

Financial Literacy as a Protective Factor Against Problem Gambling:

Longitudinal Evidence from the HILDA Survey

Vandana Arya, Tony Cavoli, Nirosha Wellalage

Adelaide University, Australia

and

Ilke Onur

Flinders University, Australia

Abstract

Many adults gamble without experiencing serious harm, making the transition from recreational participation to problem gambling a central question for prevention. This study examines financial literacy as a protective capability within that transition. We use nationally representative longitudinal data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, linking objective financial literacy measured two waves earlier to gambling participation and Problem Gambling Severity Index outcomes. The empirical design distinguishes entry into gambling from harmful escalation and combines probit models with panel fixed effects, instrumental-variable sensitivity analyses, a Heckman selection correction, behavioural interactions and KHB decomposition. The evidence points to a selective rather than uniform role for financial literacy. Its protective association is more pronounced for problem gambling than for participation, is stronger among financially risk-tolerant individuals, and is largest in skill-and-chance gambling environments. Behavioural pathways involving risk tolerance, long-term planning and social trust account for part of this relationship. By connecting financial capability with gambling harm prevention, the study identifies where financial literacy is most likely to matter and supports its targeted integration into early-intervention and consumer-protection strategies while recognising the limits of observational evidence.

Keywords: financial literacy; problem gambling; gambling participation; gambling type; behavioural channels; HILDA Survey; Australia; harm prevention

JEL Classification: D14, D81, G53, I12

1. Introduction

Problem gambling is a public-health concern with substantial financial, social and psychological consequences. Gambling is a common recreational activity, but a minority of participants experience escalation marked by persistent behaviour despite mounting losses and wider harm. The Problem Gambling Severity Index (PGSI) captures this broader continuum of risk and harm (Ferris and Wynne, 2001; Currie et al., 2013), while longitudinal evidence documents movement between gambling-risk categories over time (Suomi et al., 2025). In Australia, high per-capita gambling expenditure and the associated effects on households make prevention, rather than treatment alone, an important policy priority (Productivity Commission, 2010; Australian Gambling Research Centre, 2022; AIHW, 2024). This paper asks whether financial literacy helps protect individuals from gambling harm. Gambling decisions require people to interpret probabilities, expected values and cumulative losses while balancing immediate rewards against future financial consequences. These are closely related to the competencies developed through financial literacy (Lusardi and Mitchell, 2014). Yet the gambling literature has paid far more attention to risk factors (Dowling et al., 2017) than to the financial knowledge and decision capabilities that may prevent harmful escalation.

Two recent systematic reviews identify a generally negative association between financial literacy and gambling but also show that the evidence has been dominated by cross-sectional studies, brief literacy measures and gambling frequency outcomes rather than validated measures of harm (O'Connor and Ivory, 2025; Barone and Graffigna, 2025). Hoang and Vo (2026) provide important Australian evidence using HILDA data, showing that higher financial literacy is associated with lower PGSI risk and

examining locus of control as a mechanism. This shifts the remaining question toward when, for whom and in which gambling environments financial literacy is most protective.

We address this gap through a conceptual framework drawing on behavioural economics and financial capability research. The framework distinguishes two margins of behaviour. The extensive margin is participation in gambling. The intensive margin is problem gambling among those who gamble. This distinction changes the substantive question: a factor may have only a modest relationship with recreational participation while offering meaningful protection against escalation. We test the framework using two matched wave pairs from the nationally representative HILDA Survey, with financial literacy measured two waves before gambling outcomes.

The paper extends this emerging Australian evidence in four ways. First, it separates the extensive margin of gambling participation from the intensive margin of gambling harm while measuring financial literacy two waves earlier. Second, it examines whether the association differs across chance-only and skill-and-chance gambling activities. Third, it tests whether financial risk tolerance, long-term planning and social trust condition the protective role of financial literacy. Fourth, it uses KHB decomposition to organise the direct and behavioural pathways represented in Figure 1.

The empirical strategy combines lagged probit models, linear probability models, individual fixed effects, two instrumental-variable approaches and a Heckman selection correction. These approaches cannot transform observational panel data into an experimental intervention, but they provide complementary checks on reverse causality, time-invariant heterogeneity, endogeneity and selection into the gambling sample.

The results support a targeted interpretation of financial literacy. The association is stronger for problem gambling than for participation, and the largest protective patterns appear among risk-tolerant individuals and participants in skill-and-chance gambling. This suggests that financial literacy is most relevant where products are complex, betting can be repeated frequently and potential losses are substantial.

The remainder of the paper proceeds as follows. Section 2 reviews the literature and sets out the conceptual framework. Sections 3 and 4 describe the data and empirical strategy. Section 5 presents the main estimates. Section 6 reports robustness checks, heterogeneity, interaction effects and the channel decomposition. Section 7 discusses implications, limitations and conclusions.

2. Literature Review and Conceptual Framework

2.1 Financial Literacy and Financial Behaviour

Financial literacy refers to the knowledge and capacity required to process financial information and make informed choices. A large literature links it to retirement saving, wealth accumulation, portfolio diversification, borrowing and mortgage outcomes (Lusardi and Mitchell, 2014). These relationships persist after accounting for education, income and other dimensions of human capital, suggesting that financial knowledge is an independent input into decision quality.

Evidence from interventions and quasi-experimental studies also indicates that financial knowledge can affect economic behaviour rather than simply proxying for advantage. Hastings et al. (2013) review evidence on saving, borrowing and insurance choices, while Gerardi et al. (2013) show that numerical ability predicts mortgage default. The shared mechanism is an improved capacity to evaluate complex financial consequences under uncertainty.

Three mechanisms are especially relevant to gambling. First, financial literacy can improve probabilistic reasoning and reduce susceptibility to overconfidence, base-rate neglect and the illusion of control (Kahneman, 2011). Second, it can make future costs more salient and strengthen intertemporal discipline (O'Donoghue and Rabin, 1999). Third, it can give individuals an independent basis for financial judgement when social settings normalise gambling.

