative records at the individual level on pension plan choices, and (2) the Household, Income and Labour Dynamics in Australia Survey (HILDA).[13]

The first dataset consists of administrative records at the individual level on a random subsample of UniSuper members. As mentioned, UniSuper is a large superannuation fund covering all employees of Australia's higher education and research sector. Each month, the fund collects data on demographics, voluntary contributions and pension plan type, as well as some job (mobility) indicators. We use two waves of UniSuper data, corresponding to May and September 2012. We restrict our sample to individuals who were *active members* in Wave 1, according to whether they (or their employers) have made any contributions to the fund over the previous four months. After merging Waves 1 and 2 of the UniSuper data, our sample consists of 16,988 individuals that provide a total of 22,949 observations across the two waves (6,607 individuals appear only in Wave 2 because they form the refresher sample drawn for that wave).

For permanent employees, there are three sources of information about the pension accounts: the type of pension plan (DB or DC), the cumulative account balance and whether the individual contributed voluntarily to the pension plan.[14] Since casual employees do not

[12] Since DB members can choose the investment option to which their DC component balance is allocated.
[13] http://www.melbourneinstitute.com/hilda/
[14] We abstract from the decision to make standard member contributions because most of the individuals

have the option of choosing their plan type, we only observe their account balance and their voluntary contributions. To capture attitudes to risk, we use two variables denoting whether the individual i) purchased supplementary (disability) insurance, and ii) opted for the default investment allocation (i.e., the balanced investment option). We also use the number of employers currently contributing to the fund, the length of the contribution period (in years), the annual wage and the type of employment contract to account for job characteristics. UniSuper data also provides information on a member's age and gender.

Since UniSuper collects limited background information on its members, we supplement the administrative records with economic variables from the last available wave of HILDA (i.e., wave 10). Specifically, HILDA contains information on consumption and wealth, real and financial assets, pension accounts (i.e., percentage and amount of employer/employee contributions), as well as health,[15] education,[16] marital status and number of children. To match HILDA data to UniSuper records we use an iterative procedure that first matches the datasets along eight individual dimensions (i.e., age, gender, quintiles for wage, pension account balance and years of contribution, whether the spouse contributes, type of pension plan selected and type of employment contract). For the observations unmatched in the first stage, the procedure drops one dimension (for example, whether the spouse also contributes) and attempts the matching again. Thus, after the initial matching along all eight dimensions, we employed the matching procedure three additional times, progressively excluding whether the spouse also contributes, the type of plan, and finally the type of employment contract.[17]

3.1 Descriptive statistics

The set of retirement savings choices differs by the type of employment contract. As a result, we examine the permanent and casual employees separately. We also divide the sample by

in our sample who decide to contribute this way stay in the default option, i.e., contribute 7% of their wage if permanent staff, and 0% if they are casuals. We are, however, accounting for the amount of these contributions when empirically analyzing the pension balance, as well as in the quantitative model when contructing the pension benefit functions.

[15] Health status is captured by a dummy equal to 1 if self-reported health is excellent or very good.

[16] We use two dummies denoting whether individuals have university level education (bachelor or honours, grad and postgrad diploma) and whether they have 12 years of education or less.

[17] As a result, we match 46% of our entire sample when bringing into UniSuper data the HILDA demographics, as well 100% and 71% of our panel sample when bringing wealth and consumption, respectively.

whether individuals choose to stay with the default investment (i.e., the balanced option) or not. We split the sample this way because we expect attitudes towards risk (and defaults) to be correlated with the choice of plan type and the decision to voluntarily contribute.

Panel A in Table 1 shows that this is indeed the case. Looking at those who opted for the default investment allocation, we find that the DC prevalence is roughly ten times smaller than the DB prevalence. Among those with non-default allocation, however, the situation is more balanced, with 46% of this subsample enrolled in a DC plan. Hence, plan and investment defaults appear to be sticky for permanent employees. This is also the case for casual employees, with less than a fifth not enrolled in the default investment allocation. For permanent employees however, this stickiness does not extend to other financial options offered by the fund. For instance, there is an almost 50:50 split between default and non-default members both in terms of making voluntary contributions and purchasing supplementary insurance. We note however that overall the proportion of members who take advantage of these opportunities is relatively limited (i.e., 17% and 10%, respectively for permanent employees; 6% and 4%, respectively for casuals).

All these differences between permanent/casual employees and default/non-default members are reflected in the pension accounts. Panel B in Table 1 reports mean and median account balance, contribution period and sources, also split by investment allocation options. As expected, permanent employees appear to have considerably higher pension balance, higher number of employers contributing and longer periods of contribution, as well as higher salaries than casuals. But in terms of investment allocations, default members appear to have lower salaries and so, lower pension balance, despite contributing for longer than the non-default members (at the median).

Table 2 reports the demographic characteristics of our sample. We note that the average UniSuper member with a permanent contract is around 45 years old, employed, married and with 1.8 children. As expected, a vast majority have a Bachelor/Honours degree or above. The average casual is seven years younger, between jobs, with 1.5 children and lower educational attainments. The conditional statistics in Table 2 show no further significant differences between those who do and do not default to the balanced investment option.

Table 1. Job and pension account features

Panel A.	All		Default Allocation		Non-Default Allocation	
	Permanent Employees	Casual Employees	Permanent Employees	Casual Employees	Permanent Employees	Casual Employees
Plan type:						
DB	3,831		2,861		1,150	
DC	1,192		212		980	
DC-casual		5,358		4,389		969
Is voluntarily contributing	854	342	424	206	430	136
Has supplementary insurance	536	218	270	112	266	106

Panel B.	All		Default Allocation		Non-Default Allocation	
	Mean	Median	Mean	Median	Mean	Median
Permanent Employees						
Account balance	256,430	148,313	259,825	141,204	251,817	159,417
Number of employers contributing	1.22	1.00	1.17	1.00	1.28	1.00
Years of contributions	12.55	11.91	12.75	12.17	12.28	11.58
Annual wage (estimated)	97,048	90,328	94,795	87,755	100,107	92,618
Casual Employees						
Account balance	28,626	3,871	18,797	2,676	73,037	23,115
Number of employers contributing	0.49	0.00	0.34	0.00	1.15	1.00
Years of contributions	5.49	3.75	4.84	3.00	7.9	6.33
Annual wage (estimated)	32,882	18,292	26,914	13,737	59,911	44,808

Notes: Panel A presents the total number of sample members ("All"), as well as the number of members in subsamples defined by participation in the default investment allocation ("(Non-)Default Allocation") and type of employment contract ("Permanent/Casual Employees"). Panel B presents mean and median for total amount accummulated in the pension account, number of employers currently contributing, years of contribution and estimated salary. The sample consists of members from the first (May 2012) wave of the Unisuper data, containing 5,023 permanent employees and 5,358 casual employees.

Table 2. Demographic characteristics

	All		Default Allocation		Non-Default Allocation	
	Permanent Employees	Casual Employees	Permanent Employees	Casual Employees	Permanent Employees	Casual Employees
Age	45.6	38.3	45.6	37.7	45.6	40.8
Male (%)	38.64	21.87	36.4	20.62	41.69	27.55
Married (%)	83.83	60.92	82.96	58.3	85.02	72.76
Number of children	1.84	1.54	1.85	1.53	1.82	1.59
Low education (%)	4.62	23.83	5.18	26.43	3.85	12.07
Medium education (%)	10.81	18.42	11.03	18.36	10.52	18.68
High education (%)	84.57	57.75	83.79	55.21	85.63	69.25
Good health (%)	49.69	57.69	48.32	58.35	51.55	54.7

Notes: The table presents averages for sample members ("All"), as well as the number of members in subsamples defined by participation in the default investment allocation ("(Non-)Default Allocation") and type of employment contract ("Permanent/Casual Employees"). The sample consists of members from the first (May 2012) wave of the Unisuper data, containing 5,023 permanent employees and 5,358 casual employees.

3.2 Empirical analysis

We examine the association between pension choices and risk, demographics and job characteristics by estimating linear models that correlate the accumulated pension savings with measures of such factors. The estimation methods that we use include ordinary least squares (OLS) and logit models. In all our main specifications, the outcome variables will be the three indicators of pension decisions, i.e., type of pension plan, pension account balance, and whether an individual contributes voluntarily. To tease out the attitudes towards risk and default, we use two variables indicating whether an individual purchased supplementary insurance and whether she opted for the default investment allocation. In terms of demographics, we include age, gender, marital status, number of children, whether in good health and education as described above. Finally, for job characteristics variables we include the log of annual wage, number of employers contributing and years of contribution. We also include an indicator for the survey wave, as pension decisions tend to be sticky. In all specifications, we present robust standard errors clustered at the individual level.

Table 3 reports the marginal effects (m.e.) from OLS and logit specifications (for the sample of permanent employees) and Table 4 reports m.e. for the sample of casuals. The first three columns in Table 3 present results from a logit model of individual decisions to participate in a DC plan (rather than stay in the DB), an OLS model on log of pension balance and, finally, a logit model on the decision to voluntarily contribute. The previous section revealed systematic differences between default and non-default allocation members that might transfer to other pension decisions. We thus present estimation results for the two groups next to the estimation results for the whole sample. We do this for a baseline observation defined as a 45-year-old, married female with a Bachelor degree (or above), 1.8 children on average, no supplementary insurance, 12 years of contributions and average wage, who opted for the default investment allocation.

3.2.1 Permanent employees

For the *decision to opt for a DC plan*, wage appears to be an important predictor, both for the whole sample and for the two default/non-default investment subsamples. A unit increase in log wage, which roughly corresponds to a 100% increase in wage relative to the baseline, significantly increases the DC plan participation probability for the whole sample by 3.7%. The effect is larger in the non-default investment subsample (7.0%) than in the default one (2.6%). Moreover, changing the baseline from non-default to default investment allocation member decreases the participation in the DC plan by 34.9%, which is the cumulative effect of being in the default and being in the default interacted with log wage. Interestingly, years of contributions seem to have a small negative effect on the choice of DC plan in the default investment subsample, but a considerably high and positive one for the non-default members. This confirms our findings on default stickiness: Members who stay in the default allocation option are also more likely to stay in the default (DB) pension plan. Conversely, if they opted for the non-default allocation, they will also opt for a DC plan. Married individuals are significantly more likely to opt for a DC plan, possibly because of intra-household risk-sharing or because of an added need for job-market mobility that may make the DB less attractive. The marginal effect for the whole sample suggests that changing marital status from single to married increases the probability that an individual selects a DC plan by 5.1% (a significant change). Finally, age seems to have a small positive effect, while low education appears detrimental to the likelihood of choosing something other than the default plan. For instance, changing the education level from medium to low significantly decreases DC participation probability in the whole sample by 5.6%. This is a quantitatively large effect and underscores the importance of financial literacy (Lusardi and Mitchell, 2007). All these demographics-related results (for marital status, age and education) appear more pronounced in the non-default investment subsample than in the default one.

