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Measuring Financial Wellbeing with Self-Reported and Bank Record Data*

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We develop scales of the financial well-being of customers of a major Australian bank using self-reported survey data matched to customer financial records. Using item response theory (IRT) models, we develop: (1) a Reported Financial Wellbeing Scale from information about people's experiences and perceptions of financial outcomes; and (2) an Observed Financial Wellbeing Scale from financial record measures of customers' account balances, net spending and payment problems. Each scale reliably differentiates between a wide range of outcomes, and the scale components have similar power to discriminate. We confirm the validity of the scales by estimating predictive models using other measurable characteristics.

I Introduction

People's financial well-being is an issue of substantial social and research concern. Health and economic crises, volatile incomes, rising housing costs, and growing personal responsibility to finance educations and retirements put more pressure on people's use of financial tools. Wider and more sophisticated sets of financial products increase the choices that people face but can also add to risks. Researchers,

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[Correction added on 17 May 2022, after first online publication: CAUL funding statement has been added.]

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regulators, financial institutions and consumers need valid, reliable measures of financial well-being to understand how financial well-being is changing, how personal and external circumstances contribute to financial well-being, and how policies, products and interventions can improve financial well-being.

Because of its complexity, financial well-being has tended not to be well or consistently measured, with many analyses relying on measures of convenience rather than measures that are carefully conceived or formally developed. Formal measures are coming into use in other countries, including financial well-being scales for the United States (Prawitz *et al*., 2006; Consumer Financial Protection Bureau [CFPB], 2017; Netemeyer *et al*., 2018) and Norway (Kempson *et al*., 2017). Each of these measures reliably summarises a wide set of aspects of people's *perceived* financial wellbeing. However, the measures were not developed or validated in the Australian context, which differs markedly from the United States and Norway.[1] Also, the measures rely entirely on self-reports, which can be manipulated by positive and negative framing (Netemeyer *et al*., 2018) and are subject to misreporting from recall error, social desirability bias and other problems (Bound *et al*., 2001). Objective data gathered directly from people's financial records have the potential to address these problems, and summative measures based on financial records have been proposed (e.g., Parker *et al*., 2016). However, to our knowledge, no individual-level scale of financial well-being has been implemented with financial record data.

This paper reports results from a unique business and academic collaboration to collect self-reported and bank record data on Australians' financial outcomes, formally develop multi-item scales of financial well-being from both sources of data, and quantitatively analyse the predictors of financial well-being. Our data come from a survey of 5682 customers of one of Australia's largest banks. The survey asked questions about customers' financial well-being outcomes that were used as candidate items for scales. The questions were based on a careful conceptualisation of financial well-being and were mostly drawn from questions that had been used in previous research. Importantly, the respondents gave permission for their answers to be linked to their bank records. The bank record data were used to form additional candidate measures of financial well-being.

We apply a comprehensive, data-driven process to these measures to uncover and develop two related but distinct measures of Australians' financial well-being. We develop the first individual-level financial well-being scale to use bank record data, an Observed Financial Wellbeing Scale that is formed from measures of customers' cash balances, savings, credit and payments. We are also the first to use linked self-reported and bank record data and construct a Reported Financial Wellbeing Scale that is formed from answers to questions about people's perceptions and experiences of their financial outcomes.

The scales are developed through formal quantitative analyses, including factor analyses and item response theory (IRT) graded-response models. The factor analyses show that the self-reported and bank record data lead to separate scales. Results from the IRT models indicate that every outcome for each item contributes unique information to the scales and that the items function similarly across different population groups. The scales have very high reliability, and though distinct, they are strongly positively correlated. We confirm these properties in alternative samples. They can therefore be used as validated measures of financial well-being of broad populations by researchers and financial institutions. At the same time, the scales are easy to interpret, making them useful for consumers, counsellors and financial educators.

We use additional data from the survey and some additional bank record measures in machine-learning analyses of the characteristics that correlate with financial well-being. Our data include more than 100 measures that might serve as predictors. We estimate least absolute shrinkage and selection operator (LASSO) models (Tibshirani, 1996) that select the best predictors of financial well-being from among the entire set of available measures in a data-driven way without imposing initial and possibly arbitrary exclusions. These analyses reveal that people's savings habits are especially strong correlates of their reported and observed financial well-being. The models also indicate that household income, education, spending habits, credit card behaviour,

[1] For example, Australia has a very generous social assistance system with near-universal coverage on some programmes, unlike the United States. In contrast to Norway, however, the Australian social assistance system is heavily targeted, with most programmes being strictly means-tested.

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difficulties with housing payments, and the use of and access to social or government support are associated with both types of financial well-being. However, showing some of the distinctions between the two financial well-being measures, a better self-assessed understanding of finances, recent financial improvements and a willingness to put off financial decisions are associated with higher reported financial well-being but lower observed financial well-being. Overall, these results suggest that financial well-being is most closely related to modifiable saving and spending behaviours, highlighting the scope for programmes that improve these behaviours – such as spending trackers, financial advisors, financial education – to improve people's financial well-being.

Our study makes several important contributions. Our Observed Financial Wellbeing Scale is a first-of-its-kind, consumer-oriented measure of well-being that is transparent, easy to implement by other financial institutions and can be scaled to measure consumer well-being across large subpopulations. This scale allows financial institutions to quantify the social impact of their products and improve the welfare of their customers by providing tailored products and services. Consumer welfare could also be improved even by simply providing customers with a measure of financial well-being which they can monitor and act upon. Our Reported Financial Wellbeing Scale provides an excellent complementary measure of financial well-being. It is formally developed and validated for the Australian context, so it can be directly incorporated into research studies. It is simple to implement yet covers a broad set of constructs. Making information on observed and reported financial well-being available to customers can help them cross-benchmark information, bringing both elements of financial well-being in line and empowering customers with additional diagnostic information. Importantly, both the Reported and Observed Financial Wellbeing Scales use only outcome-based measures, which means they can be used to uncover the predictors of financial well-being, reducing concerns for reverse causality. Reverse causality can be introduced by including measures of *determinants* rather than *outcomes* in the scales (e.g., including a proxy for income as a scale item, and then regressing the scale on other income measures), which does occur in other financial well-being measures. For all these reasons we believe there can be large social gains from the widespread adoption of these scales.

II Previous Studies

Financial well-being is multifaceted and complex. Because of its complexity, studies have varied in their definitions and measurement of financial well-being (for a comprehensive review, see Joo, 2008), and no single definition or measure has been universally adopted.

(i) Conceptualisations

Measures of financial well-being should be grounded in a conceptualisation and definition. However, many studies omit these and simply analyse measures they have at hand, such as financial satisfaction (Bonke & Browning, 2009; Brown & Gray, 2016), subjective prosperity (Brown & Gray, 2016), and net wealth (Schmeiser & Seligman, 2013). The drawbacks with this informal approach are that it may omit relevant elements or worse, not genuinely align with financial well-being. We can only assess the adequacy of an empirical measure if we have a conceptualisation to compare it with.