2.2 Financial Literacy and Gambling Behaviour

The empirical literature on financial literacy and gambling is small but increasingly consistent. Studies from Japan, the United States, Thailand, China and Australia generally report that higher objective

financial literacy is associated with lower gambling frequency, intensity or severity (Amonhaemanon, 2022, 2023; Cho, 2022; Wang et al., 2023; Watanapongvanich et al., 2021; Hoang and Vo, 2026). The cross-country pattern suggests that the relationship is not confined to a single gambling market or institutional setting.

Two systematic reviews identify continuing limitations in this evidence base. Many studies are cross-sectional, use brief or subjective financial-literacy measures, or focus on gambling frequency rather than validated harm outcomes (O'Connor and Ivory, 2025; Barone and Graffigna, 2025). Hoang and Vo (2026) address several of these concerns with objective financial literacy, longitudinal HILDA data, instrumental-variable analysis and locus-of-control mediation. Their findings establish a close Australian benchmark but leave scope to distinguish entry into gambling from harmful escalation and to examine heterogeneity by gambling type and behavioural vulnerability.

Australian longitudinal evidence has also established that gambling severity predicts later financial stress (Koomson et al., 2022). Together with Hoang and Vo (2026), this work links financial capability and gambling harm in both directions. The present study builds on it by imposing a two-wave lag between literacy and outcomes, explicitly separating participation from problem gambling, comparing chance-only with skill-and-chance activities, and assessing risk tolerance, planning and trust as moderators and behavioural channels.

2.3 Behavioural Conceptual Framework and Expectations

Rather than proposing a formal theoretical model, the paper integrates insights from behavioural economics, financial literacy research and gambling studies to derive empirically testable expectations. The framework is intended as an organising structure for the empirical analysis rather than a complete behavioural model.

Our framework treats financial literacy as a capability that can operate directly through knowledge and indirectly through behavioural dispositions. The direct pathway reflects recognition of expected losses,

better interpretation of probabilities and more disciplined financial decision-making. The indirect pathways operate through financial risk tolerance, long-term planning orientation and generalised social trust.

Financial risk tolerance is the most immediate pathway. Individuals who understand the negative expected return embedded in gambling products may be less likely to translate a general willingness to take financial risk into repeated gambling. We therefore expect financial literacy to be especially protective among risk-tolerant individuals, whose baseline vulnerability is higher (Dohmen et al., 2011; Falk et al., 2018).

Long-term planning captures the intertemporal dimension. Present-biased individuals place greater weight on immediate rewards and less weight on cumulative future losses. Financial literacy may strengthen attention to those future costs, implying a larger protective role among people with weaker planning orientation.

Social trust is more ambiguous. Trust may support information sharing and prudent behaviour, but trusted social networks can also normalise gambling (Duflo and Saez, 2003; Putnam, 2000). Financial literacy may offset social influence at the participation margin while being less effective once gambling is embedded in a trusted network. We therefore treat the direction of this interaction as an empirical question.

Gambling type provides a further test of the framework. Chance-only activities such as lotteries and keno are relatively simple and infrequent. Skill-and-chance activities, including electronic gaming machines, sports betting, race betting and casino table games, tend to involve greater complexity, repetition and scope for perceived control. If financial literacy protects through probability assessment and disciplined loss management, its association with problem gambling should be stronger in the latter group.

3. Data, Sample and Variable Construction

3.1 The HILDA Survey

We use the Household, Income and Labour Dynamics in Australia (HILDA) Survey, a nationally representative longitudinal panel administered by the Melbourne Institute (Summerfield et al., 2023; Wilkins et al., 2024). HILDA follows individuals and households over time and contains detailed information on income, employment, family circumstances, financial behaviour and selected gambling outcomes.

The analysis links gambling outcomes observed in waves 18 and 22 to financial literacy measured two waves earlier. This t-2 structure corresponds to financial literacy in waves 16 and 20 matched to subsequent outcomes in waves 18 and 22. The pooled analytic sample contains 17,785 person-wave observations. Models of problem gambling are restricted to 6,664 person-wave observations for gambling participants. N denotes person-wave observations throughout the paper.

The two outcome waves also span a period in which gambling opportunities and participation patterns changed, including the COVID-19 disruption and subsequent reopening (Suomi et al., 2024). Wave fixed effects absorb common shifts between the two periods, and wave-specific estimates are reported in the appendix.

3.2 Survey Weights and Attrition

Consistent with much of the HILDA literature, the primary analyses are estimated without longitudinal survey weights because the specifications include extensive individual controls and state and wave fixed effects. Appendix Table A10 reports weighted estimates using the relevant HILDA longitudinal survey weights. The weighted estimates are close to the corresponding unweighted estimates and produce the same substantive conclusions.

As with all longitudinal surveys, sample attrition may affect representativeness over time. HILDA provides longitudinal weights that partially adjust for differential non-response and attrition. The

stability of the estimates across weighted and unweighted specifications suggests that attrition is unlikely to drive the main findings.

3.3 Financial Literacy

Financial literacy is measured using five objective questions covering the risk-return relationship, diversification, simple interest, inflation and real purchasing power. Correct answers are summed to form an index from zero to five, with higher values indicating greater financial knowledge. This objective measure avoids conflating confidence with competence and captures a broader range of knowledge than the commonly used three-item measure (Lusardi and Mitchell, 2014).

The mean score in the matched analytic sample is 4.51. Appendix Table A1 reports item-level performance, while Appendix Table A2 reports the wave-level distribution for the broader samples with non-missing financial-literacy data. The appendix and analytic-sample statistics therefore describe different sample bases.

3.4 Gambling Outcomes

Gambling participation equals one when a respondent reports gambling in a typical month and zero otherwise. It captures the extensive-margin decision to gamble. In the pooled sample, 6,664 of 17,785 person-wave observations are classified as gambling participants.

Problem gambling is defined using the Problem Gambling Severity Index. The main binary outcome equals one for PGSI scores of three or above and zero otherwise, and is estimated among gambling participants. This threshold captures moderate-risk and problem gambling and is consistent with evidence that harm becomes meaningful below the most severe category (Currie et al., 2013). Among gamblers, 590 person-wave observations, or 8.9%, meet the main threshold. Continuous PGSI and alternative cut-offs are examined in the appendix.