We now turn to the determinants of the *accumulated pension balance*. For the whole sample and the two subsamples, we estimate a linear regression model for the amount accumulated in the pension account measured in terms of log pension balance. Results are given by specifications (2), (5) and (8) in Table 3. As expected, older individuals with more years of contributions and more employers contributing will accumulate more in their pension account. This is also the case for individuals taking out supplementary insurance. Compared to women, men appear to have a significantly higher balance (the associated m.e. is 7.3%),

Table 3. Estimation results for plan selection, pension account balance and voluntary contributions indicator - Permanent Employees

Variable	All			Default Allocation			Non-Default Allocation		
	DC participation	Log balance	Voluntarily contributing	DC participation	Log balance	Voluntarily contributing	DC participation	Log balance	Voluntarily contributing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Age/10	0.013*	0.345***	0.122***	0.005	0.252**	0.102***	0.023*	0.462***	0.154***
	(0.006)	(0.079)	(0.005)	(0.005)	(0.103)	(0.006)	(0.014)	(0.121)	(0.008)
$Age^2/100$		-0.003			0.003			-0.012	
		(0.008)			(0.011)			(0.013)	
Male	-0.008	0.073***	-0.018**	-0.017*	0.074***	-0.027**	0.008	0.068**	-0.006
	(0.010)	(0.021)	(0.009)	(0.009)	(0.027)	(0.011)	(0.024)	(0.031)	(0.015)
Married	0.051***	0.339***	0.016	0.011	0.337***	0.021*	0.129***	0.339***	0.007
	(0.013)	(0.029)	(0.010)	(0.011)	(0.036)	(0.012)	(0.031)	(0.047)	(0.017)
Low education	-0.056**	-0.090	-0.003	-0.019	-0.144*	-0.012	-0.123*	-0.014	0.011
	(0.028)	(0.061)	(0.020)	(0.024)	(0.078)	(0.022)	(0.070)	(0.097)	(0.037)
High education	0.010	0.254***	0.019*	0.007	0.225***	-0.009	0.016	0.289***	0.068***
	(0.016)	(0.032)	(0.011)	(0.013)	(0.038)	(0.013)	(0.037)	(0.057)	(0.020)
Children	0.004	-0.018***	-0.011***	-0.0007	-0.016**	-0.010***	0.010	-0.019**	-0.012***
	(0.003)	(0.006)	(0.003)	(0.003)	(0.007)	(0.003)	(0.007)	(0.009)	(0.004)
Good health	0.015	0.004	-0.016*	0.006	0.033	-0.004	0.032	-0.036	-0.031**
	(0.009)	(0.017)	(0.008)	(0.008)	(0.023)	(0.010)	(0.022)	(0.027)	(0.013)
Suppl. insurance	0.019	0.074***	0.012	0.019	0.070***	0.019	0.032	0.073**	0.004
	(0.013)	(0.021)	(0.011)	(0.013)	(0.027)	(0.014)	(0.031)	(0.031)	(0.017)
Log annual wage	0.037**	1.108***	0.010	0.026**	1.189***	0.015	0.070**	1.142***	-0.001
	(0.015)	(0.037)	(0.010)	(0.012)	(0.034)	(0.013)	(0.035)	(0.040)	(0.018)
Default allocation	-0.349***	-1.286**	-0.044***						
	(0.009)	(0.514)	(0.007)						
Default alloc X Log wage		0.113**							
		(0.044)							
Years of contribution	0.009***	0.090***	0.0007	-0.004***	0.097***	0.0009	0.032***	0.082***	0.0005
	(0.001)	(0.002)	(0.0006)	(0.0007)	(0.002)	(0.0008)	(0.002)	(0.002)	(0.0009)
Employers	-0.006	0.048***	0.005	0.001	0.066***	0.004	-0.016	0.019	0.007
	(0.005)	(0.009)	(0.004)	(0.004)	(0.011)	(0.005)	(0.013)	(0.013)	(0.007)
Wave 2	X	X	X	X	X	X	X	X	X
Observations	10,421	10,471	10,471	5,967	5,965	5,967	4,454	4,452	4,424
Model Fit	Ps R^2: 23.6%	R^2: 75.8%	Ps R^2: 14.2%	Ps R^2: 1.9%	R^2: 77.7%	Ps R^2: 12.6%	Ps R^2: 15.4%	R^2: 73.4%	Ps R^2: 15.6%

Notes: All specifications are logit models (marginal effects reported), except for (2), (5) and (8), which are OLS. The Default (Non-Default) Allocation columns present results for the subsamples who opted for (out of) the default investment allocation. Standard errors (robust, clustered by individual id) are in parentheses below estimated parameters. ***p-value<0.01, ** p-value<0.05, * p-value<0.1.

probably because they are less likely to have prolonged career interruptions, like maternity leave. Being married and highly educated appear crucial drivers of retirement savings, both in the whole sample and in the two subsamples. The number of children has a significant negative effect, which can suggest their role as competing alternative investments to retirement savings (Scholz and Seshadri, 2009a). Notably, all these effects hold for both the default and non-default investment subsamples. Pension balance elasticity of wage is roughly 1.11 for the whole sample, and 1.19 (1.14) for the subsamples of default members (non-default members). These high figures are due to the fact that both employers and employees contribute, and an increase in wage will affect the pension balance via both these channels. Finally, being in the default allocation has a large negative effect on the log of the account balance (the m.e. is -1.17). This is the result of a negative (and significant) effect of being in the default allocation and a positive (and significant) effect of the interaction between being in this default and wage on account balance.

As for *voluntary contributions*, older people and women appear more likely to use this option to increase their retirement savings. This is not surprising as i) older people are closer to retirement and so, more conscious of the importance of retirement savings, and ii) most women have career interruptions and thus use voluntary contributions to insure their retirement savings against such events. Unsurprisingly, highly educated people are more likely to contribute than those with medium achievements, while having two children, for example, will decrease the probability of making extra contributions by 2.2%. Once more, the defaults appear sticky: compared to a non-default allocation member, a default member has also a 4.4% lower probability of opting out of the zero voluntary contributions default. While statistically insignificant for default allocation members, being healthy (and facing a higher work longevity) decreases the chances to voluntary contribute by 3.1% for non-default members, which may reflect the trade-off between working longer and saving at a higher rate.

3.2.2 Casual employees

Casuals do not have the option of choosing their pension plan type (i.e., they are automatically enrolled in a DC-casual plan), and also receive a substantially lower employer contribution than permanent employees. Furthermore, they receive substantially lower salaries, with an annual mean wage of around $33,000. At this rate, almost 70% of the casuals in our sample should be below the poverty line. This is not likely to be the case as, for most of the casuals, working in the university sector either represents a secondary job (that supplements the main income source) or is a part-time job (especially for students). As a result, the factors affecting the overall pension balance for casuals and whether they voluntarily contribute are slightly different. Results are presented in Table 4. We first note that the factors that affect voluntary contributions for permanent employees also appear to be active for casuals. However, job-related factors like wage, years of contribution and the number of employers contributing also play an important role, as does taking supplementary insurance. These findings point to casuals being more actively involved in supplementing their account balance. Additionally, both voluntary contributions and account balance appear to increase with age, but for account balance this happens at a decreasing rate (i.e., the coefficients of age and age^2 are positive and negative, respectively). Surprisingly, both high and low education have a negative impact. While having low education implies perhaps a worse understanding of pension choices, it is not clear why having a high education would be detrimental to the pension balance.We must consider, however, that high education individuals are more likely to be employed as permanent staff and so, for the ones that are employed as casuals there must be special circumstances at play that are not directly observable in the data.[18] It is worth noting that being healthy (and facing a higher work longevity) has a significant negative effect on the pension balance only for the default investment members.

3.3 Summary

We have provided an in-depth empirical analysis of the choice of pension plan type, the accumulated pension balance and of voluntary contributions. Our results confirm that defaults are very sticky (Fellner and Sutter, 2009; Carroll et al., 2009; Chetty et al., 2012). Indeed, more than 75% of the permanent employees stay in the default (DB) plan, and more than

[18]This might be due to highly educated casuals having a main pension account with a different fund (corresponding to their primary job) and UniSuper not allowing them to consolidate all their pension accounts in these alternative funds.

Table 4. Estimation results for pension account balance and voluntary contributions indicator - Casual Employees

Variable	All		Default Allocation		Non-Default Allocation	
	Log balance	Voluntarily contributing	Log balance	Voluntarily contributing	Log balance	Voluntarily contributing
	(1)	(2)	(3)	(4)	(5)	(6)
Age/10	0.378***	0.015***	0.346***	0.011***	0.749***	0.057***
	(0.088)	(0.001)	(0.099)	(0.001)	(0.218)	(0.007)
Age^2/100	-0.043***		-0.042***		-0.071***	
	(0.010)		(0.012)		(0.026)	
Male	-0.025	-0.005*	-0.039	-0.003	0.061	-0.015
	(0.026)	(0.003)	(0.029)	(0.003)	(0.057)	(0.018)
Married	0.150***	0.004	0.126***	0.002	0.281***	0.017
	(0.025)	(0.003)	(0.028)	(0.003)	(0.058)	(0.017)
Low education	-0.232***	-0.003	-0.217***	-0.001	-0.352***	-0.027
	(0.038)	(0.004)	(0.041)	(0.004)	(0.107)	(0.027)
High education	-0.065**	0.001	-0.068**	0.001	-0.020	0.012
	(0.031)	(0.003)	(0.034)	(0.003)	(0.076)	(0.018)
Children	-0.015	-0.002*	-0.004	0.001	-0.049**	-0.006
	(0.011)	(0.001)	(0.012)	(0.001)	(0.022)	(0.005)
Good health	-0.051**	-0.002	-0.054**	-0.002	-0.052	-0.00001
	(0.022)	(0.002)	(0.024)	(0.002)	(0.054)	(0.015)
Suppl. insurance	0.132**	0.009**	0.169**	0.012***	0.069	0.017
	(0.057)	(0.004)	(0.071)	(0.004)	(0.090)	(0.022)
Log annual wage	0.668***	0.010***	1.061***	0.008***	0.657***	0.027***
	(0.030)	(0.001)	(0.012)	(0.001)	(0.036)	(0.007)
Default allocation	-4.366***	-0.015***				
	(0.328)	(0.003)				
Default alloc X Log wage	0.395***					
	(0.031)					
Years of contribution	0.167***	0.001***	0.169***	0.001***	0.150***	0.003*
	(0.003)	(0.0002)	(0.003)	(0.0002)	(0.006)	(0.001)
Employers	0.167***	0.005***	0.200***	0.005***	0.067**	-0.0006
	(0.016)	(0.001)	(0.020)	(0.001)	(0.027)	(0.008)
Wave 2	X	X	X	X	X	X
Observations	12,504	12,528	10,306	10,328	2,198	2,200
Model Fit	R^2: 84.6%	Ps R^2: 19.0%	R^2: 84.0%	Ps R^2: 17.6%	R^2: 72.2%	Ps R^2: 11.6%

Notes: Specifications (1), (3) and (5) are OLS models, while (2), (4) and (6) are logit (marginal effects reported). The Default (Non-Default) Allocation columns present results for the subsamples who opted for (out of) the default investment allocation. Standard errors (robust, clustered by individual id) are in parentheses below estimated parameters. ***p-value<0.01, ** p-value<0.05, * p-value<0.1.

75% of these also have a default investment allocation. Casuals, who have only one plan option available (DC), appear to mainly stick with the default allocation, with less than 20% choosing otherwise. We observe that participation in the DC plan increases with age, wage and years of contribution, and is lower for those with low education or with default investment allocation. Having children or being in the default allocation appears detrimental to the overall pension balance, while being an older male, married, highly educated, with high wage and many years of contribution is positively associated with higher accumulated pension. Finally, females are more likely to voluntarily contribute than men, while the number of children, being healthy and choosing the default allocation reduces voluntary investing in the selected pension plan. For casuals, wage and risk attitude (as denoted by whether the individual is an insurance holder), as well as contribution years and number of employers currently contributing seem to be crucial for the decision to voluntarily contribute. However, in terms of actual amount in the pension account, those who are healthy and highly educated seem to be accumulating less. This is consistent with young educated individuals, who take casual second jobs in the university sector, being less engaged; it would also explain their high default rate on the investment allocation option.