Formal conceptualisations of financial well-being tend to have multiple elements with varying degrees of breadth. Joo (2008) has offered one of the broadest conceptualisations, which includes people's satisfaction with their financial situation, the objective status of finances, financial attitudes, and financial behaviours. Joo's conceptualisation paints an extensive picture of people's financial situations. However, its exceptional breadth carries an analytical weakness, as it cannot be used to test how attitudes, behaviours, and other financial circumstances *separately* contribute to well-being because the conceptualisation includes these as components. We want our measure to be used in these types of analyses and therefore, focus on conceptualisations based on financial outcomes.

Among the outcome-oriented conceptualisations, some consider subjective elements. The CFPB (2017) defined financial well-being as having control over day-to-day and month-to-month finances, being able to absorb a financial shock, being on track to meet financial goals, and having financial freedom. Brüggen *et al*. (2017) defined financial well-being in terms of (1) people's perceptions of current and anticipated desired living standards and (2) financial freedom. Kempson *et al*. (2017) framed financial well-being in terms of meeting commitments,

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financial comfort and financial resilience. Prawitz *et al*. (2006) considered stress, satisfaction, meeting expenses and financial freedom; while Netemeyer *et al*. (2018) considered current money management stress and future financial security.

Other conceptualisations have objective elements. Parker *et al*. (2016) characterised financial well-being in terms of spending, saving, borrowing and planning outcomes. Greninger *et al*. (1996) offered ratios and thresholds of objective indicators, while Bray (2001) focused on financial hardships, financial management and financial exclusion.

A few conceptualisations combine subjective and objective elements. Muir *et al*. (2017) considered domains of meeting expenses with money left over, being in control of finances and feeling secure. Arber *et al*. (2014) considered the ability to make ends meet and problems with household expenditures. Shim *et al*. (2009) considered satisfaction, debt positions and economising outcomes.

(ii) Measurement

All the existing scale measures are formed from *self-reported* indicators. The CFPB (2017) developed a 10-item scale with a single, underlying latent variable. Prawitz *et al*. (2006) developed the InCharge Financial Distress/Financial Well-being (IFDFW) scale as an eight-item self-reported scale. Other self-reported scales have been developed by Bray (2001), Bray *et al*. (2011), Delafrooz and Paim (2013), FiftyFive5 (2016), Garon *et al*. (2018), Kempson *et al*. (2017), Muir *et al*. (2017), Riitsalu and Murakas (2019) and Vlaev and Elliott (2014).

Financial institutions have frequently used payment, debt and transaction data to analyse consumer behaviour, and researchers have also analysed such measures in their work. Credit scores are the most salient example of this practice (e.g., Meier & Sprenger, 2010, 2012). Like the conceptualisation by Joo (2008), credit scores incorporate financial outcome, behaviour and other data and are therefore unsuitable for exploring some of their determinants. The scores are also proprietary and do not address all aspects of financial well-being. Despite recent developments in psychological and behavioural measures using administrative record data (e.g., Gladstone *et al*., 2019; Garbinski *et al*., 2020), there is no existing outcome measure of financial well-being that exclusively uses financial record data.

Existing scale measures also differ in the statistical formality of their design. CFPB (2017), Kempson *et al*. (2017), Netermeyer *et al*. (2018) and Prawitz *et al*. (2006) have used formal psychometric procedures to form scales. Others, including Delafrooz and Paim (2013), Riitsalu and Murakas (2019) and Vlaev and Elliott (2014), have proceeded less formally. Formal methods are needed to establish the properties of the scales, including their dimensions and whether individual items belong in them.

(iii) Covariates

Studies find that people's economic resources are key predictors of financial well-being, with higher levels of personal or household income being associated with greater financial well-being (Bonke & Browning, 2009; Shim *et al*., 2009; Schmeiser & Seligman, 2013; Brown & Gray, 2016). Other personal resources, including education (Taft *et al*., 2013; Brown & Gray, 2016), self-control (Shim *et al*., 2009; Netemeyer *et al*., 2018) and financial literacy (Shim *et al*., 2009; Schmeiser & Seligman, 2013; Gerrans *et al*., 2014; Riitsalu & Murakas, 2019), are also associated with higher financial well-being. In the case of financial literacy, self-assessed knowledge tends to have stronger associations with financial behaviour and well-being than objective knowledge (Schmeiser & Seligman, 2013; Lusardi & Mitchell, 2014; Allgood & Walstad, 2016; Riitsalu & Murakas, 2019).

Resources in the form of family and social support can also contribute to financial well-being (Shim *et al*., 2009; Brown & Gray, 2016). However, larger households and increased numbers of children are associated with lower financial well-being.

Research has also identified especially strong associations between financial well-being and financial behaviours (Shim *et al*., 2009; Gutter & Copur, 2011; Delafrooz & Paim, 2013; Netemeyer *et al*., 2018) and attitudes, such as risk tolerance, materialism and self-efficacy (Shim *et al*., 2009; Netemeyer *et al*., 2018).

(iv) Lessons

Although researchers have developed several definitions and measures of financial well-being, no definition or metric has been universally adopted. In addition, no study has built a comprehensive, outcome-focused scale from financial record measures nor combined self-reported and financial record data. Where

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subjective and objective self-reported components have been combined, conceptualisations have not distinguished between these components or explained how they can lead to separate dimensions of financial well-being. Several conceptualisations combine financial outcomes and potential determinants of financial well-being in their measures, which makes them unsuitable for investigating the determinants of financial well-being. Differences across the existing scales and evidence that the measurement of financial well-being depends on country context (e.g., Kempson *et al*., 2017) demonstrate the need for a formal scale development process.

III Conceptualisation of Financial Well-being

(i) Definition

We define financial well-being in terms of financial outcomes that people experience, rather than all the conditions, characteristics and behaviours that might contribute to those outcomes. Our definition is informed by several considerations.

First, financial well-being has objective components, or attainments, $\boldsymbol{w}$, that can be observed in people's financial records or reports of their financial outcomes. It also has subjective components that people report based on their valuation of the objective attainments, $v(\boldsymbol{w})$. Second, financial well-being has temporal elements, including financial outcomes people face day-to-day, outcomes that prepare them for weather unexpected adverse events, and outcomes that allow them to sustain their well-being over time and achieve long-term goals. Third, the definition includes goals and objectives that people and financial planners commonly identify (Prawitz *et al*., 2006; Brüggen *et al*., 2017; CFPB, 2017; Kempson *et al*., 2017; Muir *et al*., 2017; Netemeyer *et al*., 2018). These goals are for people to meet their financial obligations, have the financial freedom to enjoy extra consumption and make choices, have control over their finances, and be secure and free from financial worries. Fourth, it considers financial well-being along a continuum, rather than as an either/or condition. From these considerations, we define people's financial well-being as the extent to which people both perceive and have: (1) financial outcomes in which they meet their financial obligations; (2) financial freedom to make choices that allow them to enjoy life; (3) control of their finances; and (4) financial security – now, in the future and under possible adverse circumstances.