For the gambling-type analysis, chance-only participation includes lotteries and keno. Skill-and-chance participation includes electronic gaming machines, sports betting, race betting and casino table games.

The classification distinguishes comparatively simple chance products from activities with greater strategic complexity, repetition or perceived scope for skill.

3.5 Control Variables

The baseline specifications include age, age squared, gender, years of schooling, log household income, marital status, family size, employment status, number of children and major-city residence. State and wave fixed effects absorb persistent geographic differences and common temporal shocks. The Heckman model is the exception: major-city residence enters the gambling-participation equation but is excluded from the problem-gambling outcome equation. The behavioural models additionally use financial risk tolerance, long-term planning orientation and generalised social trust, measured before or alongside the relevant outcomes as specified in the analysis.

Descriptive statistics for the full sample and gambling subgroups are reported in Table 1.

Table 1: Descriptive Statistics

Variable	Full Sample	Non-Gamblers	Gamblers	Non-Problem Gamblers	Problem Gamblers
N =	17,785	11,121	6,664	6,074	590
Financial literacy (0-5)	4.51	4.51	4.50	4.51	4.30
Age (years)	49.50	47.38	53.03	53.40	46.66
Male (proportion)	0.53	0.487	0.597	0.588	0.700
Schooling (years)	13.08	13.35	12.63	12.66	12.26
Log income	11.43	11.46	11.38	11.39	11.24
Married (proportion)	0.72	0.716	0.732	0.740	0.622
Financial risk-taker (proportion)	0.60	0.597	0.607	0.594	0.764
Long-term planner (proportion)	0.42	0.443	0.384	0.394	0.269
Trusting (proportion)	0.68	0.682	0.682	0.693	0.522
Major city (proportion)	0.64	0.656	0.603	0.603	0.624
Employed (proportion)	0.70	0.706	0.681	0.680	0.702

Notes: This table presents means or proportions for the matched analytic sample, non-gamblers, gamblers, non-problem gamblers among gamblers, and problem gamblers. Problem gambling is defined as a PGSI score of 3 or above (moderate risk or problem gambling). Financial literacy is measured two waves prior to gambling outcomes. N denotes person-wave observations. Financial literacy is measured at $t-2$ (two waves prior to gambling outcomes). Problem gambling is defined as $PGSI \geq 3$ (moderate risk or problem gambling). Non-problem gamblers include all gamblers with $PGSI < 3$.

4. Empirical Strategy

4.1 Baseline Specification

Our baseline model estimates the probability of gambling outcome Y for individual i in wave t as:

$$\Pr(Y_{it} = 1) = \Phi(\alpha + \beta \text{FinLit}_{i,t-2} + \gamma'X_{it} + \delta_s + \lambda_t + \varepsilon_{it}) \quad (1)$$

FinLit is the financial literacy index measured two waves earlier, X is the vector of individual controls, δ denotes state fixed effects and λ denotes wave fixed effects. We report average marginal effects from probit models so that coefficients can be interpreted as percentage-point changes in outcome probability. All standard errors are clustered at the individual level to account for repeated observations in the panel. Lagging financial literacy strengthens temporal ordering and reduces the immediate reverse-causality concern that current gambling behaviour determines measured financial knowledge. It does not eliminate all time-varying confounding or slower feedback from earlier gambling experiences, so the paper uses several complementary robustness strategies and avoids treating the baseline association as equivalent to a randomised intervention effect.

4.2 Instrumental-Variable Estimation

The first instrumental-variable strategy uses a postcode-level leave-one-out mean of financial literacy. For each respondent, the instrument is the average literacy of other respondents in the same postcode and wave. Local information environments can shape financial knowledge, while excluding the individual avoids mechanical correlation. The exclusion restriction requires local financial literacy to affect gambling harm only through individual literacy after controls and fixed effects. The IV models are estimated among gambling participants because problem gambling is observed conditional on participation; observations with incomplete postcode information are excluded from specifications using the postcode instrument.

The second strategy follows Lewbel (2012), generating instruments from heteroskedasticity in the first-stage residuals. We estimate a Lewbel-only model and a model combining generated instruments with the postcode instrument. The combined specification provides an overidentification test of the external instrument conditional on the internally generated instruments; diagnostic tests follow standard IV practice (Angrist and Pischke, 2009; Baum et al., 2007).

4.3 Selection into Gambling

Problem gambling is observed only among people who gamble. If unobserved determinants of participation correlate with the severity of gambling harm, estimates from the selected sample may be biased. We therefore estimate a Heckman two-step selection correction (Heckman, 1979). The first step is a probit model of gambling participation. The resulting inverse Mills ratio enters the second-stage problem-gambling equation estimated among participants. Because the outcome is binary, this specification is treated as a selection-sensitivity check rather than as a structural probability model.

The exclusion restriction is major-city residence. Geographic location influences exposure to gambling venues and opportunities to participate in gambling activities. Once participation occurs, however, problem-gambling severity is expected to be driven primarily by individual behavioural and socioeconomic characteristics rather than geographic location. Consistent with this argument, major-city

residence significantly predicts gambling participation ($p < 0.01$) but is not significantly associated with problem-gambling severity in baseline models. Appendix Table A11 reports the selection-equation estimates and the corresponding outcome-equation check. This evidence supports the relevance and plausibility of the restriction, although it cannot prove exclusion from the outcome equation.

4.4 Interaction and Gambling-Type Models

We estimate separate problem-gambling models for chance-only and skill-and-chance participants. We also interact lagged financial literacy with financial risk tolerance, trust and long-term planning. Because nonlinear interaction coefficients do not directly equal interaction effects on probability, interpretation focuses on model-based average marginal effects. Subgroup AMEs are calculated from the fitted probit models at moderator values of zero and one and are reported in Appendix Table A9.