4 The Model

In this section we develop a life cycle model of consumption and pension choices consistent with the facts presented in Section 3. We consider the problem of an individual, who plans to retire at age $R = 65$, faces a stochastic time of death and lives to a maximum age $T = 100$. For simplicity, the retirement age R is assumed to be exogenous and deterministic. Let t denote adult age, and s_t denote the probability that the individual is alive at time $t+1$, conditional on being alive at time t. While alive, in each period, the individual derives utility from the consumption of a single good, according to

$$u(c_t) = \frac{c_t^{1-\gamma} - 1}{1-\gamma}, \tag{1}$$

where c_t is the level of time t consumption and $1/\gamma$ is the intertemporal elasticity of substitution. When an individual dies, she values her total bequeathable wealth a_t^B, according to a bequest function $b(a_t^B)$,

$$b(a_t^B) = \theta \frac{\left(a_t^B + k\right)^{1-\gamma}}{1-\gamma}, \tag{2}$$

where θ is the bequest weight, k determines the curvature of the bequest function,[19] and bequeathable wealth a_t^B is the sum of both pension wealth $a_t^{DB/DC}$ and non-pension wealth a_t. Below we describe in detail the DB and the DC plan wealth accumulation processes.

We assume an individual starts working at age t_0 and while working she earns an annual wage w_t. We use a traditional Mincer (1958) type specification for the wage equation, where the logarithm of wages at time t, $\ln w_t$, is a function of age and years of service,[20]

$$\ln w_t = \lambda_0 + \sum_{k=1}^{4} \lambda_k t^k + \sum_{k=1}^{2} \lambda_{4+k} \tau^k + \xi_t, \tag{3}$$

$$\xi_t = \phi_w \xi_{t-1} + \epsilon_t^w, \ \ \epsilon_t^w \sim \mathcal{N}\left(0, \sigma_w^2\right). \tag{4}$$

where τ is the number of service years. Note that we also include an autoregressive term ξ_t with innovation ϵ_t, which follows an i.i.d normal distribution. The AR(1) process allows us to capture some level of persistence in wages among individuals, and will be represented by a discrete Markov process with N_ξ discrete state points.

At this stage, we differentiate between the model for permanent and for casual employees, as described below.

4.1 Permanent employees

Following the UniSuper choice architecture, we assume that individuals choose the type of pension plan (DB or DC), the amount of voluntary contributions and the investment allocation. First, upon becoming a UniSuper member, a permanent employee is automatically enrolled into the DB plan, which is the default (plan type) option in UniSuper. However,

[19] If $k = 0$ there is infinite disutility of leaving non-positive bequests. If $k > 0$, the utility of a zero bequest is finite.

[20] We use years of service to proxy for potential labor market experience; using only a quadratic in t yields almost identical results.

within the first year of UniSuper membership, he/she can irrevocably switch to the DC plan by submitting an application form. If the member does not switch within the first service year, the default (DB) plan enrolment becomes permanent. In the model, we assume that if the member decides to switch to a DC plan, a fixed utility cost u_p must be paid. This cost varies with age and captures the effort of researching, comparing and filing the forms,[21]

$$u_p = \exp\left(\nu_0^p + \nu_1^p t + \nu_2^p t^2\right). \tag{5}$$

After choosing the pension plan type, the employer and the employee start making their contributions,[22] which we model as a function of the employee's wage. Specifically, in each period the employer's mandatory contribution v_E and the standard employee contribution v_S are set to certain fixed shares of employee's gross income w_t. What is not fixed (but the individual can decide upon each period) are the voluntary contributions $v_t \in \{v_i, i = 1, 2...N_v\}$, which we model as a discrete choice among a number N_v of different contribution levels. The default choice for these contributions is 0%, and so, if individuals decide to make positive voluntary contributions, they would need to set up online transfers or mail cheques. In the model, if one chooses to make positive voluntary contributions, a switching cost u_{vc} needs to be paid. This cost captures the liquidity value of savings outside the pension plan, which we do not explicitly account for in the model, but is especially important for young employees and those with low non-pension wealth.[23] Hence, we model u_{vc} as a function of age and non-pension wealth,

$$u_{vc} = \nu_0^{vc} + \nu_2^{vc}\left(t - \nu_1^{vc}\right)^2 + \nu_3^{vc} \max\left\{0, \log\left(a_t\right)\right\}, \tag{6}$$

and interpret it in terms of utility lost.[24]

[21] Assuming $u_p = f(t)$ reconciles the pension plan-age profiles with the data, as specified in Section 5.1.

[22] We differentiate between employer and employee contributions because the way in which the benefits from these two sources accumulate differ with the type of plan selected by the employee. We assume all contributions are pre-tax and subject to 15% concessional tax rate, for the first $25,000 (concessional contribution cap). Any exceeding amount is subject to 46.5% tax rate.

[23] For example, one might need to save for a house down payment. The 2011 ABS Census recorded a 67% home ownership in Australia, with a greater proportion of housing being owned by mature and older people.

[24] We use log of wealth (instead of wealth level) to capture the diminishing marginal utility of wealth.

Each period individuals can choose whether to leave the balance accumulated in their DC component to be invested into the default (balanced) investment allocation, or to actively switch to a more (or a less) risky option. These investment options differ by expected return and risk, as specified below. If the member chooses a non-default investment option, either via an online account or by mailing the relevant form to UniSuper, a fixed switching cost (in terms of utility lost) u_{inv} needs to be paid. Similar to u_{vc}, this cost captures the extra effort of gathering information and completing the paperwork. Consistent with the data profiles on i) the proportion of individuals choosing the default investment option, and ii) the proportion of DC balance invested in this default option, we assume u_{inv} depends on age and the DC balance, [25]

$$u_{inv} = \exp\left(\nu_0^{inv} + \nu_1^{inv} t + \nu_2^{inv} t^2 + \nu_3^{inv} \max\left\{0, \log\left(a_{t,dc}^{DB/DC}\right)\right\}\right). \tag{7}$$

The defining characteristic of a DB plan is that the employer pays the employee a nominal benefit based on a formula related to the individual's age, service years (i.e., contribution years), level of contributions and average wage over the last years of continuous employment. However, the UniSuper DB plan includes both a genuine DB component and a separate DC component. Hence, there is substantial heterogeneity in the replacement rates under this type of contract. All the employee's voluntary contributions v_t will be made in the DC component, while his/her standard contributions v_S will be made into the DB component. As for the employer's contribution, a share αv_E will be made in the DB component, and the remaining $(1-\alpha)v_E$ will be transferred to the DC component. Hence, the amount of DB benefit is calculated according to[26]

$$a_{t+1}^{DB} = f_t^{ACF}(v_s) \cdot f_t^{LSF}(t) \cdot f^{ASF} \cdot \tau \cdot \overline{w}_t, \tag{8}$$

where f_t^{ACF} is the Average Contribution Factor (ACF) over the entire service time span,[27]

[25] Please note that we do not explicitly model the correlation among these three types of switching costs, but the correlation could be high, depending on the parameter estimates.

[26] See http://www.unisuper.com.au/~/media/4B64BFC32B0A4467B790D93C0A3EADFF.pdf

[27] For employees receiving employer contributions v_E of more than 9%, the contribution factor is 100% for

while f_t^{LSF} is the Lump Sum Factor (LSF), with

$$f_t^{LSF}(t) = \max\{18,\ \min\{23,\ 23 - 0.2\,(65 - t)\}\}/100. \tag{9}$$

Thus, for a member who is 65-years or older $f_t^{LSF}(t \geq 65) = 23\%$, while for someone 40-years or younger $f_t^{LSF}(t \leq 40) = 18\%$. We also assume permanent workers always work full-time and so, the Average Service Fraction (ASF) f^{ASF}=100%. Finally, the average wage over the last three years of continuous employment, $\overline{w}_t$, is calculated as

$$\overline{w}_t = \frac{1}{3}\left[w_t + g\left(w_{t-1}\right) + g\left(w_{t-2}\right)\right], \text{ and} \tag{10}$$

$$g\left(w_{t-j}\right) = \frac{1}{Pr\left(\xi_t\right)} \sum_{i=1}^{N_\xi} Pr\left(\xi_i\right) \cdot P\left(\xi_i, \xi_t\right) \cdot exp\left[\lambda_0 + \sum_{k=1}^{4} \lambda_k\left(t-j\right)^k + \sum_{k=1}^{2} \lambda_{4+k}\left(\tau - j\right)^k + \xi_i\right] \tag{11}$$

This is derived from the reverse of the Markov process (4) (Chung and Walsh, 1969), with N_ξ discrete state points, distribution $Pr(\cdot)$ and transition matrix $P(\cdot,\cdot)$.[28]

The DC account balance, on the other hand, is accumulated according to

$$a_{t+1}^{DC} = \begin{cases} (1+r_t)\cdot\left[a_t^{DC} + \left(v_t + (1-\alpha)\,v_E\right)w_t\right], & \text{if in DB} \\ (1+r_t)\cdot\left[a_t^{DC} + \left(v_t + v_S + v_E\right)w_t\right], & \text{if in DC} \end{cases} \tag{12}$$

where $r_t \in \left\{r_t^l, r_t^d, r_t^h\right\}$ is the rate of return corresponding to the investment allocation selected. There are three allocation options available, namely: i) a balanced option (which is the default and yields r_t^d), ii) a higher-risk/higher-return one (yielding r_t^h), and a iii) lower-risk/lower-return option (yielding r_t^l). This choice will have a significant impact on the sequence of returns individuals face. However, it will only affect the amount accumulated in the DC component (if they are in a DB plan) or in their DC account (if in a DC plan).

If an individual opts for the default allocation, we assume that their investment will yield

pre-tax standard contributions v_S of 5.25% or more, 97.4% for $v_S = 4.70\%$, 91.7% for $v_S = 3.55\%$, 86.0% for $v_S = 2.35\%$, 80.2% for $v_S = 1.20\%$, and 74.5% for $v_S = 0\%$.

[28]This simplification allows us to significantly reduce the computational burden, otherwise we have to carry (ξ_{t-2}, ξ_{t-1}) in the state space.

log-normally distributed returns based on a balanced portfolio with log gross return $\ln r_t^d$ given as the sum of a constant mean and a normal shock,

$$\ln r_t^d = r^d + \varepsilon_t^d, \text{ with } \varepsilon_t^d \sim N(0, \sigma^2_{\varepsilon_t^d}). \tag{13}$$

Conversely, if the higher risk allocation is chosen, investments yields a return rate r_t^h, with

$$\ln r_t^h = r^h + h\varepsilon_t^d, \text{ with } \varepsilon_t^d \sim N(0, \sigma^2_{\varepsilon_t^d}), \tag{14}$$

where $r^h > r^d$ is the mean return for the high risk asset and $h > 1$ is an arbitrary scaling factor that amplifies asset market shocks. Similarly, we define a relatively low risk investment as a re-scaling of the balanced portfolio,

$$\ln r_t^l = r^l + l\varepsilon_t^d, \text{ with } \varepsilon_t^d \sim N(0, \sigma^2_{\varepsilon_t^d}), \tag{15}$$

where $r^l < r^d$ is the mean return for the low risk asset and $l < 1$ is an arbitrary scaling factor that dampens asset market shocks.