We formally distinguish between the objective elements of *observable financial well-being*, $\boldsymbol{w}$, and the subjective elements of *perceived financial well-being*, $v(\boldsymbol{w})$.

(ii) Conceptual Model

We consider people's financial behaviour through a series of time periods. We assume that people care about the goods and services that they can purchase and use in each period. People's economic resources to make purchases come from their earnings, investment income, borrowing, wealth and other sources. External conditions (largely outside of people's control) and financial behaviours (largely in their control) also determine the goods and services they consume. If people spend less than they earn, they increase their savings. If they spend more than they earn, they must borrow or deplete their wealth.

Our model also imposes some conceptual restrictions, such as financial behaviours or external conditions not *contemporaneously* affecting personal and household characteristics. These restrictions ease the conceptualisation of dynamics in financial well-being and do not preclude effects on *future* personal and household characteristics. Today's financial behaviours can, for example, improve tomorrow's household material resources. In addition, we assume that resources and characteristics are known in the current period but uncertain and subject to shocks in future periods.

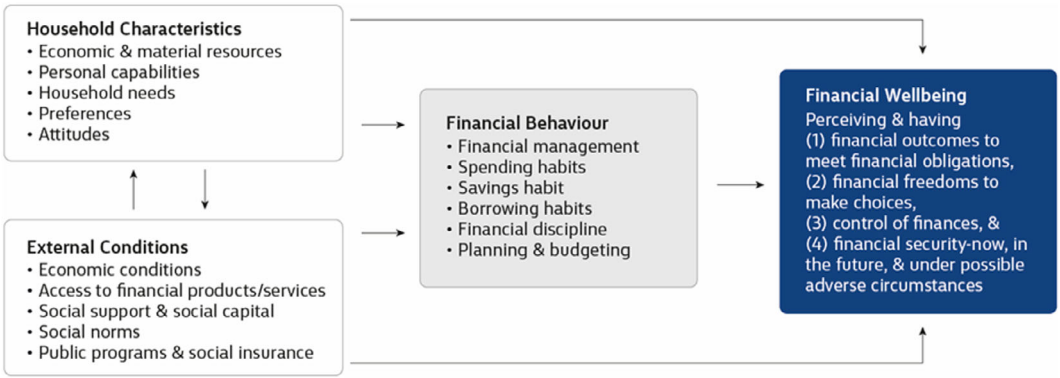
We assume that people undertake financial behaviours to maximise their current and expected future consumption, subject to their personal and household characteristics and external conditions. People's objective access to more of this consumption is captured by *observable financial well-being*, $\boldsymbol{w}$, whereas their subjective enjoyment of this consumption – also influenced by their behaviours, characteristics, and external conditions – is captured by their *perceived financial well-being*, $v(\boldsymbol{w})$. We overview the relationships in Figure 1.

IV Data

Our empirical analyses use responses to an online survey that was conducted in August 2017 with 5682 customers of one of Australia's largest banks. The analyses also use financial record data linked to these customers' responses. The questionnaire and other survey materials are provided in Appendix D in the supporting information.

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FIGURE 1
Conceptual Model of the Determinants of Financial Well-being.



A key consideration for recruiting survey subjects was what we would be able to see from their bank records. Bank records are a rich source of data, but their depiction of financial activities is incomplete if customers transact or hold products with other institutions (which are not observed in our data). We were especially interested in recruiting people who use the bank as their main financial institution (MFI) because their records would describe most or all of their financial outcomes. We also wanted a sample that described all the bank's customers, regardless of MFI status. To balance these needs, we sampled from three strata:

- A nationally representative sample of 1611 of the bank's customers.
- A sample of 2899 'sole-MFI' customers whose transactions data indicated that they conducted their banking solely through the bank.
- A sample of 1172 'split-MFI customers' for whom the bank appears to be their main banking institution, but not their only bank.

Potential subjects were adult customers with email addresses who had not opted out of online research and marketing communications from the bank. Approximately 300,000 customers were emailed invitations from the bank that each contained a unique survey link. As in most online surveys, ours had a low response rate, yet Haisken-DeNew *et al*. (2018) show that reweighting the survey data to make them representative of the Australian population has negligible effects on their results. After several screening questions, the survey asked about the person's perceptions and experiences with financial outcomes, including questions about financial well-being. It also asked about major life events, financial behaviours, banking relationships, household financial holdings, loans, financial capacity, financial habits, attitudes, and many demographic and economic characteristics.

We conduct our empirical analyses with two principal samples. For both samples, we drop observations for 50 people who did not answer all the financial well-being questions and for 1162 people who reported not being MFI customers. This includes, for instance, respondents with accounts in several banks who use another bank's account for their day-to-day banking. Our analysis sample for developing the financial well-being scales consists of the remaining 4470 people who are all either sole- or split-MFI customers. For the multivariate data-driven analyses of the predictors of the scales (see Section 6), we exclude an additional 949 observations for people with missing values for any of the other survey variables, leaving an analysis sample with 3531 observations.

V Developing the Scales

Our survey asked 33 questions about financial outcomes for possible inclusion in the scales; the questions are listed in Table A1 in the

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TABLE 1
Reported Financial Well-being Scale Components

Question	Responses
1. In the last 12 months, how difficult was it for you to meet your necessary cost of living expenses like housing, electricity, water, health care, food, clothing or transport?	0: Very difficult 1: Difficult 2: Neither difficult nor easy 3: Easy 4: Very easy
How well do the following statements describe you or your situation?	0: Not at all 1: Very little 2: Somewhat 3: Very well 4: Completely
2. I can enjoy life because of the way I'm managing my money	
3. I could handle a major unexpected expense	
4. I am securing my financial future	
How often do the following statements apply to you?	0: Never 1: Rarely 2: Sometimes 3: Often 4: Always
5. My finances control my life[a]	
6. I have money left over at the end of the month	
7. Giving a gift for a wedding, birthday or other occasion would put a strain on my finances for the month[a]	
When it comes to how you think and feel about your finances, please indicate the extent to which you agree or disagree with the following statements:	0: Disagree strongly 1: Disagree 2: Neither agree nor disagree 3: Agree 4: Agree strongly
8. I feel on top of my day-to-day finances	
9. I am comfortable with my current levels of spending relative to the funds I have coming in	
10. I am on track to have enough money to provide for my financial needs in the future	

[a]Negative statement that is reverse coded in scale.

additional supporting information. All the questions corresponded to elements of our conceptual definition of financial well-being, and almost all had been validated in earlier analyses, including Bray (2001), CFPB (2017), Fiftyfive5 (2016) and Muir *et al*. (2017). In addition, we used the conceptual definition to develop 12 measures of financial well-being from the financial record data and linked these to the survey records. The bank record measures are listed in Table A2 in the additional supporting information.