4.5 KHB Decomposition

The Karlson-Holm-Breen method decomposes the total financial literacy coefficient in a nonlinear probability model into a direct component and an indirect component associated with specified mediators while correcting for rescaling across nested models (Karlson et al., 2012). We use financial risk tolerance, long-term planning and social trust as the three behavioural channels. The decomposition is estimated among gamblers ($N = 6,664$). Channel shares are interpreted as descriptive mechanisms within the model, not as experimentally identified mediation effects.

4.6 Panel Fixed Effects and Omitted-Variable Sensitivity

We also estimate a linear probability model with individual fixed effects:

$$Y_{it} = \alpha_i + \beta \text{FinLit}_{i,t-2} + \gamma' X_{it} + \lambda_t + \varepsilon_{it} \quad (2)$$

Individual fixed effects absorb time-invariant unobserved characteristics, including stable cognitive ability, personality and background. The fixed-effects coefficient is identified by respondents contributing within-person variation across the observed waves. Oster (2019) sensitivity analysis is

intended to assess how strong selection on unobservables would need to be, relative to observables, to account for the estimated association.

5. Main Results

5.1 Gambling Participation

Table 2 reports the participation models. In the preferred probit specification with full controls, a one-point increase in lagged financial literacy is associated with a 2.1 percentage-point reduction in gambling participation. Relative to the sample participation rate of 37.5%, this is a reduction of approximately 5.6%.

The estimate is stable across functional forms. The linear probability model also yields -0.021, while the individual fixed-effects model yields -0.018. The persistence of the negative association after absorbing stable individual heterogeneity suggests that the result is not driven solely by time-invariant differences between more and less financially literate respondents.

Table 2: Financial Literacy and Gambling Participation

	(1)	(2)	(3)	(4)
	Probit (No Controls)	Probit (Full Controls)	LPM	LPM with FE
Financial literacy (t-2)	-0.030*** (0.004)	-0.021*** (0.005)	-0.021*** (0.005)	-0.018*** (0.004)
Age		0.022*** (0.001)	0.022*** (0.001)	
Age squared		-0.017*** (0.001)	-0.017*** (0.001)	
Male		0.090*** (0.007)	0.090*** (0.007)	
Schooling		-0.030*** (0.002)	-0.030*** (0.002)	
Log income		0.003 (0.005)	0.003 (0.005)	
Employed		0.059*** (0.001)	0.059*** (0.014)	0.055*** (0.013)

	(1)	(2)	(3)	(4)
	Probit (No Controls)	Probit (Full Controls)	LPM	LPM with FE
Financial risk-taker		0.045*** (0.008)	0.045*** (0.008)	0.038*** (0.007)
Long-term planner		-0.055*** (0.008)	-0.055*** (0.008)	-0.049*** (0.007)
Trusting		-0.003 (0.008)	-0.003 (0.008)	-0.004 (0.008)
Additional controls	No	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Individual FE	No	No	No	Yes
Oster δ			2.45	2.15
N	17,785	17,785	17,785	17,785

Notes: Dependent variable: Gambling participation (1 = gambles in a typical month, 0 otherwise). Columns (1)-(2) report average marginal effects from probit estimation. Column (3) reports OLS coefficients from a linear probability model (LPM). Column (4) reports coefficients from an LPM with individual fixed effects. Robust standard errors clustered at the individual level are reported in parentheses. Columns (1)-(2) report average marginal effects (AMEs) from probit estimation. Column (4) absorbs all time-invariant individual unobserved heterogeneity. Additional controls include: marital status dummies, separated, divorced, widowed, family size, major city, unemployed, number of children. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2 Problem Gambling

Table 3 reports models for problem gambling among gambling participants. The preferred probit estimate is -0.016, indicating that a one-point increase in lagged financial literacy is associated with a 1.6 percentage-point reduction in the probability of meeting the PGSI threshold. Relative to the 8.9% problem-gambling rate among gamblers, the proportional association is approximately 18%.

The coefficient remains -0.016 in the linear probability model and -0.014 in the individual fixed-effects specification. Although the absolute percentage-point estimate is slightly smaller than for participation, its proportional magnitude is more than three times larger. This pattern supports the two-margin framework: financial literacy is associated more strongly with avoiding harmful escalation than with avoiding gambling altogether.

Among the behavioural covariates, financial risk tolerance is positively associated with problem gambling, while long-term planning and trust are negatively associated. These relationships motivate the interaction and decomposition analyses reported below.

Table 3: Financial Literacy and Problem Gambling

*** p<0.01, ** p<0.05, * p<0.10.

	(1)	(2)	(3)	(4)
	Probit (No Controls)	Probit (Full Controls)	LPM	LPM with FE
Financial literacy (t-2)	-0.021*** (0.004)	-0.016*** (0.005)	-0.016*** (0.005)	-0.014*** (0.004)
Age		-0.001 (0.001)	-0.001 (0.001)	
Age squared		0.000 (0.001)	0.000 (0.001)	
Male		0.018*** (0.006)	0.018*** (0.006)	
Schooling		-0.008*** (0.002)	-0.008*** (0.002)	
Log income		-0.012** (0.005)	-0.012** (0.005)	
Married		-0.034** (0.013)	-0.034** (0.013)	-0.029** (0.012)
Financial risk-taker		0.063*** (0.007)	0.063*** (0.007)	0.055*** (0.006)
Long-term planner		-0.032*** (0.007)	-0.032*** (0.007)	-0.028*** (0.006)
Trusting		-0.033*** (0.008)	-0.033*** (0.008)	-0.030*** (0.007)
Additional controls	No	Yes	Yes	Yes
Wave FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Individual FE	No	No	No	Yes
Oster δ			1.92	1.75
N	6,664	6,664	6,664	6,664

Notes: The dependent variable is problem gambling (1 = PGSI $\geq$ 3, 0 otherwise). The sample is restricted to gambling participants (N = 6,664), of whom 590 (8.9%) meet the problem-gambling threshold. Columns (1) and (2) report average marginal effects (AMEs) from probit models, Column (3) reports linear probability model (LPM) estimates, and Column (4) reports LPM estimates with individual fixed effects. Column (4) absorbs all time-invariant individual heterogeneity. Robust standard errors clustered at the individual level are reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.