To close the model we derive the budget constraint. We assume all workers cash out their pension as a lump-sum upon retirement at age $R = 65$, and there is only one risk-free asset in which individuals can invest (outside the annuity market) and that yields a constant gross interest rate r. The intertemporal budget constraint can be written as

$$a_{t+1} = \begin{cases} (1+r)\,a_t + (1 - v_t - v_S)\,w_t - c_t, & \text{if } t < R \\ (1+r)\,a_t + a_t^{DB} + a_t^{DC} - c_t, & \text{if } t = R \\ (1+r)\,a_t - c_t, & \text{if } t > R \end{cases} \tag{16}$$

Finally, we assume individuals face a borrowing constraint $a_{t+1} \geq \underline{a} > 0$, since $(1 - s_t) > 0$ in any period.

Timing of the events and Bellman equation. The dynamic problem can be viewed as a two stage optimization. At the beginning of the first period, each individual with asset

a_{t_0} and labor income shock ξ_{t_0} irrevocably chooses the pension plan type. The associated Bellman equation for period t_0 is therefore

$$V_{t_0}(X_{t_0}) = \underset{DB/DC}{Max} \{V_{t_0}(X_{t_0}|DB) + \zeta_{DB}, V_{t_0}(X_{t_0}|DC) - u_p + \zeta_{DC}\}. \tag{17}$$

where $X_t = \left(a_t, a_t^{(DB/DC)}, \xi_t, \tau, (DB/DC)\right)$ is the vector of state variables, (DB/DC) denotes the pension plan type (DB or DC), and u_p is the utility cost of choosing the DC (non-default) plan. We further assume there is an unobservable utility component in each option $\zeta_{DB/DC}$, which follows a type I extreme value distribution. This component captures the idea that the econometrician might not observe everything that affects each individual's decision.[29] Hence, the probability of choosing the DC plan is (McFadden, 1974; Rust, 1987)

$$Pr(DC) = \frac{\exp(V_{t_0}(X_{t_0}|DC) - u_p)}{\exp(V_{t_0}(X_{t_0}|DB)) + \exp(V_{t_0}(X_{t_0}|DC) - u_p)}. \tag{18}$$

After this stage, in each period the individual sequentially chooses voluntary contribution v_t (from the set $\{v_i, i = 1, 2...N_v\}$), investment allocation (from the set $\{r^d, r^h, r^l\}$), and optimal consumption c_t (before observing the interest rate realization) to maximize the discounted present value of life-time utility. Formally, the value of each discrete v_t level is

$$\tilde{V}_t(X_t, v_t) = V_t(X_t, v_t) + \zeta_{v_t}, \tag{19}$$

where ζ_{v_t} is the unobservable utility of the v_t choice. The deterministic value $V_t(X_t, v_t)$ is

$$V_t(X_t, v_t) = E\left\{\max_{r_t(v_t)\in\{r^d, r^h, r^l\}} \tilde{V}_t(X_t, v_t, r_t(v_t))\right\} - u_{vc} \cdot \mathbf{1}\{v_t \neq 0\}, \tag{20}$$

where $\tilde{V}_t(X_t, v_t, r_t(v_t))$ is the value of the investment choice r_t, defined as

$$\tilde{V}_t(X_t, v_t, r_t(v_t)) = V_t(X_t, v_t, r_t(v_t)) + \zeta_{r_t}, \tag{21}$$

[29] These terms allow for the possibility of individuals making mistakes, with the probability of error depending on the value difference among alternatives.

with ζ_{r_t} being the unobservable utility for the choice of r_t. The observable part is defined as

$$V_t\left(X_t, v_t, r_t\left(v_t\right)\right) = \max_{c_t\left(X_t, v_t, r_t\right)} u\left(c_t\left(X_t, v_t, r_t\left(v_t\right)\right)\right) - u_{inv} \cdot \mathbf{1}\left\{r_t \neq r^d\right\} + \\ + \beta E_t\left[s_t V_{t+1}\left(X_{t+1}\right) + \left(1 - s_t\right) b\left(a_{t+1} + a_{t+1}^{(DB/DC)}\right)\right], \tag{22}$$

subject to the budget constraint (16), where β is the time discount factor and

$$V_{t+1}\left(X_{t+1}\right) = E\left\{\max_{v_t \in \{v_i\}_{i=1}^{N_v}} \tilde{V}_{t+1}\left(X_{t+1}, v_{t+1}\right)\right\}. \tag{23}$$

We assume both unobservable utilities ζ_{v_t} and ζ_{r_t} follow type I extreme value distributions independently. Therefore, the calculation can be simplified as follows:

$$V_t\left(X_t\right) = \gamma_E + \log\left\{\sum_{v_t \in \{v_i\}_{i=1}^{N_v}} \exp\left[V_t\left(X_t, v_t\right)\right]\right\} \tag{24}$$

$$V_t\left(X_t, v_t\right) = \gamma_E + \log\left\{\sum_{r_t(v_t) \in \left\{r^d, r^h, r^l\right\}} \exp\left[V_t\left(X_t, v_t, r_t\left(v_t\right)\right)\right]\right\} - u_{vc} \cdot \mathbf{1}\left\{v_t \neq 0\right\}, \tag{25}$$

where $\gamma_E = 0.57721$ is the Euler constant. The discrete choice probabilities are

$$Pr\left(v_t = v_i\right) = \frac{\exp\left[V_t\left(X_t, v_i\right)\right]}{\sum_{v_t \in \{v_i\}_{i=1}^{N_v}} \exp\left[V_t\left(X_t, v_t\right)\right]} \tag{26}$$

$$Pr\left(r_t\left(v_t\right) = r^j\right) = \frac{\exp\left[V_t\left(X_t, v_t, r^j\right)\right]}{\sum_{r_t(v_t) \in \left\{r^d, r^h, r^l\right\}} \exp\left[V_t\left(X_t, v_t, r_t\left(v_t\right)\right)\right]} \tag{27}$$

Solving the model numerically. Because there is no analytic solution, the model is solved numerically. First, each of the continuous state variables $\left(a_t, a_t^{(DB/DC)}, \xi_t\right)$ is discretized into a certain number of gridpoints.[30] The value function and policy functions are then solved using backward induction: in period t, given that $(t+1)$ the value function and the policy functions are solved for every combination of points in the state space grid of

[30]The asset space and the DC balance space are each discretized into 35 gridpoints. The wage autoregressive term ξ_t is discretized into a 5-state Markov process following Kopecky and Suen (2010).

$X_t = \left(a_t, a_t^{(DB/DC)}, \xi_t, \tau, (DB/DC)\right)$,[31] we calculate the values and choice probabilities of (23)-(27) for each contribution level v_t and each corresponding investment choice $r_t(v_t)$, [32] with optimal consumption computed via the Euler Equation[33]

$$c_t(X_t, v_t, r_t)^{-\gamma} \geq \beta(1+r) E_t \left\{ s_t c_{t+1}^{-\gamma} + (1-s_t)\theta \left(a_{t+1} + a_{t+1}^{(DB/DC)} + k\right)^{-\gamma} \right\}. \qquad (28)$$

Finally, the choice probabilities will be calculated from (26) and (27). This mechanism starts from the last period where the terminal value is given by the bequest function.

4.2 Casual employees

The model for casual employees follows the same specifications as the model presented above for the permanent staff, except for two features. First, casuals do not have the choice of plan type, being enrolled by default in the DC-casual plan. Second, given the short-term contracts these employees have, we must model the separation risk, which affects the age of exit $\rho = t_0 + \tau$. Separation probabilities are assumed to follow an exponential hazard rate by age,[34] and are summarized by probabilities $p_\rho(t)$ where $\sum_{\rho=t+1}^{R} p_\rho(t) = 1$ for each t. Once separated, the employee still needs to wait until the eligible age to access the DC pension accumulated. We assume the separation is permanent and that men and women have different probabilities of continuing their work.

The Bellman equation for the case of casual employees then becomes

$$\begin{aligned} V_{t\geq t_0}\left(a_t, a_t^{DC}\right) = \underset{c_t, v_t, r_t}{Max} E\{\max_{v_t} \; E\{\max_{r_t(v_t)}\{\max_{c_t(r_t(v_t))} \; & u(c_t) + \beta s_t \left(1 - p_\rho(t)\right) E_t V_{t+1}\left(a_{t+1}, a_{t+1}^{DC}\right) \\ & + \beta\left[s_t p_\rho(t)\theta_c + (1-s_t)\right] b\left(a_{t+1} + a_{t+1}^{DC}\right)\} - u_{inv} \cdot \mathbf{1}\left\{r_t \neq r^d\right\} + \zeta_{r_t}\} \\ & - u_{vc} \cdot \mathbf{1}\left\{v_t \neq 0\right\} + \zeta_{v_t}\} \end{aligned} \qquad (29)$$

[31] The space of service year τ is integer and ranges from 0 to 49 $(= 65 - 16)$. With a binary pension type (DB/DC) and 50 gridpoints for τ, the dimension of X_t mounts from 12,250 gridpoints for period 16 to 612,500 gridpoints for period 65. For ages 66+, X_t has only 35 gridpoints in each period since there is only one state variable, a_t.

[32] We consider 6 different levels of voluntary contribution rates including 0%, and 3 different investment choices (r^d, r^h, r^l).

[33] The equality holds for the interior solution, and the inequality holds for a corner solution where the borrowing constraint binds.

[34] We also experimented with Weibull and Gompertz distributions, but found the exponential one to fit our data best.

where θ_c captures the option value of the DC-pension accumulation to a separated employee.

5 Calibrations and estimation method

Since it would be computationally too burdensome to estimate all parameters simultaneously, we use a two-step strategy (Gourinchas and Parker, 2002; Cagetti, 2003; French and Jones, 2011). In the first step, we estimate or calibrate some parameters to fix the data generating process for the state variables. In the second step, we use these estimated data generating processes to simulate life-cycle profiles for a large number of hypothetical individuals. The goal is to find the set of parameters that generate simulated profiles that match the data. For efficiency reasons, we estimate the model separately by sex and type of employment.

As we mentioned, we first calibrate the parameters that determine the survival probabilities, annual wages, the standard employee and the employer contribution rates, the pension factors, as well as the returns on investment. Specifically, survival probabilities s_t are calibrated to match the Human Mortality Database average survival probability between age t and $t+1$ in Australia. The parameters in the wage equation are determined using an OLS model with AR1 standard errors that associates the log of estimated wages to a quartic in age and a quadratic in years of service. The shock ξ_t is discretized and represented with $N_\xi = 5$ gridpoints. For voluntary contributions, we set the standard employee rates $v_S = 2.35\%$ for permanent employees (with a corresponding f_t^{ACF} of 86.0%)[35] and 0% for casuals. For employer contributions, if individuals choose a DC plan, we set v_E to 17% for permanent employees and 9% for casuals. For permanent employees with a DB plan, we allocate $\alpha = 100\%$ of employer's contribution v_E to the DB component (for a total of 17%), and the remaining $(1-\alpha)v_E = 0\%$ to the DC component.[36] We assume a constant interest

[35] The mean and median of the average contribution factor among UniSuper DB members is 84.8% and 87.3%, respectively. Upon enrolling to UniSuper, each member needs to choose a pre-tax standard contribution rate. The options are 8.25%, 5.25%, 4.70%, 3.55%, 2.35%, 1.20%, or 0%. Members can decrease their standard contributions any time (contribution flexibility), but they cannot subsequently increase it. Young employees usually have binding borrowing constraints, and so, cash has higher liquidity value for them. In such cases, they often choose a standard contribution smaller than 8.25%. This is why in the data we observe both small standard contributions and positive voluntary contributions.