We conducted preliminary quantitative analyses of the individual items, correlation analyses, and exploratory factor analyses to reduce the set of candidate measures to 17 self-reported items and nine bank record items. We then performed an exploratory factor analysis on the reduced set of items. The analysis indicated that the combined set of measures were well explained by two factors. Inspection of the factor loadings revealed that all but one of the self-reported measures align strongly on the first factor and that all the financial record measures align on the second factor. The results from the factor analysis conform with our conceptualisation of financial well-being having perceived and observable components.

Using the results from the factor analysis, we further reduced the set of items to 10 self-reported measures and five bank-reported measures. We estimated IRT models of the relationships of the self-reported measures with one scale and relationships of the bank record measures with another scale. The IRT results indicated that the items for each scale had comparable discrimination and that every outcome from every item contributed information to a scale. Details of our procedures are reported in Appendix A in the supporting information.

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TABLE 2
Observed Financial Wellbeing Scale Components

Item	Outcomes
11. Payment problems in last year[a]	0: In arrears for six or more months or multiple serious problems 1: In arrears for two to five months; had declines, dishonours or overlimit fees for nine or more months; had late fees for three or more months; had a payday loan; or had multiple moderate problems 2: Had fewer months of arrears, declines, dishonours, overlimit fees or late fees 3: Had no payment problems
12. Days in last year with low liquid balances	0: Less than one week's expenses of 75% or more 1: Less than one week's expenses of 75–50% 2: Less than one week's expenses of 50–10% 3: Less than one week's expenses of 10% or less, but sometimes less than four week's expenses 4: Never below four weeks' expenses
13. Months in last year when spending exceeded 80% of inflows	0: 11 or 12 months 1: 9 or 10 months 2: 7 or 8 months 3: 4, 5 or 6 months 4: 3 or fewer months
14. Days in last year during which customer had the ability to raise one or three months' expenses from savings or available credit	0: Could raise one month's expenses for 15 or fewer days 1: Could raise one month's expenses for 15–90 days 2: Could raise one month's expenses for 91–330 days 3: Could raise one month's expenses for 330 or more days, but sometimes could not raise three months' expenses 4: Could always raise three months' expenses
15. Age-normed residual of customer's median savings balance	0: Below –2.5 SD 1: –2.5 to –1 SD 2: –1 to 1 SD 3: 1 to 2.5 SD 4: > 2.5 SD

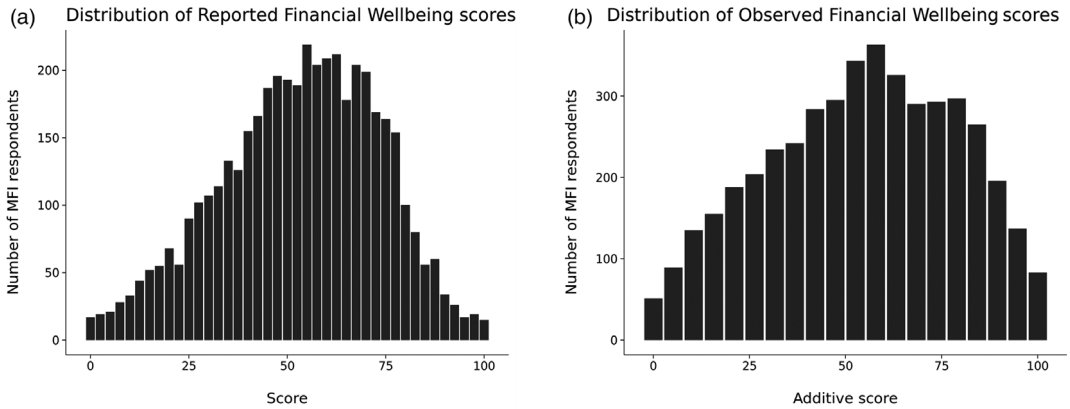
[a]Item 11 has three categories since we found no reasonable four-category coding of this item where each category would contribute independent and meaningful information to the scale as described by their item characteristic curves.

Based on these analyses, we measure financial well-being through two scales. The Reported Financial Wellbeing Scale is formed by adding the responses to 10 self-reported 0–4 Likert items, which are listed in Table 1, that describe people's perceptions and experiences of financial outcomes. We multiply the sum of the responses by 2.5 to produce a 0–100 scale in which larger values indicate higher levels of financial well-being. We interpret the scale as a measure of people's perceived financial well-being. In our sample, the median was 55 and the average was 53.2.

The Observed Financial Wellbeing Scale is formed by adding outcomes from five ordered-categorical bank record measures, which are listed in Table 2, that describe customers' payment outcomes, net spending (measured via account outflows), balances, and available funds. We multiply the sum by 100/19 to produce a 0–100 scale. We interpret this scale as a measure of people's observable financial well-being. In our

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FIGURE 2
Distributions of the Financial Well-being Scales.



sample, the median was 57.9 and the average was 54.0.

The distributions for the scales are shown in Figure 2. Both scales are slightly skewed towards higher values but cover the entire range of possible values. The scales are distinct, but strongly positively related, with a Spearman rank correlation of 0.46.

Both scales are formed from simple summations of categorical responses. We have compared the scales with more complex scales based on predicted values from IRT models. The summative reported scale is correlated 99.2 per cent with the IRT empirical Bayes mean prediction, and the summative observed scale is correlated 98.0 per cent with the IRT prediction. The reported and observed scales have high reliability, with Cronbach's alpha coefficients of 0.92 and 0.85, respectively.

VI Data-Driven Predictors of Financial Well-being

We use additional measures that are available in our survey and from customers' bank records to estimate multivariate data-driven models of the predictors of people's reported and observed financial well-being. This exercise supports the convergent validity of our scales by exploring correlates that are drawn from our conceptual model and that have been explored in the literature. The associations in these analyses cannot be interpreted as causal, yet we do find correlations between our financial well-being scales and measures we would *ex ante* expect to be related to them. This helps ascertain the validity of our scales. The fact that these correlations are uncovered in a data-driven way – without imposing restrictions on which variables should be excluded from our predictive models – further solidifies our findings.

From the survey, we have 103 potential predictors, which describe the respondents' personal and household characteristics (including measures such as household income, home ownership, employment status and savings preferences); external conditions and events (including changes in household financial situation, illnesses, and natural disasters among others); and financial behaviours (including ownership of term deposits, credit cards, personal loans, and savings and spending behaviours). For financial behaviours, the survey asked several questions of saving and spending behaviour that were closely related. Based on exploratory factor analyses, we combine measures of whether respondents (1) make sure to have money for bad times, (2) try to save money regularly, and (3) try to save to fall back on in the future to form a scale of savings behaviour. We also combine measures of whether respondents (1) consider they are doing a good job balancing spending and savings, (2) run short on money because overspend, and (3) buy things

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they cannot afford to form a scale of spending behaviour. The data also include five variables derived from the customers' financial records which measured gambling transactions, government support use, and contact with the bank via telephone, in-branch visits and online. Importantly, none of our regressors are variables that are used in our scales or that that were used in the scale development process. Table A6 in the additional supporting information lists and provides descriptive statistics of all the predictors considered in our analyses.