6. Robustness and Additional Analyses

6.1 Instrumental Variables and Selection Correction

Table 4 reports the instrumental-variable and Heckman estimates. All IV models use the gambler subsample. The postcode-instrument models contain 5,324 person-wave observations with complete postcode information, while the Lewbel-only model contains 6,664. The postcode instrument has a first-stage F-statistic of 37.07. Its coefficient is -0.076 and is significant at the 10% level, although it is less precise than the baseline. The Lewbel-only estimate is -0.019, and the combined Lewbel plus postcode estimate is -0.016. Both are statistically significant and close to the baseline magnitude.

The combined model reports a C-statistic p-value of 0.138, which does not reject the conditional exogeneity of the postcode instrument. However, the Sargan-test p-values are 0.021 for the Lewbel-only model and below 0.001 for the combined model, rejecting the corresponding overidentifying restrictions at conventional levels. The Lewbel estimates are therefore treated as sensitivity checks rather than conclusive identification evidence. The Heckman model yields a financial-literacy coefficient of -0.016 and a negative, significant selection correlation. Appendix Table A11 shows that major-city residence significantly predicts participation (0.043) but is not significantly associated with problem-gambling severity among gamblers (-0.003). The Oster delta statistics range from 1.84 to 2.43, indicating that selection on unobservable would need to be stronger than selection on observables to account fully for the association. Overall, the direction and magnitude of the estimates are broadly stable, but the IV diagnostics warrant caution.

Table 4: Robustness Checks (IV, Heckman and Oster)

	(1)	(2)	(3)	(4)
	Standard IV (Postcode)	Lewbel IV (Gamblers)	Lewbel + Standard IV	Heckman Selection
Financial literacy (t-2)	-0.076* (0.043)	-0.019*** (0.005)	-0.016*** (0.005)	-0.016*** (0.005)
First-stage F-statistic	37.07	124.61	96.53	--
Rho (selection corr.)	--	--	--	-0.037***
Wald test rho=0 (p-value)	--	--	--	0.001
Sargan statistic (p-value)	Exactly ID	0.15 (0.021)	0.20 (0.000)	--
C-statistic: postcode IV exogeneity (p-value)	--	--	0.138	--

	(1)	(2)	(3)	(4)
	Standard IV (Postcode)	Lewbel IV (Gamblers)	Lewbel + Standard IV	Heckman Selection
Oster		1.84	2.43	2.31
Full controls	Yes	Yes	Yes	Yes
N	5,324	6,664	5,324	17,785

*Notes: The dependent variable is problem gambling ($PGSI \geq 3$). Columns (1) and (3) use the postcode leave-one-out mean financial literacy instrument and are estimated on 5,324 gambler observations with complete postcode information. Column (2) uses Lewbel (2012) heteroskedasticity-based generated instruments and is estimated on the full gambler sample ($N = 6,664$). Column (3) combines the Lewbel and postcode instruments. Column (4) reports the outcome equation from a Heckman two-step selection model, where gambling participation is estimated in the full sample ($N = 17,785$) and problem gambling is estimated conditional on participation ($N = 6,664$). The C-statistic does not reject the conditional exogeneity of the postcode instrument ($p = 0.138$). The Sargan tests reject the overidentifying restrictions in the Lewbel specifications; these estimates are therefore interpreted as sensitivity checks rather than definitive identification evidence. Major-city residence is used as the exclusion restriction in the Heckman model and enters only the participation equation. Appendix Table A11 reports the selection-equation results and exclusion-restriction check. N denotes person-wave observations. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

6.2 Heterogeneity by Gambling Type

Table 5 examines heterogeneity by gambling type. Financial literacy is not significantly associated with problem gambling among participants who engage only in chance-based activities such as lotteries and keno (AME = -0.011). In contrast, the estimated association is larger and statistically significant among participants involved in skill-and-chance gambling activities (AME = -0.047). The estimated effect is larger among skill-and-chance gamblers than among chance-only gamblers. A formal test rejects equality of the two coefficients ($p = 0.03$), indicating that the association between financial literacy and problem gambling differs significantly across gambling types. These results suggest that financial literacy may be more closely related to reduced gambling harm in environments characterised by greater complexity, more frequent betting opportunities, and a stronger perceived role for skill. However, the estimates are based on separate subgroup models, and in the absence of a formal equality test, differences between the two coefficients should be interpreted cautiously. The results therefore provide suggestive rather than conclusive evidence that the protective association of financial literacy is stronger in skill-and-chance gambling environments.

A one-point increase in financial literacy is associated with a 4.7 percentage-point lower probability of problem gambling among skill-and-chance participants. While this pattern is consistent with the conceptual framework developed in Section 2, the subgroup analysis does not isolate the specific mechanism responsible for the observed difference. Factors such as product complexity, betting frequency, perceived control, or differences in participant characteristics may all contribute to the observed heterogeneity.

Table 5: Heterogeneity by Gambling Type (Chance vs Skill-and-Chance)

Dependent variable: Problem gambling (PGSI ≥ 3)

Variables	Chance-Only	Skill-and-Chance
Financial literacy	-0.011 (0.009)	-0.047*** (0.014)
Heterogeneity Test	0.03	
Controls	Yes	Yes
State FE	Yes	Yes
Observations	4,218	2,446
Problem gamblers	184	406

*Notes: Estimates are reported as average marginal effects (AMEs). The two reported categories are mutually exclusive and together comprise the gambler sample. Chance-only activities include lotteries and keno. Skill-and-chance activities include electronic gaming machines (EGMs), sports betting, race betting and casino table games. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

6.3 Behavioural Moderators

Table 6 examines whether the relationship between financial literacy and gambling differs by behavioural traits. For participation, the financial-literacy effect among non-risk-takers is close to zero, while the interaction with financial risk tolerance is -0.041 and significant at the 1% level. For problem gambling, financial literacy is protective among non-risk-takers (-0.018), and the additional interaction for risk-takers is -0.015, also significant at the 1% level. The implied total effect for risk-takers is -0.033. The updated estimates therefore indicate protection in both groups at the harm margin, with a substantially stronger association among financially risk-tolerant individuals.