[36] If a DB member makes 8.25% pre-tax standard contributions, then $\alpha = 82.3\%$. For any standard contribution of 5.25% or lower, no employer contribution goes into the DC component and so, $\alpha = 100\%$. Here $v_S = 2.35\%$, which implies $\alpha = 100\%$.

rate for non-pension wealth equal to 2.4%, which is the average real return for long-term (indexed) treasury bonds for the period 1982-2012.[37] For pension wealth, we set the interest rate parameters for the default and the two non-default options to match the risk and return targets stated in the UniSuper product disclosure statements. Specifically, we set r_t^d to 2.88%, r^l and r^h to 1.93% and 4.76%, respectively, $\sigma_{\varepsilon_t^d}$ to 0.064, l and h to 0.54 and 1.68 respectively. Following Ding (2012), we set the bequest shifter parameter k equal to the weighted average of the marital status-specific parameters, and take both $\underline{a}$ and $p_\rho(t)$ (i.e., casuals separation hazard rate) from the data.

We use Simulated Method of Moments (SMM) (McFadden, 1989; Pakes and Pollard, 1989) to estimate the following parameters[38]

$$\phi = \left\{\gamma, \beta, \theta, \left\{v_j^p\right\}_{j=0}^{2} / \theta_c, \left\{v_j^{vc}\right\}_{j=0}^{3}, \left\{v_j^{inv}\right\}_{j=0}^{3}\right\} \in \mathbb{R}^{14/12}.$$

The SMM matches the distributions related to pension plan, voluntary contributions and investment allocations to the corresponding moments of the same variables in the simulated sample. The objective is to find the vector of preferences $\widetilde{\phi}$ that simulates the distributions such that they fit the data best. To this end, we match total pension and non-pension wealth, voluntary contributions and the proportion of individuals making voluntary contributions, opting for the DC plan and remaining with the balance (default) allocation, all conditional on age cohort, sex and employment type, as well as the share of total pension wealth in the default investment option.

For efficiency reasons, we separately estimate four models, corresponding to the four sex/employment contract type combinations. For each model, we calculate the age-specific empirical moments in three steps. First, we select the appropriate subsample. Second, we break the data into five-year age cohorts as follows: the first cohort consists of individuals with ages below 25 in May 2012, the second cohort contains ages 25-29, and so on.[39] We use

[37] http://www.rba.gov.au/statistics/tables/index.html#historical

[38] Note that we estimate u_p for permanent employees and θ_c for casual employees.

[39] The last cohort, labelled "60-64", also contains a few observations on individuals 65+. Their data (i.e., on wealth and consumption, contributions and investments) is, however, not very different from the "60-64" cohort data and so, including the 65+ in the last cohort does not significantly alter the empirical moments.

two waves of UniSuper data, corresponding to May and September 2012. Finally, we take cell means by cohort,[40] for the balanced panel. For the share of total pension wealth in the default investment option, we use the figures from the 2012 UniSuper Annual Report.[41]

To compute the simulated moments, we first simulate $N = 10,000$ paths of individual choices, collecting the simulated values of each variable for each path.[42] Each employee starts the first service year with zero pension wealth. The initial conditions, including the non-pension wealth and the age in the first service year, are jointly drawn from the data. We then compute the set of moments conditional on the initial values of the state variables ∇_0 and on the parameters ϕ_0, and minimize J_T – the weighted sum of squared deviations of simulated moments from their empirical counterparts, where

$$J_T = \arg\min_{\widetilde{\phi}}[m_T - \frac{1}{N}m_N(\nabla_0, \widetilde{\phi})]'W[m_T - \frac{1}{N}m_N(\nabla_0, \widetilde{\phi})], \tag{30}$$

where m_T represents data moments and $m_N(\nabla_0, \phi_0)$ is the set of moments of each of the N simulated paths of the artificial economy. W is the weighting or distance matrix that almost surely converges to $W = S^{-1}$, where S is the limit, as $NT \to \infty$, constant full-rank matrix of the covariance of the estimation errors.[43]

For a given number N of paths, as $T \to \infty$, if the weighting matrix W is chosen optimally,

$$T[m_T - \frac{1}{N}m_N(\nabla_0, \widetilde{\phi})]'W[m_T - \frac{1}{N}m_N(\nabla_0, \widetilde{\phi})] \to \chi^2(j - k),$$

where j is the number of moments and k is the number of estimated parameters.[44]

[40] For pension and non-pension wealth, as well as for consumption, we deal with outliers by excluding the 1st and the 99th percentile of each data series.

[41] See http://unisuper.com.au/˜/media/Files/Forms%20and%20Downloads/Forms%20and%20Brochures/Annual%20reports/2012-Report-to-members.pdf

[42] Using more paths than 10,000 to compute moments didn't change results materially.

[43] As described in Andrews (1991), an optimal weighting matrix is obtained as the inverse of the variance-covariance matrix of the moment conditions evaluated at a set of first-step estimates, in which W is set equal to the identity matrix. This matrix is consistently estimated using the estimator proposed by Newey and West (1994), which places more weight on moments that are more precisely estimated. Implementing this method entails fitting the moments of the simulated series to their real data counterparts under the condition of $W = I$ and then using estimates from this stage to form the weighting matrix $W = S^{-1}$ for use in a second and final stage estimation of the J_T equation.

[44] The standard errors of the parameters are obtained using the Newey and West (1994) weighting matrix W and the first order derivatives of the moments conditions with respect to each parameter:

5.1 Identification

To address the question of which moments identify certain parameters, we proceed in two stages. Given that providing analytic proof is not possible, we first present some intuitive arguments as to why each parameter might significantly affect only a subset of moments. Second, to validate these intuitions, we also established identification in a local neighborhood of a selected subset of parameters via simulation.[45]

Altering one of the target data moments, however, changes more than one parameter. The parameters γ, θ and β, for instance, are jointly identified by the first order moments of the wealth profiles. A high estimate of the coefficient of relative risk aversion for consumption makes individuals accumulate more. Similarly, a higher discount factor means they are more future orientated and dissave more slowly than with a lower β. And having a strong bequest motive (high values of θ) also generates higher savings. We better identify these parameters by requiring the model to also match the first order moments of pension wealth by age. To see this, note first that the Euler equation can give some intuition for the identification of γ, β and θ. Ignoring bequests, the Euler equation shapes the savings profiles, i.e., the non-pension wealth profiles (at least before retiring and cashing out the pension benefits). So, these wealth profiles are largely dictated by a combination of time discounting (β) and taste for smoothing (γ). However this equation identifies the product $\beta s_t(1+r)$, but not its individual elements. Therefore, lower values of r and/or s_t can lead to higher estimates of β. To check whether the interest rate can be separately identified, we set its value to the maximum rate observed for the high risk-high return investment option and re-estimate the models. As expected, the realized returns are on average higher than our benchmark assumption of 2.4%, and our β's are accordingly lower. We therefore conclude that we can only identify $\beta(1+r)$, but not each term separately.

Going back to the Euler equation, we note that bequest motives are related to the total

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$se = \frac{1}{\sqrt{T}}(DW^{-1}D')^{-1}$ with $D' = \underset{T}{plim}\left\{ \frac{\partial\left[m_T - \frac{1}{N}m_N(\nabla_0,\phi)\right]}{\partial\phi}\Big|_{\phi=\widetilde{\phi}} \right\}$.

[45] To do so, we compute the moments and fit the value function at and around the estimated parameter values. We then check to what extent the resulting simulated profiles fit the empirical ones as we vary the value of the selected parameter and verify the fitted function shape in a neighbourhood of the selected parameter value.

amount of resources that could be passed on as bequethable wealth. Thus, the bequest weight θ will apply to both non-pension and pension wealth, and we additionally identify this parameter via the age-profile of the median pension account balance.

Turning to switching costs, we note that their identification comes from the observations where employees actually switched away from defaults. For instance, to identify the age parameters of the cost associated with opting out of the DB plan, we match the age-specific proportion of people that switched to a DC plan. To capture the cost of making voluntary contributions, we match the median level of voluntary contributions by age to identify ν_3^{vc} and the age-specific proportion of people contributing to identify the age coefficients. For the investment switching costs, the parameter ν_3^{inv} of $\log\left(a_{t,dc}^{DB/DC}\right)$ is identified by the share of DC wealth invested in a balanced investment option, while ν_1^{inv} and ν_2^{inv} are once again identified by the proportion of people with default allocations by age.

Finally, note that we did not directly fit consumption. The next section discusses in more detail the model's performance in fitting this variable, effectively presenting an informal over-identification test. For permanent staff, it is remarkable that the model manages to endogenously replicate the increasing consumption patterns with age observed in the data. And, for females, it also generates lower consumption than for men, supporting previous findings on gender patterns in non-durable spending (Blow et al., 2004). For casuals, the worse fit is due to higher data volatility, although the profile shape is fairly well maintained.

6 Results from the structural model

This section presents the results obtained via SMM and discusses our model's ability to recreate the patterns observed in the data. Specifically, Table 5 presents the parameter estimates, while Table 6 displays selected moments (empirical vs. simulated),[46] for both permanent and casual employees.

[46]Despite fitting only the share of total pension wealth invested in the default allocation option, we also obtain a very good fit for the share split of total pension wealth between the low and high allocation. This is indicative of our model performing well when the value function includes the unobservable component.

Table 5: Parameter estimates

		Male Permanent		Female Permanent		Male Casual		Female Casual	
		Estimates	S.E.	Estimates	S.E.	Estimates	S.E.	Estimates	S.E.
CRRA	γ	4.976	(0.006)	4.304	(0.003)	4.971	(0.015)	3.155	(0.013)
Time discount	β	0.855	(0.037)	0.830	(0.021)	0.738	(0.093)	0.874	(0.044)
Bequest weight ($000)	θ	53,960	(201)	66,480	(406)	48,960	(10,705)	73,430	(3,705)
Switching costs:									
Voluntary	ν_0^{vc}	11.528	(0.106)	11.630	(0.110)	12.875	(0.106)	12.851	(2.278)
contribution	ν_1^{vc}	39.004	(2.513)	35.841	(6.044)	49.170	(6.399)	36.479	(7.377)
	$\nu_2^{vc} * 10^3$	−6.271	(2.397)	−4.123	(0.423)	−0.065	(0.022)	−9.271	(1.798)
	ν_3^{vc}	−0.616	(0.005)	−0.626	(0.012)	−0.626	(0.145)	−0.492	(0.053)
Investment	ν_0^{inv}	0.501	(0.047)	0.017	(0.026)	6.718	(1.136)	11.518	(1.322)
allocation	$\nu_1^{inv} * 10^2$	−0.921	(0.070)	−2.800	(0.408)	0.854	(0.168)	4.410	(1.737)
	$\nu_2^{inv} * 10^4$	−3.939	(0.356)	4.268	(0.221)	−4.450	(0.296)	0.177	(0.012)
	ν_3^{inv}	0.046	(0.004)	0.022	(0.021)	−0.648	(0.166)	−1.417	(0.393)
Pension plan	υ_0^p	0.270	(0.060)	0.431	(0.105)				
	$\upsilon_1^p * 10^3$	−0.140	(0.060)	−1.096	(0.055)				
	$\upsilon_2^p * 10^5$	−5.291	(0.278)	−5.233	(0.119)				
Option value on separation for casuals $\theta_c * 10^2$						3.340	(1.045)	0.987	(0.425)

Table 6: Moment fit

% of wealth invested in default investment	Males		Females	
	Emp. Mom.	Sim. Mom.	Emp. Mom.	Sim. Mom.
Permanent employees	0.45	0.496	0.45	0.571
Casual employees	0.45	0.432	0.45	0.457

To ease the interpretation, we use Figures 1-5 (for permanent staff) and Figures B1-B4 in Appendix (for casuals) to show the moments matched by cohort. In all figures, the lines labelled "data1" and "data2" correspond to Wave 1 and 2 of UniSuper data, whereas lines "sim1" and "sim2" denote their simulated counterparts.