All the variables in Table A6 in the additional supporting information are plausible predictors of financial well-being, and entering the analysis, we do not make any assumptions regarding which ones might be excluded from our models. Instead, we reduce the number of predictors in a systematic, data-driven way using Tibshirani's (1996) least absolute shrinkage and selection operator (LASSO). LASSO estimates multivariate linear regression coefficients that minimise (1) the sum of squared differences between a dependent variable and its linear predictions *plus* (2) a penalty term based on the sum of absolute values of model coefficients. Let FWB_i be the dependent variable – either the Reported or Observed Financial Wellbeing Scale value – for the ith customer; and let X_{ij} be the jth potential predictor for the customer. Our LASSO estimates $(\hat{\beta}_0, \hat{\beta}_1, \cdots, \hat{\beta}_J, \hat{\lambda})$ solve:

$$(\hat{\beta}_0, \hat{\beta}_1, \cdots, \hat{\beta}_J, \hat{\lambda}) = \text{argmin}\Big\{\sum_{i=1}^{N}(FWB_i - \beta_0 - \sum_{j=1}^{J}\beta_j X_{ij})^2 + \lambda \sum_{j=1}^{J}|\beta_j|\Big\},$$

where the β_j terms are model coefficients and $\lambda\,(>0)$ is a shrinkage weight. The term $\lambda\sum_j|\beta_j|$ on the right-hand side of this equation penalises solutions for β_j that are large in absolute magnitude, which effectively shrinks the coefficient estimates. Importantly for our analyses, this shrinkage sets coefficients on weak or redundant predictors of financial well-being to zero, eliminating them from the model. We leverage this property of LASSO to make a data-driven selection of the best predictors of financial well-being. We consider all J = 103 potential predictors of financial well-being in our data and estimate our models with 3531 observations for which we have complete information on all predictors and outcomes.

Two complications of LASSO are that (1) its coefficient estimates are biased by virtue of the shrinkage properties of the estimator, and (2) its selection of a subset of predictors of financial well-being from the data affects inference on the coefficients of the predictors that are retained for our models. We address these problems by (1) estimating ordinary least squares (OLS) coefficients on the variables that are selected by LASSO (we refer to this second procedure as post-OLS) to produce estimates that are not subject to shrinkage bias, and (2) calculating correct post-selection upper and lower confidence bounds on our post-OLS estimates using a method developed by Lee *et al*. (2016).

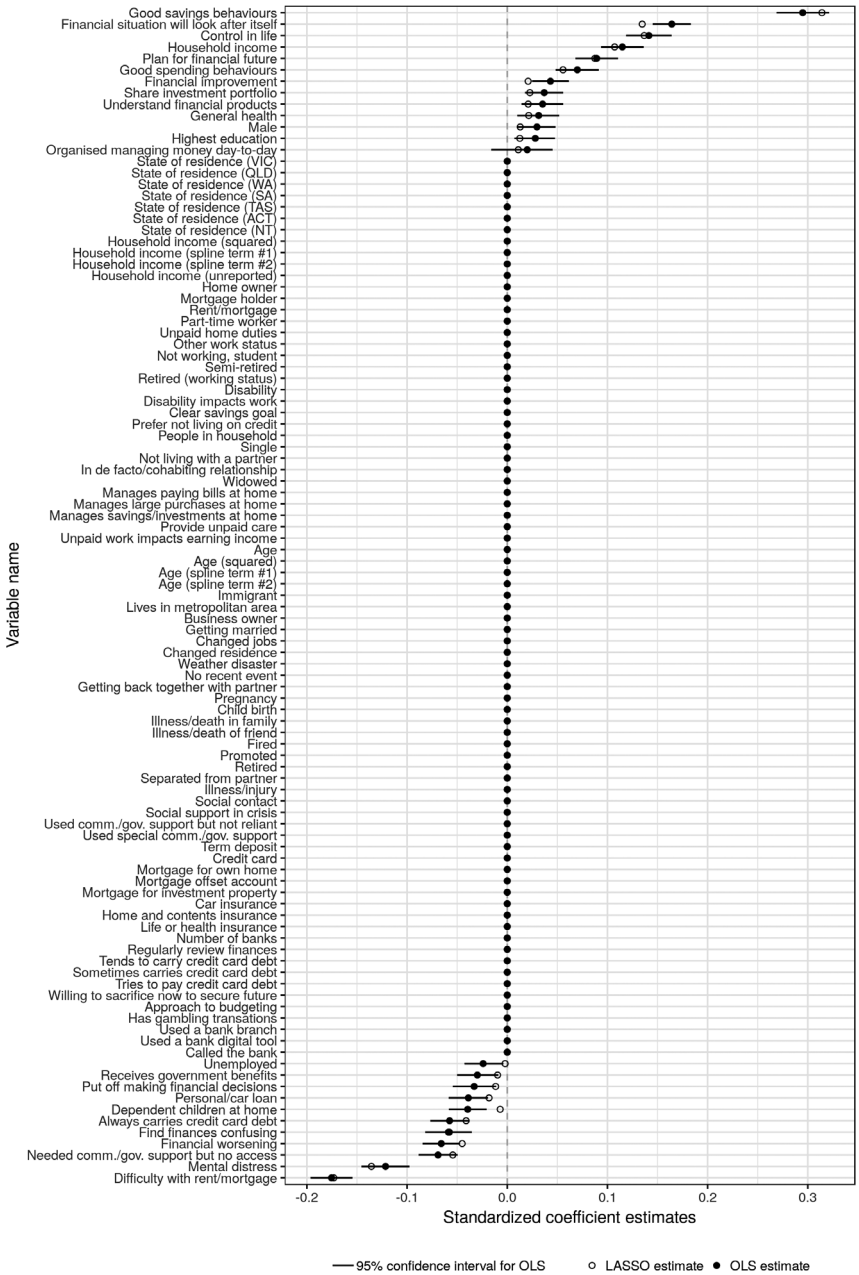
Figures 3 and 4 report our LASSO-estimated coefficients (hollow circles), with their corresponding post-OLS estimated coefficients (filled circles) and corresponding post-selection confidence intervals which are usually not symmetric around those estimates. For these figures and in the underlying LASSO models, the outcome variables – the Reported and Observed Financial Wellbeing scales – as well as all regressors were rescaled to have a standard deviation (SD) of 1. We note again that neither LASSO nor post-OLS coefficients in these models should be given a causal interpretation. Rather they should be seen as providing evidence of the strength of partial associations – that is, associations *holding all other predictors in each model constant* – between the regressors and our measures of Reported and Observed financial well-being.

We have also made the following decisions for estimating the models in this section: (1) the relation between financial well-being and continuous predictors (age and household income) were estimated using restricted cubic splines with knots at each quartile in the predictor distribution; (2) values of λ were chosen at 0.0302 and 0.0301 for reported and observed financial well-being models following three-fold cross validation and applying the 'one standard error' rule from Hastie *et al*. (2015); and (3) missing values of household income for 9.9 per cent of our sample were imputed at the sample mean.