Trust moderates the two margins differently. The financial-literacy by trust interaction is negative for participation (-0.018) but positive for problem gambling (0.011). One interpretation is that financial literacy can offset social influence at the point of entry, while trusted networks that normalise gambling may weaken its protection among people who already gamble. Because the interaction is observational, this mechanism should be tested directly in future work.

The interaction with long-term planning is not significant for participation and is positive but only marginally significant for problem gambling (0.008). We therefore treat this pattern as suggestive.

Appendix Tables A8 and A9 present supplementary moderator and marginal-effect summaries.

Table 6: Interaction Effects / Behavioural Moderators

	Gambling Participation (1)	Gambling Participation (2)	Gambling Participation (3)	Problem Gambling (4)	Problem Gambling (5)	Problem Gambling (6)
Interaction with:	Fin. Risk Taker	Trust	Long-term Plans	Fin. Risk Taker	Trust	Long-term Plans
Financial literacy (t-2)	-0.000 (0.007)	-0.009 (0.008)	-0.016*** (0.006)	-0.018*** (0.002)	-0.019*** (0.005)	-0.014*** (0.003)
Financial risk-taker	0.227*** (0.044)			0.014*** (0.004)		
FL x Financial risk-taker	-0.041*** (0.010)			-0.015*** (0.005)		
Trusting		0.077* (0.045)			-0.069*** (0.023)	
FL x Trusting		-0.018* (0.010)			0.011** (0.005)	
Long-term plans			0.000 (0.047)			-0.053*** (0.002)
FL x Long-term plans			-0.012 (0.010)			0.008* (0.004)
N	17,785	17,785	17,785	6,664	6,664	6,664

Notes: Entries are model-based average marginal effects (AMEs) from probit models. Columns (1)-(3) examine gambling participation ($N = 17,785$) and Columns (4)-(6) examine problem gambling among gamblers ($N = 6,664$). Each specification includes one interaction between financial literacy and the indicated behavioural characteristic, together with the full set of controls, wave fixed effects and state fixed effects. The financial-literacy coefficients in Columns (1) and (4) represent the estimated effect for the reference group (non-risk-takers); corresponding subgroup AMEs are reported in Appendix Table A9. Interaction rows report the model-based difference in AMEs associated with the moderator. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

6.4 Behavioural Channel Decomposition

The final KHB estimates in Table 7 decompose the total financial-literacy effect of -0.016 into a direct component of -0.010 and a combined indirect component of -0.006. The updated shares are 62.4% direct and 37.6% indirect. Thus, just over one-third of the estimated protective association is represented by the three measured behavioural channels, while nearly two-thirds is associated with pathways not captured by those mediators.

Financial risk tolerance remains the largest reported channel, accounting for 18.8% of the total effect.

Long-term planning accounts for 12.5% and social trust for 6.3%. The channel shares should not be

interpreted as perfectly separable causal effects because the mediators are correlated and the decomposition inherits the assumptions of the underlying nonlinear model.

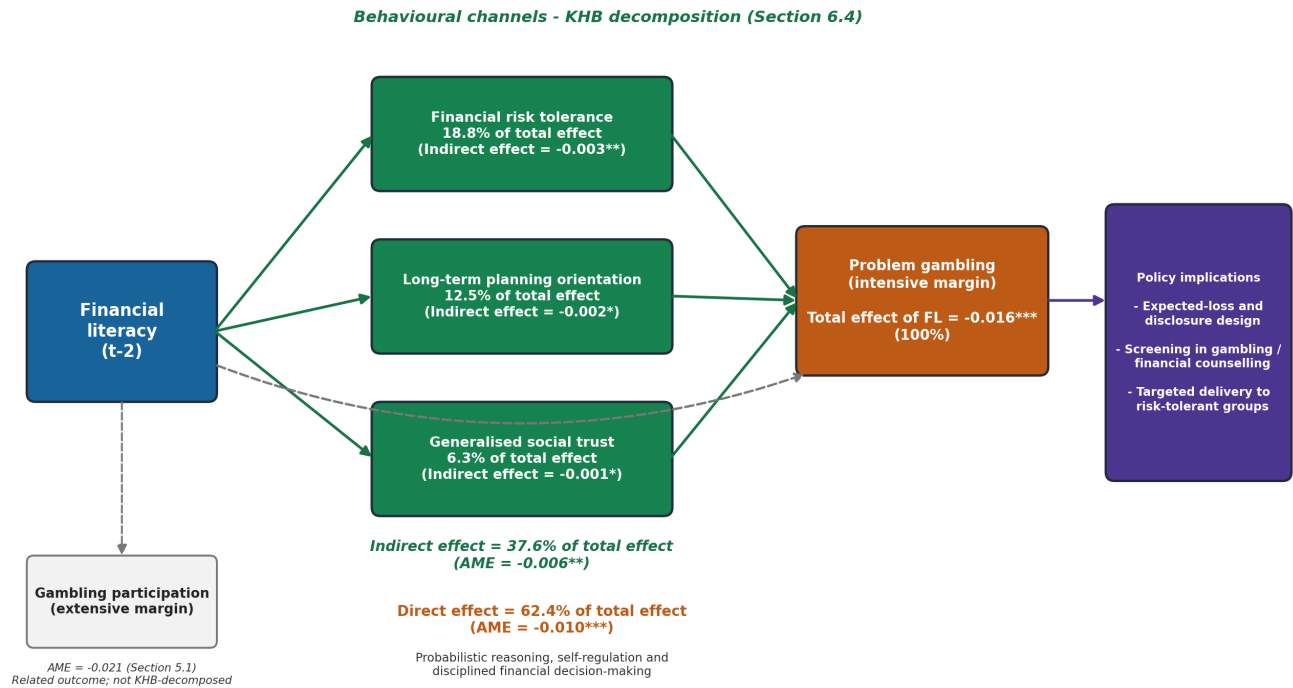
Table 7: KHB Decomposition

Component	Average marginal effect	Std. Error	% of Total Effect
Total effect of FL on problem gambling	-0.016***	(0.005)	100%
Direct effect (net of channels)	-0.010***	(0.004)	62.4%
Total indirect effect (all channels)	-0.006**	(0.003)	37.6%
of which: via financial risk-taking	-0.003**	(0.001)	18.8%
of which: via long-term planning	-0.002*	(0.001)	12.5%
of which: via social trust	-0.001*	(0.001)	6.3%
N (gamblers only)	6,664		
Full controls included	Yes		
Wave and state FE	Yes		