6.1 Data patterns and model fit

A quick glance at Table 6, Figures 1 - 5 and Figures B1 - B4 in the Appendix reveals that the gender-specific models fit quite well overall, for both permanent and casual employees. In particular, we have successfully replicated both i) the high prevalence of plan type and investment allocation defaults, and ii) the increasing incidence and level of voluntary contributions with age, that we observe in the sample. The goodness of fit between the simulated and the empirical (i.e., data) moments is assessed via a χ^2-test (or corresponding $p-value$). In all four cases, the model easily passes the χ^2-test of goodness of fit, with χ^2-values well below the 5 percent critical value. Thus, we cannot reject the null that the simulated and the empirical moments are the same at standard significance levels.

Let us now take a closer look at the data profiles for permanent staff. Figures 1 and 2 show the level of non-pension and pension wealth by cohort, respectively. As expected, both types of wealth increase with age, but women appear to accumulate less in their superannuation account than men. As explained before, this pension gradient might be due to women working fewer hours and being more likely to face career interruptions, due to maternity leave.[47] With fewer years of service and potentially a slower rate of wage growth, they will also have lower pension balances. Additionally, women are less likely to opt for the DC plan: on average, only 19% of women switch out of the default (DB plan), compared to 24% of

[47]Council of Australian Governments Report, October 21, 2013: "Tracking equity: Comparing outcomes for women and girls across Australia" (http://www.healthinfonet.ecu.edu.au/key-resources/bibliography/?lid=26482).

the men (see Figure 3). These differences further deepen the wealth gradient between sexes due to missed opportunities for high return investments.

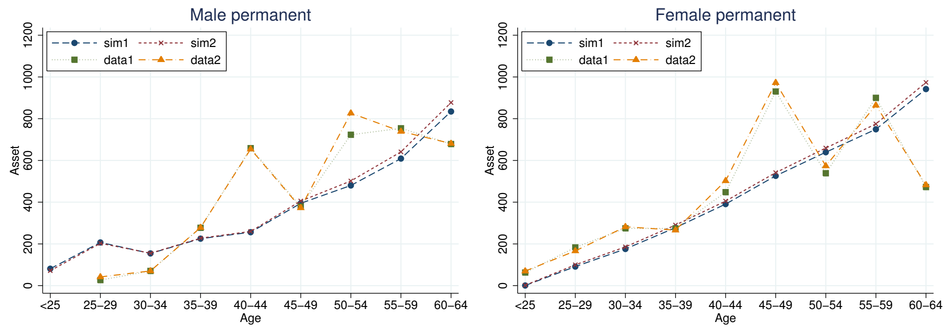

Figure 1: Mean Non-pension Wealth by Cohort (thousands of $)

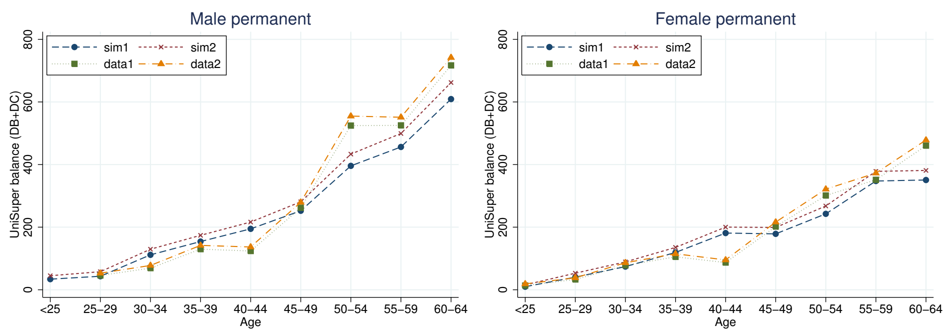

Figure 2: Mean Pension Wealth (DB+DC) by Cohort (thousands of $)

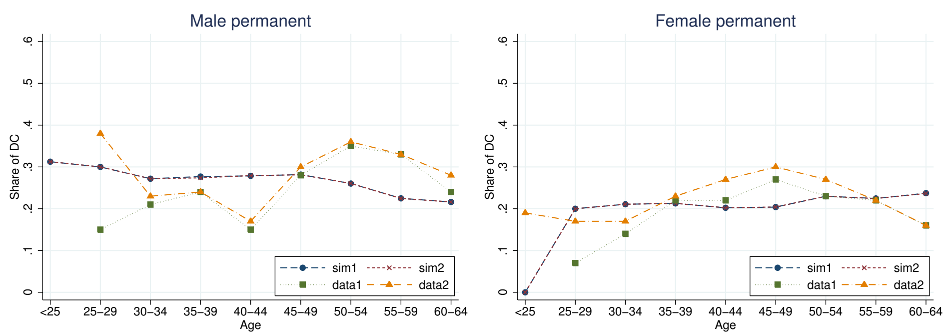

Figure 3: Proportion of Individuals Choosing Non-default (DC) Plan by Cohort

One possible way to supplement pension wealth is by making voluntary contributions. Surprisingly, women do not rely significantly more than men on this option to insure their retirement savings against negative labor events. Indeed, Figure 4 shows that, across cohorts, women are only 0.56% more likely to contribute than men, which confirms our empirical results in Section 3. When looking at the amounts effectively contributed, however, the gender gap becomes much more severe: compared to women, men voluntarily contribute roughly 40% more on average over the entire life span. The difference in contributions increases as individuals become older, with men contributing on average roughly 47% more even at age 55 or older (see Figure 5).

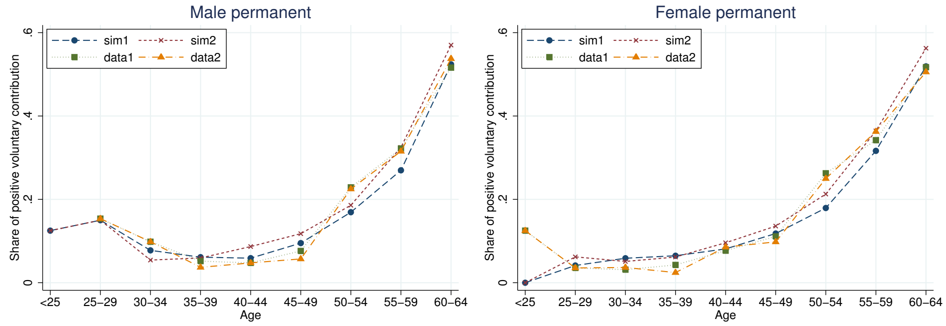

Figure 4: Proportion of Individuals Making Voluntary Contributions by Cohort

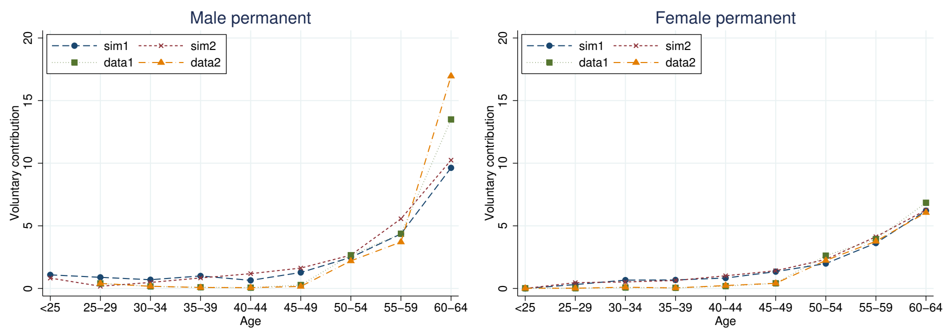

Figure 5: Mean Voluntary Contributions by Cohort (thousands of $)

In general terms, the data patterns for casuals resemble those for permanent staff (see Appendix A). Unsurprisingly, however, there is a higher degree of volatility in these profiles, which corresponds to the nature of the employment contracts. First, casuals are hired on less than two year contracts, with high permanent separation probabilities after the contract expires. Second, for most of them, working in the research sector either represents a secondary job (that supplements the main income source) or a part-time job (especially for students). Hence, the income and contribution streams we observe here are not fully representative of the overall labor (and retirement plan) participation for this category.

A few interesting differences between casuals and permanent employees are worth mentioning. First, we note that both pension and non-pension wealth for women casuals are significantly lower than for men. Second, we observe this wealth discrepancy despite the fact that women voluntarily contribute more than men. This is consistent with men working considerably longer hours and having longer job tenure, as documented in the Council of Australian Governments Report. Similar to permanent staff, however, women and men on casual contracts are almost as likely to supplement their pension balance via voluntary contributions.

Finally, we note that our estimation procedure did not include fitting consumption. In Figure 6 and B5 (in Appendix), we show our model's performance in fitting this variable, effectively presenting an informal over-identication test. We find that all models were able to endogenously generate cohort-specific consumption patterns with trends resembling the empirical ones, except (partially) for men casuals. In terms of level, however, we note a significant discrepancy between simulations and data. There are two possible reasons for this gap. First, it might be that we are under-estimating real consumption by limiting it to non-durables, effectively excluding some expenses especially important for men (i.e., durable goods, mortgage downpayments). Consumption for women, who are well known to spend a greater share of their budget than men on non-durables (i.e., fuel and power, clothing, toys, household goods and services) or personal care (Bradbury, 2004; Blow et al., 2004), might therefore be more accurately estimated in the data. As a result, we would expect the simulated consumption among permanents, for instance, to be higher than the empirical one for males, but less so for females. This is precisely what we observe in Figure 6.

Second, our model does not include income from other household members, which would lower our simulated consumption profile below the real one. The discrepancy would be larger for casuals, and especially for (married) women, since for them the income of other family members is expected to be much higher than for other groups. Notably, this prediction is consistent with the patterns presented in Figure B5 (in the Appendix).