The first thing to note from Figures 3 and 4 is that LASSO sets many coefficients of predictors to zero. Out of a total of 103 coefficients, 79 are set to zero for the reported financial well-being model, and 63 are set to zero for the observed financial well-being model. Moreover, one of the 24 predictors with a non-zero coefficient has a statistically insignificant relationship with

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FIGURE 3
Predictors of Reported Financial Well-being.

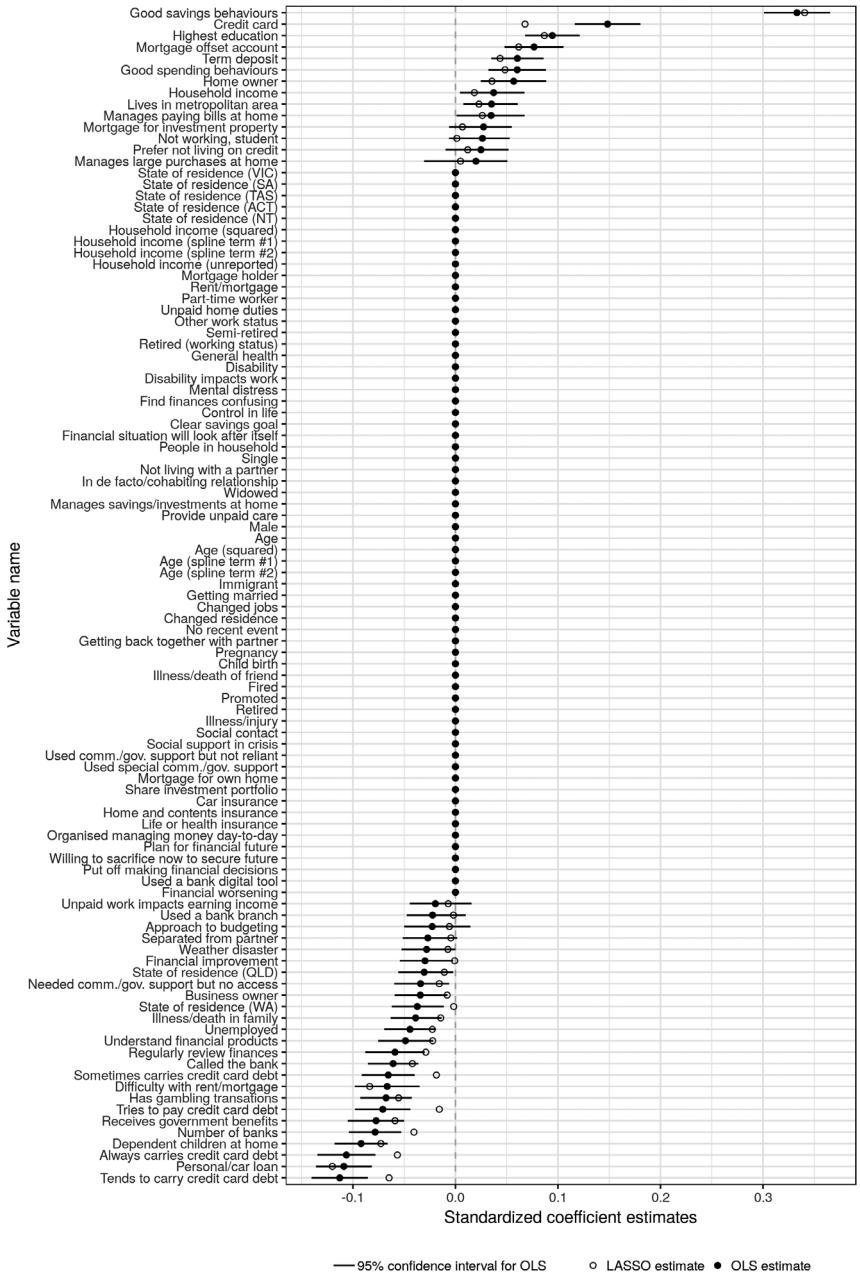


Note: Included are standardised coefficients, some of which are set to zero by the least absolute shrinkage and selection operator (LASSO) estimator. The λ parameter of the LASSO estimator is chosen as 0.0302 using a three-fold cross-validation and Hastie *et al.*'s (2015) 'one standard error' rule. $N = 3531$; root mean square error (RMSE) = 11.2065.

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FIGURE 4

The Predictors of Observed Financial Well-being.



Note: Included are standardised coefficients, some of which are set to zero by the least absolute shrinkage and selection operator (LASSO) estimator. The λ parameter of the LASSO estimator chosen as 0.0301 using three-fold cross-validation and Hastie *et al.*'s (2015) 'one standard error' rule. $N = 3531$; root mean square error (RMSE) = 17.8354.

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reported financial well-being, whereas seven of the 40 predictors with non-zero coefficients have statistically insignificant relationships with observed financial well-being. Given that we made typical choices for regularisation in our models, these results indicate there are relatively few independent key predictors of reported and observed financial well-being in our data and that variable selection is warranted.

Figures 3 and 4 show that the single best positive predictor of both reported and observed financial well-being is good savings behaviours, as measured by our subscale. A SD increase in the savings behaviours subscale is associated with a 0.29 SD increase in reported financial well-being (about 6 points on the scale) and a 0.33 SD increase in observed financial well-being (about 8 points in the scale). These are strong associations, especially since they are partial associations that hold constant other characteristics correlated with good savings behaviours in our model. Our spending behaviour subscale is also a positive predictor of reported and observed financial well-being, though its partial association with both scales is not as strong as savings behaviour. A 1 SD increase in the good spending behaviours measure is associated with 1.4 more points on the Reported Financial Wellbeing Scale and 1.5 more points on the Observed Financial Wellbeing Scale. The LASSO results also indicate that income and education are positive predictors of both types of financial well-being, while unemployment, difficulties with housing payments, the number of dependent children at home, needing but not being able to access community or government support, personal or car loans, and not holding a credit card are negative predictors.

To simplify the discussion and interpretation of our main findings, Table 3 presents the partial associations of the statistically significant predictors of reported and observed financial well-being only. The table expresses these partial associations as implied relationships of each predictor with the financial well-being scales in easy-to-understand units. These estimates still account for all predictors selected by LASSO in each model and should be interpreted as partial associations – that is, associations between the predictor and the financial well-being measures *holding all other predictors in each model constant*. Results from the complete LASSO and post-OLS analyses are reported in Table A5 in the additional supporting information.