*Notes: KHB decomposition following Karlson, Holm and Breen (2012). The analysis is estimated among gambling participants (N = 6,664) using a probit specification and corrects for the rescaling problem in nonlinear models. To facilitate comparison with Table 3, all estimates are reported as average marginal effects (AMEs) rather than latent-index probit coefficients. The total effect represents the overall marginal effect of financial literacy on problem gambling, while the direct and indirect effects denote the AME decomposition across the specified behavioural channels. The percentage mediated is calculated as the ratio of the indirect effect to the total effect. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.*

Figure 1 summarises the study's two-margin framework, the behavioural channels represented in the KHB decomposition and the resulting policy implications. The participation pathway is shown as related to, but distinct from, the problem-gambling pathway that is decomposed.

Figure 1. Conceptual mechanism linking financial literacy to problem gambling and policy response



Note: Percentages are derived from the KHB decomposition (Karlson, Holm and Breen, 2012) of the total effect of financial literacy (t-2) on problem gambling among gambling participants (N = 6,664). The total effect is -0.016 (p < 0.01), of which 62.4% is direct and 37.6% is represented by behavioural channels. Financial risk tolerance accounts for 18.8%, long-term planning for 12.5%, and generalised social trust for 6.3%. *** p<0.01, ** p<0.05, * p<0.10.

7. Discussion

7.1 Principal Findings and Theoretical Implications

The central finding is that financial literacy is associated with lower gambling risk at both margins, but its proportional association is much larger for problem gambling. This is consistent with Hoang and Vo's (2026) Australian evidence linking higher financial literacy to lower PGSI risk, while refining that result by separating participation from harmful escalation. The distinction shifts the role of financial literacy from a general deterrent toward a capability that may be particularly relevant during escalation.

The gambling-type analysis sharpens that interpretation. The absence of a significant association in chance-only activities and the larger negative estimate in skill-and-chance activities suggest that literacy matters most in environments where probability judgements, perceived control, repeated betting and loss management are more demanding. This is consistent with the proposed probabilistic-reasoning pathway, though the subgroup design cannot isolate which product feature drives the difference.

The risk-tolerance interaction provides the strongest evidence on targeting. Financial literacy is protective among both non-risk-takers and risk-takers at the problem-gambling margin, but the negative association is substantially stronger among risk-takers. Appendix Table A9 reports corresponding subgroup AMEs of -0.018 and -0.033. The same knowledge may therefore have different behavioural value depending on baseline preferences, supporting a capability-by-vulnerability framework.

The KHB decomposition is also consistent with a mixed mechanism. The three behavioural channels account for 37.6% of the estimated association, with financial risk tolerance contributing the largest share, while 62.4% remains direct within the model. That direct component may reflect understanding of expected value, recognition of cumulative losses, budgeting discipline or other unmeasured forms of self-regulation. These mechanisms require direct measurement in future research.

The trust results point to a more context-dependent process. Trust may support prudent information exchange, but it may also bind individuals to networks in which gambling is socially accepted. The reversal across participation and problem gambling suggests that financial knowledge and social norms should be studied jointly rather than treated as independent protective factors.

7.2 Policy Implications

The findings support a preventive role for financial literacy alongside treatment, self-exclusion and financial counselling. The evidence does not justify treating education as a substitute for product regulation or operator responsibility. It suggests instead that financial capability can form one layer of a wider harm-prevention system, consistent with a choice-architecture approach that combines information with institutional safeguards (Thaler and Sunstein, 2008; Department of Social Services, 2023).

Three applications follow. First, consumer-protection disclosures for wagering products could communicate expected losses, odds and cumulative expenditure in formats designed for different levels of financial literacy. Second, gambling and financial-counselling services could incorporate brief

objective financial-literacy screening to identify people who may benefit from tailored support. Third, interventions could focus on financially risk-tolerant groups and on skill-and-chance gambling environments, where the estimated protective association is largest.

The trust interaction suggests an additional role for social-norm messaging. In communities or peer groups where gambling is normalised, information about probabilities may be more effective when paired with messages that challenge the social acceptability of harmful betting. This is a testable policy proposition rather than a result from an evaluated intervention.

7.3 Limitations

Several limitations qualify the conclusions. First, the analysis uses two outcome waves and cannot fully trace dynamic gambling trajectories. Lagging financial literacy improves temporal ordering but does not remove all time-varying confounding or slower reverse causality. The postcode instrument relies on an exclusion restriction that cannot be tested directly, and the Sargan tests reject the overidentifying restrictions in the Lewbel specifications. The IV results should therefore be viewed as sensitivity evidence rather than definitive causal identification.

Second, the problem-gambling sample is selected from gambling participants. The Heckman two-step model addresses one form of selection, but its major-city exclusion restriction remains an identifying assumption, and the binary second-stage outcome means the model is best viewed as a sensitivity check. Longitudinal attrition and underrepresentation of the most severe gamblers may also remain. Third, the gambling-type categories combine activities that differ in speed, venue, accessibility and product design. A formal equality test between the subgroup coefficients is not available in the supplied results, so the gambling-type contrast motivates more granular analysis rather than identifying a single causal product characteristic.

Fourth, the behavioural mediators are imperfect proxies for the proposed mechanisms. The KHB decomposition does not measure knowledge of gambling mathematics, impulsivity, financial self-

efficacy or self-control directly. Fifth, observational marginal effects should not be interpreted as forecasts of the effect of a specific financial-education program. Intervention studies are needed to establish which content, delivery channel and target group produce sustained reductions in gambling harm.