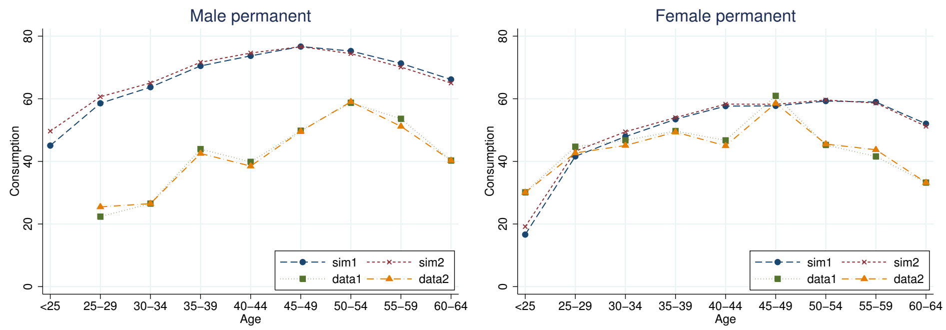

Figure 6: Mean Consumption by Cohort (thousands of $)

6.2 Switching costs

Our model features three different types of switching costs, all measured in terms of discounted life-time utility. Pension plan switching costs are paid only once during the first UniSuper enrolment year, while the voluntary contributions and investment switching costs are paid each period. To ease the interpretation, we have expressed these costs in monetary terms, as the amount required to compensate for the utility loss associated with these costs. Figures 7 plot these monetary equivalents by age.[48]

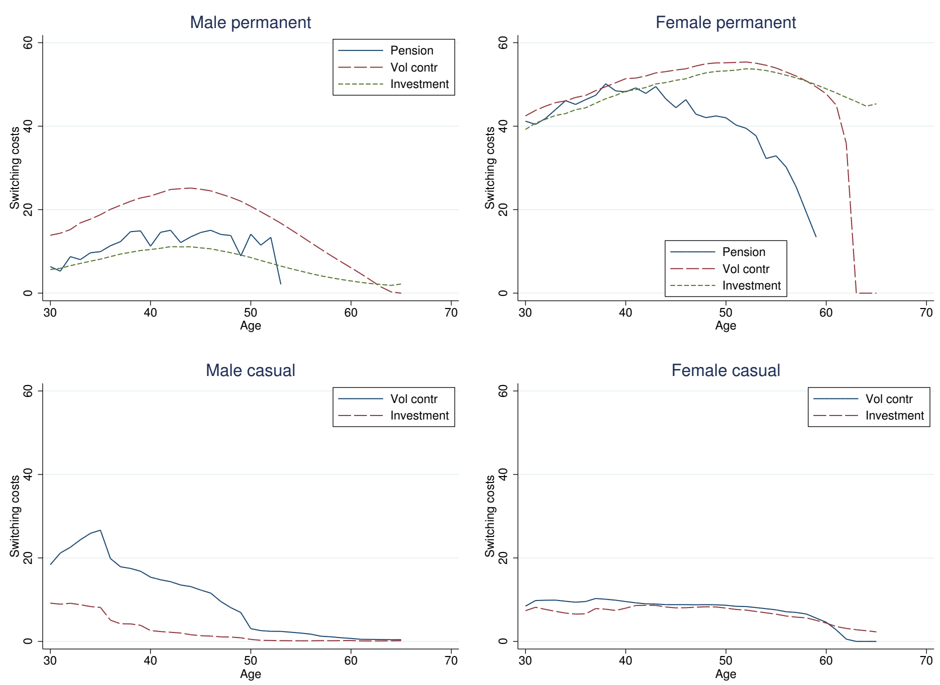

Figure 7: Median Switching Costs (thousands of $)

[48]The sharp drop in pension plan switching costs captures that no male permanent employee in our sample enters UniSuper at ages above 53.

Our calculations show a median estimated cost of switching away from the default (DB) plan of \$7,310 for males and \$38,806 for females. Compared to these figures, switching out of the default investment is roughly 11% less costly for men, but 24% more costly for women. The largest switching cost for men employed on permanent contracts is related to making voluntary contributions (i.e., u_{vc} is more than twice u_p), which is unsurprising given their illiquid nature up until retirement.[49] However, for women, switching out of the default (0%) contribution costs about the same as changing investment options, for both permanent and casual staff. We note the slightly increasing shape of the cost profiles, at least for the first half of the life-cycle profiles, indicating a higher liquidity value of non-pension wealth for young people compared to the older ones.

These results should be interpreted with appropriate caution. As we mentioned, the identification of switching costs comes from the observations related to employees who actually switched away from defaults. For these employees, the gain from switching would have to be large enough to make paying switching costs beneficial. Hence, translating the switching costs from utility to asset (monetary) terms could be misleading, because this does not actually apply to everyone, but just to those who switch. A more accurate way to interpret the switching costs is to consider how pension wealth would have changed over time had the switching been costless (i.e., run counterfactuals with u_p, u_{vc} and u_{inv} to zero). The last three rows in Panel A and B of Table 7 in the next section present the results.

7 Counterfactual simulations

This section shows results from counterfactual experiments focused on evaluating the role of different factors in shaping retirement savings. Specifically, we considered how pension wealth would have changed over time i) had the default pension plan been a DC plan, instead of a DB one (referred to as "Default: DC plan" scenario), ii) had the default investment allocation been either a low risk or a high risk investment option, instead of balanced (labelled "Default: Low risk invest." and "Default: High risk invest." scenarios), and iii) had

[49] The same is true for men employed as casuals with contributions switching costs more than three times the investment ones.

switching away from the default investment and/or plan type been costless (captured via the "SC=0" labelled scenarios). Every simulation modifies certain parameters, solves the model numerically and generates the corresponding wealth patterns. The issue is how wealth in each scenario compares with the wealth generated by the baseline model ("Baseline" scenario). Results are presented in Table 7 below for permanent employees, and in Appendix Table 8 for casuals.

First, we find that when the default pension type is changed from DB to DC, the proportion of DC members among permanent staff more than triples for both sexes. On average, this stickiness leads to a considerable 9.5% and 18.0% net increase in total pension wealth for males and females, respectively. These results are not surprising: Given the risk and returns performance reported by UniSuper, replacing the formula-based DB benefit with a market-contingent DC benefit is clearly beneficial, especially for women who have on average shorter job tenure and so, also lower wages than men towards the end of their careers.

In the second and third experiment, we change the default investment from a balanced allocation to a safer and a riskier option, respectively. At lower (higher) levels of risk, pension assets are invested at lower (higher) rates of return, which diminishes (augments) the amount accumulated as pension wealth. We find both default settings to be highly sticky: among permanent (casual) staff, more than 50% (41%) of men and 56% (46%) of women choose not to switch away. However the drop in wealth due to the new low-risk default is rather small (below 2.1%), for all four groups. Similarly, changing the default from a balanced option to a riskier one will increase pension wealth on average by 3.5% (4.7%) for men (women) on permanent contracts, and by less than 2% for casuals.

Given the high level of defaulting shown by our first three experiments, we also wanted to check what happens if we completely remove default stickiness by setting switching costs to zero. The last three rows of Panel A and B in Table 7 show that being able to freely switch between DB and DC plans yields by far the highest pension wealth gain (5.5% for men and 9.3% for women). With no cost of researching and comparing the plans and no bureaucratic costs of preparing the application, roughly 32.9% and 31.4% more men and women, respectively would have opted for the DC plan. These proportions indicate that

Table 7: Counterfactual Experiments, Permanent Employees

% of individuals choosing:	DC plan	Positive VC	Balanced invest.	High risk invest.	Low risk invest.	Average % change in Pension wealth	Average % change in Lifetime consum.
				Panel A. Males			
Data	0.29	0.20	0.45	0.28	0.27	–	–
Baseline	0.262	0.194	0.496	0.249	0.255	–	–
Default: DC plan	0.850	0.190	0.504	0.246	0.250	9.543%	3.582%
Default: Low risk invest.	0.262	0.194	0.244	0.254	0.502	−1.569%	−0.370%
Default: High risk invest.	0.262	0.193	0.244	0.501	0.255	3.526%	0.824%
Investment SC=0	0.204	0.192	0.328	0.335	0.337	−0.751%	−0.277%
DC/DB SC=0	0.591	0.192	0.497	0.250	0.254	5.482%	2.061%
Investment and DC/DB SC=0	0.514	0.191	0.326	0.332	0.342	4.678%	1.705%
				Panel B. Females			
Data	0.21	0.16	0.45	0.28	0.27	–	–
Baseline	0.215	0.180	0.571	0.227	0.202	–	–
Default: DC plan	0.823	0.177	0.576	0.215	0.209	18.060%	4.626%
Default: Low risk invest.	0.215	0.180	0.212	0.220	0.568	−2.147%	−0.491%
Default: High risk invest.	0.215	0.180	0.213	0.585	0.202	4.751%	1.078%
Investment SC=0	0.195	0.179	0.332	0.336	0.332	0.038%	0.015%
DC/DB SC=0	0.529	0.178	0.571	0.216	0.213	9.345%	2.382%
Investment and DC/DB SC=0	0.501	0.178	0.334	0.329	0.336	9.827%	2.483%

Note: Pension wealth refers to UniSuper balance right before retirement (conditional on surviving), not including the risk-free asset.

the DB plan is still sticky even in the absence of switching costs, and might be related to the relatively low discount factor that we estimate: Being less future oriented, individuals are less interested in actively accumulating in their pension accounts, even if the DC plan generates more retirement savings over time than the DB plan.

If both the plan and investment switching could happen at no cost, the pension wealth gain would be 4.7% for men and 9.8% for women.[50] The difference with respect to removing only the plan switching cost is due to more people taking advantage of the non-default investment options, and with a high prevalence of DC plan adoption, this will affect the overall pension wealth. We note that costless switching within a menu of investment options with different risk-return profiles also drives slightly more people to prefer the DB plan, whose main (DB) component guarantees a (relatively) predetermined level of pension wealth. This is particularly true for men, but is unsurprising given that their earnings grow faster than for women and so, staying in the DB is more beneficial for them (Cocco and Lopes, 2011).

Finally, if only the cost associated with opting out of the default investment option is eliminated, wealth would roughly remain unchanged, for both permanent and casual staff.

Overall, our results show that the default structure, which specifies individual outcomes when no choices are made, influences wealth accumulation in important ways. We also find that defaults tend to be quite sticky, and so if defaults are not carefully chosen, retirement savings can be severely affected.

8 Conclusions

With financial decisions becoming increasing complex and people being called upon to take charge of their economic well-being after retirement, many delay making these choices or rely on default options that specify a predetermined outcome if no choice is made. But remaining passive can lead to substantial reductions in the long-run wealth accumulation.

This paper investigates the drivers behind the high prevalence of defaults in pension

[50] Note that for men, the gain in pension wealth from removing both the plan and the investment switching costs is smaller than the gain from only making the plan switching free. This is due to the small wealth loss associated with setting investment switching costs to zero. Being more risk averse, men will opt slightly more often for the low risk investment option if switching is costless, which will affect their wealth.

choices and the impact of default provisions on retirement savings. Using administrative data on an industry-wide pension fund, we first identify the empirical elements associated with the choices related to pension plan type and voluntary employee contributions. Our results show that preferences, demographic characteristics and labor mobility can go a long way towards explaining the plan choice and overall level of savings. For permanent employees, the likelihood of selecting the DC plan increases with age, wage and years of contribution. Females, who are more likely to face career interruptions, have lower pension balances, but are slightly more likely to voluntarily contribute. Opting for a default investment allocation is associated with lower overall pension balance, regardless of the type of employment contract. Moreover, for casuals, job-related factors like wage, years of contribution, and the number of employers contributing also play an important role.

Using a structural dynamic life-cycle model, we then assess the ability of these empirically motivated decision drivers to explain the data. In our model, individuals decide how much to save for retirement, in a setting that combines an irreversible automatic (DB or DC) enrolment with an active decision regime (related to contributions and investment option). We focus on one of Australia's largest pension funds (UniSuper) and estimate the model using simulated method of moments. Our results show that defaults are highly persistent, both over time and across various decisions. Additionally, we find an increasing incidence and level of voluntary contributions with age.