Several personal and household characteristics are good predictors of both reported and observed financial well-being. Each additional A$10,000 in household income is related to a 0.4 point increase in the Reported Financial Wellbeing Scale and a 0.1 point increase in the Observed Financial Wellbeing Scale. Being unemployed is related to a decrease of 2.7 points relative to full-time employment in the Reported Financial Wellbeing Scale and 5.9 points in the Observed Financial Wellbeing Scale. Experiencing difficulty paying mortgage or rent is also associated with lower reported and observed financial well-being, consistent with living costs stress putting pressure on people's finances even after accounting for income differences. Higher education is related to better financial well-being, with people with postgraduate degrees enjoying 2.3 and 9.3 points higher reported and observed financial well-being compared with people with only primary education. Each additional dependent child at home is associated with a decrease of 1 point in the Reported Financial Wellbeing Scale and 2.9 points in the observed scale.

Other personal and household characteristics predict reported but not observed financial well-being. These include gender, good general health, mental distress, finding finances confusing, having a strong sense of control in life, and believing that one's financial situation will look after itself.

Conversely, observed but not reported financial well-being is predicted by business and home ownership, being a student, preferring not to live on credit, having unpaid work that interferes with earning income, metropolitan residence, and state of residence. Finally, reporting a better understanding of financial products is associated with higher reported financial well-being but lower observed financial well-being. This is consistent with some people being overconfident about their understanding of financial products, leading them to report a higher financial well-being but also to make mistakes that decrease their objective financial well-being. It could also be that people with a good understanding of financial products also have more complex financial situations which are difficult to capture in objective financial well-being measures.

The partial associations of several external conditions and events are different for reported and observed financial well-being. Reporting a financial improvement is associated with a 3.6 point increase in reported financial well-being but a 3.0 point decrease in observed financial well-

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TABLE 3
Partial Associations between Reported and Observed Financial Well-being and its Statistically Significant Predictors with at Least 95% Confidence after Least Absolute Shrinkage and Selection operator (LASSO) Selection

Characteristic	Change in the characteristic's from	Partial association with reported financial well-being	Partial association with observed financial well-being
Personal and household characteristics			
Household income	Every additional A$10,000 per year	0.4	0.1
Business owner	No → Yes	n.s.	–2.8
Homeowner	No → Yes	n.s.	4.0
Difficulty with rent/mortgage	No → Yes	–3.7	–1.7
Unemployed	Full time worker → Unemployed	–2.7	–5.9
Not working, student	Full time worker → Not working, student	n.s.	2.5
Highest education	Primary → Postgraduate	2.3	9.3
General health	Poor → Excellent	2.6	n.s.
Mental distress	Median → Level of mental illness	–3.2	n.s.
Find finances confusing	Strongly disagree → Strongly agree	–5.0	n.s.
Understand financial products	Not at all → Very well	2.6	–4.3
Control in life	None → Complete control	14.2	n.s.
Prefer not living on credit	Strongly disagree → Strongly agree	n.s.	2.6
Financial situation will look after itself	Strongly disagree → Strongly agree	14.3	n.s.
Dependent children at home	Each additional child	–1.0	–2.9
Unpaid work impacts earning income	No → A lot	n.s.	–1.1
Male	No → Yes	1.2	n.s.
Lives in metropolitan area	No → Yes	n.s.	1.9
State of residence	NSW → QLD	n.s.	–1.9
State of residence	NSW → WA	n.s.	–3.1
External conditions and events			
Recent financial improvement	No → Yes	3.6	–3.0
Recent financial worsening	No → Yes	–7.3	n.s.
Recent separated from partner	No → Yes	n.s.	–3.5
Recent illness/death in family	No → Yes	n.s.	–3.1
Recent weather disaster	No → Yes	n.s.	–5.5
Community/government support	No need → Need but no access	–4.9	–2.9
Financial behaviours			
Term deposit	No → Yes	n.s.	5.7
Credit card	No → Yes	n.s.	7.4
Personal/car loan	No → Yes	–2.0	–6.5
Mortgage offset account	No → Yes	n.s.	5.4
Mortgage for investment property	No → Yes	n.s.	2.1
Share investment portfolio	No → Yes	2.7	n.s.
Number of banks	Each additional bank	n.s.	–2.4
Good savings behaviours	25th percentile → 75th percentile	8.2	11.0
Good spending behaviours	25th percentile → 75th percentile	1.6	1.7
Organised managing money day to day	Not at all → Completely	1.6	n.s.
Plan for financial future	Focused on today → Actively planning	4.9	n.s.
Regularly review finances	Strongly disagree → Strongly agree	n.s.	–5.8
Credit card management	No card → Try to pay debt	n.s.	–6.1
Credit card management	No card → Sometimes carry debt	n.s.	–8.5

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TABLE 3
(continued)

Characteristic	Change in the characteristic's from	Partial association with reported financial well-being	Partial association with observed financial well-being
Credit card management	No card → Tend to carry debt	n.s.	–10.8
Credit card management	No card → Always carry debt	–4.8	–10.6
Put off making financial decisions	Strongly disagree → Strongly agree	–2.8	n.s.
Structured approach to budgeting	No budget → Formal budget	n.s.	–2.2
Manages large purchases at home	No → Yes	n.s.	1.4
Manages paying bills at home	No → Yes	n.s.	2.5
Bank record measures			
Receives government benefits	No → Yes	–1.4	–4.4
Has gambling transactions	No → Yes	n.s.	–4.2
Used a bank branch	No → Yes	n.s.	–1.2
Called the bank	No → Yes	n.s.	–4.0

Note: Estimates statistically indistinguishable from zero at the 95% confidence level are marked by 'n.s.'.

being. This could occur if people increase their spending in anticipation of such financial improvements which are not yet reflected in the Observed Financial Wellbeing Scale. Reporting a financial worsening is associated with a 7.3 point decrease in reported financial well-being but no significant change in observed financial well-being. Conversely, partner separation, illness or death in the family, and experiencing a weather disaster are associated with lower observed financial well-being but not reported financial well-being. Needing government support yet having no access to it is negatively associated with both reported and observed financial well-being. Similar discordances between the predictors of reported and observed financial well-being have also been found in other studies. Tenney and Kalenkoski (2019), for example, find that that while investment-to-assets is a good predictor of subjective financial well-being, debt-to-assets or liquidity-to-assets ratios are much weaker predictors.

In addition to the good savings and spending subscales discussed above, two other financial behaviours are strongly associated with both reported and observed financial well-being: having a personal or car loan and always carrying credit card debt. Personal or car loans are associated with a 2 point reduction in reported financial well-being and a 6.5 point reduction in observed financial well-being. People who always carry debt in their credit cards have a 4.8 point lower reported financial well-being score and a 10.6 point lower observed financial well-being score compared with people who always pay their credit card balances on time. Owning financial products such as term deposits and mortgages are generally associated with higher observed financial well-being but not with reported financial well-being. An exception is holding investment shares, which is associated with higher reported financial well-being.

We see differences in some other behaviours. Being organised with day-to-day money management and planning for one's financial future are positively associated with reported but not observed financial well-being. However, regularly reviewing finances, some types of credit card behaviour, and a structured approach to budgeting are negatively associated with observed financial well-being but not associated with reported financial well-being. The results for reviewing finances and structured budgeting may reflect reverse causality with people with lower financial well-being needing to undertake these activities. Being responsible for managing large purchases and paying bills at home are associated with higher observed financial well-being but not reported financial well-being.

Finally, most characteristics measured through bank record data, including gambling transactions and contact with the bank either through a branch or through the telephone, are negatively associated with observed but not reported financial well-being. The exception is receiving

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government benefits which is negatively related to both types of financial well-being.

Sensitivity analyses of the results of this section are reported in Appendix C in the supporting information.

VII Discussion

Our strict focus on data-driven methods to construct and analyse measures of financial well-being yields powerful insights. For constructing the measures, our approach confirms our conceptualised separation between subjective and objective aspects of financial well-being. It also helps us reduce an immense set of candidate measures of financial well-being into a compact set which spans the domains of our conceptualisation yet is small enough to facilitate further analyses. Finally, our use of IRT models allows us to verify that our component measures all contribute to the scales, have similar discrimination, and can be summed to produce easily implementable scales. The IRT results also show that these measurement relationships are similar across different groups. These features define the Reported and Observed Financial Wellbeing Scales as particularly useful tools to measure financial well-being in Australia.

Our data-driven approach to analyse the characteristics associated with reported and observed financial well-being also yields useful insights. First, the LASSO greatly reduces the set of predictive characteristics for each type of financial well-being. These data reductions will focus our future research efforts on the strongest associations and will hasten the process of understanding and improving financial well-being.

Second, although many important predictors remain after implementing the LASSO, our results highlight three crucial behaviours related to financial well-being: good savings behaviour, good spending behaviour, and careful management of credit. A better understanding of the nuanced relationship between these financial behaviours and financial well-being will be crucial for designing better financial products and interventions to improve people's financial wellness.

Third, people's socioeconomic characteristics such as income, education or unemployment are also important for their financial well-being. Yet their partial associations are less strong than many of the financial behaviours we considered. This has a critical implication: people from many types of socioeconomic backgrounds and levels of wealth and income can enjoy high financial well-being. Our results suggest that a direct path to better financial well-being is to adopt financially sound behaviours, and people across the socioeconomic spectrum can adopt these.

Fourth, our results also point out that credit card debt and gambling are strongly associated with lower financial well-being. What is not clear is if credit card mismanagement and gambling cause lower financial well-being, or whether they are symptoms of other underlying issues. Yet these strong negative associations do suggest that future research should investigate the potential role of these behaviours in exacerbating bad financial outcomes. The Reported and Observed Financial Wellbeing Scales can play an important role in assessing the social cost of these behaviours.

Finally, our results show that having a sense of control and the discipline to plan for the future are strong predictors of reported financial well-being. This suggests that financial planning and literacy interventions as well as other interventions based on positive psychology could be an effective way to improve people's financial well-being.

VIII Conclusions

In this article we report the development of the first multi-item financial well-being scales that combine people's self-reported perceptions and experiences of their financial outcomes with bank record measures of their cash balances, savings, credit, and payments. The formal development of the Reported Financial Wellbeing and Observed Financial Wellbeing scales produced transparent, discerning, and easy to implement scales that can be used to systematically explore the potential predictors of financial well-being.

We use further survey and bank record data in data-driven analyses to explore which characteristics contribute to financial well-being. These additional data include over 100 measures that were available as potential predictors, yet our methods allow us to find the best actual predictors of financial well-being in a data-driven way while also maintaining our ability to correctly infer statistically significant associations. These models reveal that people's savings habits are especially strong correlates of their reported and observed financial well-being. Other strong correlates for both types of financial well-being include spending habits, credit card behaviour, difficulties with housing payments, and the use of and access to social or government support. After

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accounting for differences in these financial behaviours, socioeconomic characteristics such as household income and education have much more modest correlations with financial well-being.

Our results illustrate the possibility of combining self-reported and bank record measures to construct simple and functional financial well-being measures, and the huge benefits that these measures can bring in improving people's financial well-being. The Observed Financial Wellbeing Scale, in particular, is easy to generalise to many bank customers and provides a useful tool to monitor bank customer's financial well-being and offer assistance if they find themselves in financial difficulties. At the bank level, the Observed Financial Wellbeing Scale can become an invaluable tool to evaluate the effectiveness of financial literacy and well-being interventions and the welfare impact of existing and new financial products. At the same time, by combining self-reported objective and subjective information, the Reported Financial Wellbeing Scale provides depth to the measure of financial well-being that cannot be accessed through bank record data. The simple structure of the scale makes it easy to use by consumers. Both scales complement one another to provide a comprehensive and nuanced view of financial well-being.

Our results also illustrate the potential benefits of formally constructing and analysing financial well-being measures. Two key lessons are that (1) financial behaviours are particularly strong correlates of both reported and observed financial well-being, and (2) many of these behaviours are modifiable. If at least part of these strong correlations is driven by a causal link between financial behaviours and financial well-being, this implies we can increase financial well-being for many people by helping them modify their financial behaviours. Importantly, modifying these behaviours will likely be more easily achieved than improving people's overall socioeconomic standing by increasing their income or education. More research is needed to determine whether financial behaviours are indeed causally related to financial well-being but the strong correlations we find give us reason to believe that by using our financial well-being scales we might soon find innovative and effective ways to improve people's lives. The scales also give us a tool to test any such interventions.

Supporting Information

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

Appendix A. Development of the Financial Wellbeing Scales.

Table A1. Candidate Self-Reported Financial Wellbeing Questions.

Table A2. Candidate financial-record measures.

Table A3. Exploratory factor analysis results—two-factor solution.

Table A4. IRT severity and discrimination parameter estimates.

Table A5. Coefficients of Predictors of Reported and Observed Financial Wellbeing.

Table A6. Descriptive Statistics ($N = 3531$).

Figure A1. Exploratory Factor Loadings for the Reported Financial Wellbeing Items Across Housing Tenure, Household Composition, Work Status, Whether Respondents Find Finances Confusing, and Highest Level of Education.

Figure A2. Exploratory Factor Loadings for the Observed Financial Wellbeing Items Across Housing Tenure, Household Composition, Work Status, Whether Respondents Find Finances Confusing, and Highest Level of Education.

Appendix B. Additional Figures and Tables.

Figure B1. LASSO and post-OLS Coefficients in Models with Predetermined and Likely Exogenous Predictors of Reported Financial Wellbeing Models.

Figure B2. LASSO and post-OLS Coefficients in Models with Predetermined and Likely Exogenous Predictors of Observed Financial Wellbeing Models.

Appendix C. Sensitivity Analyses of Section 6.

Figure C1. LASSO vs Elastic Net Coefficients in Reported Financial Wellbeing Models.

Figure C2. LASSO vs Elastic Net Coefficients in Observed Financial Wellbeing Models.

Figure C3. LASSO vs Post-OLS Coefficients in Reported Financial Wellbeing Models.

Figure C4. LASSO vs Post-OLS Coefficients in Observed Financial Wellbeing Models.

Appendix D. Financial Wellbeing Survey Materials.

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