Since the choice of defaults affects retirement savings, we also perform several counterfactual experiments to study what would have happened to retirement wealth had the default structure been different. Changing the default plan for permanent staff from DB to DC leads to a considerable 9.5% and 18.0% net increase in total pension wealth for males and females, respectively. This cost emphasises the importance of default settings with irreversible implications. Additionally, defaults continue to be sticky when the standard investment option becomes either the low or high risk (instead of balanced) allocation, although the loss or gain in wealth is negligible. Being able to freely switch between DB and DC yields, however, a substantial gain for permanent employees (5.5% for men and 9.3% for women). Finally, if only the cost of opting out of the default investment option is eliminated, wealth would roughly remain unchanged, for both permanent and casual staff.

These results provide strong evidence of the crucial role that defaults play in ensuring the adequacy of savings and, ultimately, financial security in retirement. If policy-makers are to implement social security programs that protect the well-being of retirees, sustainability will require them to also support institutions and products that provide sufficient retirement income to reduce the need for other welfare programs. The recent rapid shift from DB towards DC plans combined with the potential of defaults to significantly impact retirement savings in these types of schemes, lead us to carefully assess what default types should public policy and plan architects encourage, especially given people's heterogeneous savings needs.

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Appendix

A UniSuper Features

Table A1. Mandatory, default and choice features of the UniSuper pension scheme

	Permanent Employees			Casual Employees		
	Mandatory	Default	Choice to	Mandatory	Default	Choice to
Enrolment	✔	-	-	✔	-	-
Plan type	-	**DB***	**DC** *(within 1 yr)*	**DC**	-	-
Employer contribution	17%	-	-	9%	-	-
*Employee Contributions: ** *						
- Standard	-	7%	*(Irreversible) Choice to reduce*	*NA*	*NA*	*NA*
- Voluntary	-	**0%**	*Choice to increase*	-	**0%**	*Choice to increase*
Investment option	-	***Balanced***	*Choice of 15 options*	-	***Balanced***	*Choice of 15 options*
Insurance	-	*Life and TPD*	*Choice to change cover*	-	*Life and TPD*	*Choice to change cover*

Notes: * DB has a small DC component and any voluntary member contributions are to the DC component. ** An additional choice dimension here (that we do not model) is that employee contributions can be made pre- or post-tax.

B Data profiles: Casual Employees

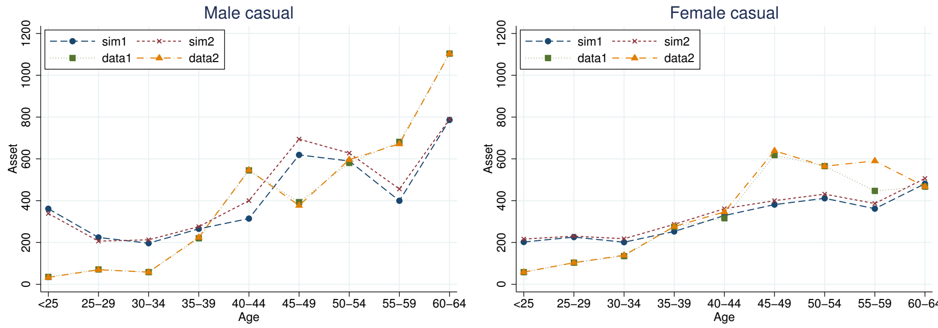

Figure B1: Mean Non-pension Wealth by Cohort (thousands of $)

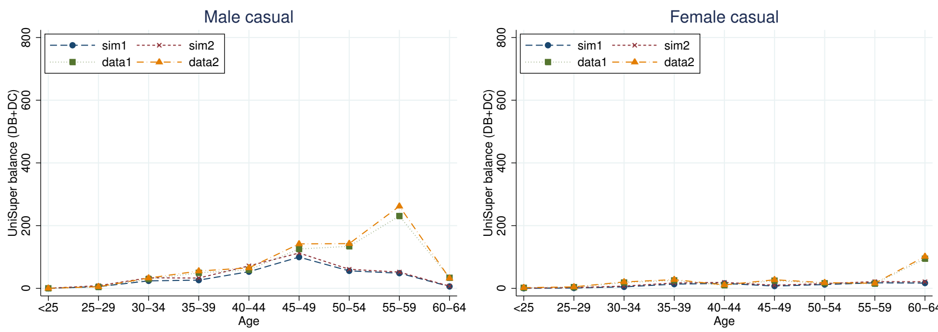

Figure B2: Mean Pension Wealth (DC) by Cohort (thousands of $)

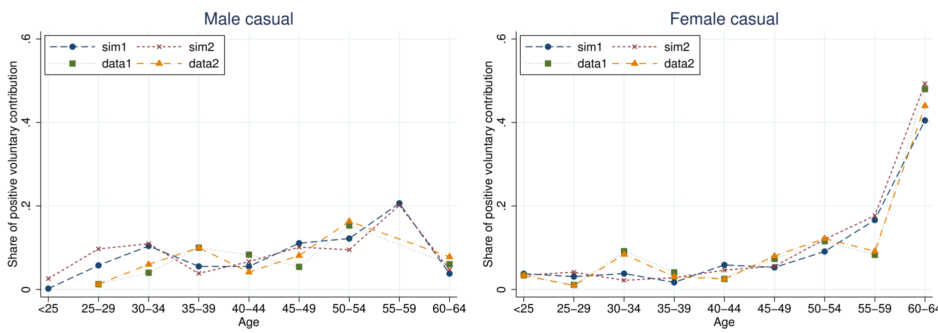

Figure B3: Proportion of Individuals Making Voluntary Contributions by Cohort

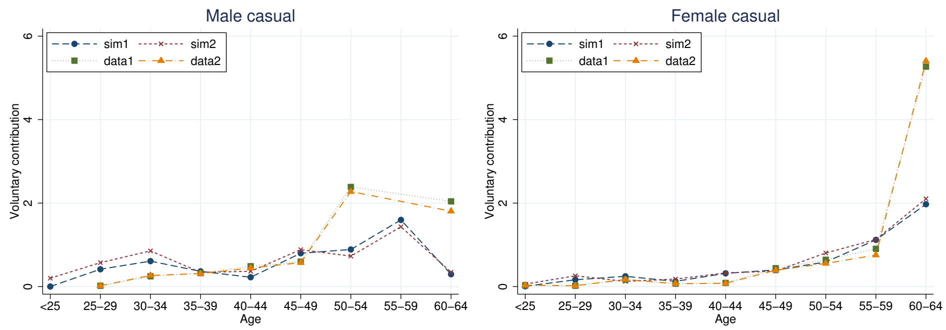

Figure B4: Mean Voluntary Contributions by Cohort (thousands of $)

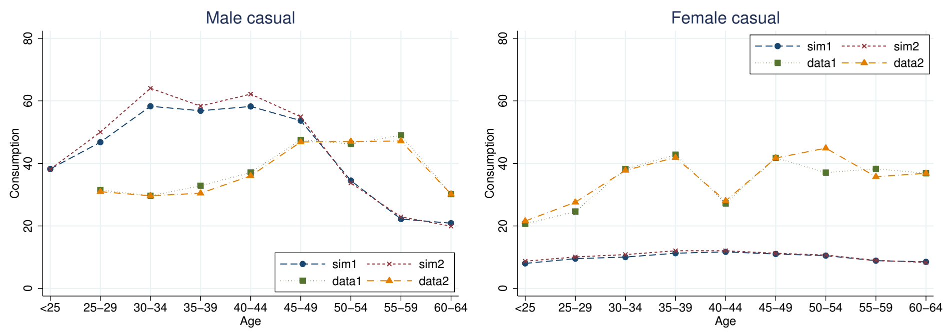

Figure B5: Mean Consumption by Cohort (thousands of $)

C Preferences estimates

Table 5 shows that the estimates for both permanent and casual employees are economically reasonable across both sexes. For instance, the relative risk aversion coefficients in the literature vary from 1 to 6, or higher depending on the context (e.g., Mehra and Prescott 1985; Kocherlakota 1996; Chetty 2006). Our estimate of γ is roughly 4.97 for males (regardless of employment type), and 4.30 and 3.15 for females permanent and casual staff, respectively. These relatively high coefficients of risk aversion (greater than 3) are in line with the estimates in Cagetti (2003) for U.S. college graduates and are likely to reflect the link between risk aversion, age and wealth: Ceteris paribus, risk aversion increases with age and decreases with wealth (Riley and Chow, 1992; Morin and Suarez, 1983). With lower wages, retirement income and wealth in general, it is not therefore surprising that women appear less risk averse than men, or that women on casual contracts are less risk averse than the ones on permanent staff.

Our estimate of β, the discount factor, for permanent employees is 0.85 for males and 0.83 for females.[51] As a result, males should accumulate more (and decumulate their wealth at a smaller rate when old) than women do, which is consistent with the data. For casuals, however, this trend is inverted and we observe a significantly higher degree of patience for women (0.87) than for men (0.74). Combined with the fact that risk aversion for casuals is lower for women than for men, this suggests that not only different time preferences but also different attitudes towards risk can explain the different savings behaviours across groups.

The term θ denotes the intensity of the bequest motive. It indirectly captures the marginal propensity to bequeath ϕ in a one-period problem where individuals are allocating wealth between consumption and immediate bequest (for people rich enough to consume at least $\theta^{\gamma}k$), since $\theta = [\phi/(1-\phi)]^{\gamma} \in [0, 1)$. Our point estimates of θ imply a ϕ close to one, and so a bequest motive that approaches a linear one with a constant marginal utility of bequests $\theta k^{-\gamma}$. Interestingly, bequest motives seem stronger for women than for men (for both employment types), which may reflect women's stronger intergenerational altruism bonds and thus greater incentive to save for their heirs (Seguino and Floro, 2003).

One additional remark on bequest motives and their role in investment allocation decisions. We note that the presence of a bequest motive acts toward making an investor's horizon longer, therefore potentially generating a higher allocation in risky investments (with higher rate of return). For those with stronger bequest motives, however, this effect is counteracted by the fact that they will optimally decumulate their wealth more slowly and 'protect' it by choosing a more balanced portfolio. Hence, the tendency to increase investment risk over time exists, but the portfolio might remain balanced up until retirement in the presence of a strong bequest motive. This analysis confirms the findings in Cocco, Gomes, and Maenhout (2005), who show the importance of the bequest motive in generating balanced portfolios.

D Counterfactual experiments: Casual Employees

[51] In order to obtain the effective discount factor our estimate has to be multiplied by the survival probability.

Table 8: Counterfactual Experiments, Casual Employees

% of individuals choosing:	Positive VC	Balanced invest.	High risk invest.	Low risk invest.	Average % change in Pension wealth	Average % change in Lifetime consum.
Panel A. Males						
Data	0.07	0.45	0.28	0.27	–	–
Baseline	0.080	0.434	0.292	0.274	–	–
Default: Low risk invest.	0.080	0.282	0.287	0.431	−0.002%	0.001%
Default: High risk invest.	0.080	0.282	0.443	0.275	0.004%	0.001%
Investment SC=0	0.080	0.333	0.342	0.325	0.004%	0.001%
Panel B. Females						
Data	0.06	0.45	0.28	0.27	–	–
Baseline	0.063	0.455	0.275	0.270	–	–
Default: Low risk invest.	0.063	0.262	0.283	0.456	−0.726%	−0.028%
Default: High risk invest.	0.063	0.261	0.470	0.270	1.681%	0.062%
Investment SC=0	0.053	0.326	0.340	0.334	−0.738%	−0.031%

Note: Note: Pension wealth refers to UniSuper balance right before retirement (conditional on surviving), not including the risk-free asset.