Finally, the conceptual framework is an organising structure rather than a complete behavioural model. Future research could develop a formal dynamic model linking financial literacy, risk preferences and gambling behaviour.

7.4 Conclusion

This study positions financial literacy as a potentially important protective capability in the progression from recreational gambling to gambling harm. Across the baseline, fixed-effects and selection-corrected models, higher lagged financial literacy is consistently associated with lower gambling participation and lower problem-gambling risk; the IV estimates point in the same direction but require caution given the diagnostic tests. The association is proportionally stronger for problem gambling, stronger among risk-tolerant individuals and more pronounced in skill-and-chance gambling.

The findings support a targeted approach in which financial literacy complements, rather than replaces, stronger consumer protection, responsible product design and treatment services. They also identify a clear research agenda: extend the behavioural decomposition with additional mediators, test the proposed mechanisms experimentally and evaluate whether tailored financial capability interventions can prevent harmful escalation in the groups and gambling environments where the observed association is strongest.

Declarations

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest: The authors declare no conflicts of interest.

Ethics approval: This study uses de-identified secondary data from the HILDA Survey accessed under licence.

No participants were recruited or contacted for this secondary analysis.

Data availability: HILDA unit-record data are available to approved users under licence from the Australian Government Department of Social Services.

Author contributions: All authors contributed to the study conception, methodology, interpretation of results, and drafting or critical revision of the manuscript. All authors approved the final manuscript.

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Appendix Tables

Appendix Table A1. Financial Literacy Components

Financial Literacy Component	Correct Response (%)	Mean
FL1: High return investments are likely to be high risk	88.5	0.885
FL2: Diversification of shareholdings reduces risk	84.3	0.843
FL3: Interest calculation (2% return on \$100)	99.5	0.995
FL4: Inflation and real purchasing power	77.5	0.775
FL5: Income and prices both double	82.1	0.821

Notes: Values represent the proportion of respondents with available item responses who answered each financial-literacy question correctly. The index is the sum of five binary indicators and ranges from 0 to 5. This descriptive item sample is broader than the matched analytic sample used in Table 1.

Appendix Table A2. Financial Literacy by Survey Wave

Wave	N	Mean	Std. Dev.
Wave 16	12,271	4.418	0.787
Wave 20	10,060	4.507	0.733
Difference (Wave 20 – Wave 16)		0.089*	
Test Statistic		Value	
t-statistic		8.69	
p-value		<0.001	
95% CI		[0.069, 0.109]	

Notes: The financial-literacy index ranges from 0 to 5 and is constructed as the sum of five questions. Wave 16 and Wave 20 are the literacy-measurement waves matched to gambling outcomes in Waves 18 and 22, respectively. The table describes respondents with non-missing literacy data and therefore has a broader sample base than Table 1. A two-sample t-test indicates that mean financial literacy is significantly higher in Wave 20 than in Wave 16 ($t=8.69$, $p<0.001$), although the magnitude of the difference is modest.

Appendix Table A3. Wave-Specific Gambling Participation Results

Variable	Wave 18	Wave 22
Financial literacy	-0.0167**	-0.0254***
N	9,415	8,370

*Notes: Separate wave-specific estimates with the full set of controls and state fixed effects. Robust standard errors clustered at the individual level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$.*

Appendix Table A4. Wave-Specific Problem Gambling Results

Variable	Wave 18	Wave 22
Financial literacy	-0.0109*	-0.0216***
N	3,533	3,131

*Notes: Separate wave-specific estimates among gambling participants with the full set of controls and state fixed effects. Robust standard errors clustered at the individual level. *** $p<0.01$, ** $p<0.05$, * $p<0.10$.*

Appendix Table A5. Continuous PGSI Score Results

Sample	Financial Literacy Coefficient	Significance
All gamblers	-0.129	p=0.002
Male gamblers	-0.116	p=0.047
Female gamblers	-0.151	p=0.007

Notes: The dependent variable is the continuous PGSI score among gambling participants. Models include the full set of controls and wave and state fixed effects. Robust standard errors clustered at the individual level.

Appendix Table A6. Alternative PGSI Cut-off Definitions

Definition	Full Sample	Male	Female
PGSI ≥ 4 (higher threshold)	-0.0147***	-0.0176***	-0.0113*
PGSI ≥ 3 (Main)	-0.016***	-0.015**	-0.018**
PGSI ≥ 2 (lower threshold)	-0.0181***	-0.0210**	-0.0148**

Notes: Entries are average marginal effects from probit models using alternative binary PGSI thresholds. Models include the full set of controls and wave and state fixed effects. Robust standard errors clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix Table A7. Heterogeneity by Gender

	Gambling Participation (1) Male	Gambling Participation (2) Female	Problem Gambling (3) Male	Problem Gambling (4) Female
Financial literacy (t-2)	-0.029*** (0.007)	-0.012* (0.007)	-0.015** (0.007)	-0.018** (0.007)
Age	0.020*** (0.002)	0.024*** (0.002)	-0.003 (0.002)	0.002 (0.002)
Schooling	-0.029*** (0.003)	-0.030*** (0.002)	-0.010*** (0.002)	-0.006*** (0.002)
Log income	0.013** (0.006)	-0.009 (0.007)	-0.010 (0.008)	-0.014* (0.008)
Financial risk-taker	0.074*** (0.011)	0.014 (0.011)	0.007*** (0.001)	0.005*** (0.001)
Long-term planner	-0.057*** (0.001)	-0.054*** (0.001)	-0.040*** (0.009)	-0.021** (0.009)
Trusting	0.002 (0.011)	-0.009 (0.011)	-0.028*** (0.010)	-0.040*** (0.013)
N	9,390	8,395	3,976	2,688

Notes: Entries are average marginal effects (AMEs) from probit models with the full set of controls, wave fixed effects and state fixed effects. Columns (1)-(2) examine gambling participation, while Columns (3)-(4) examine problem gambling among gambling participants only. Additional controls include marital status, family size, employment status, number of children and major-city residence, but are not reported. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix Table A8. Interaction Effects by Moderator

Panel A. Gambling Participation			
	Risk-taker	Trust	Long-term
Financial literacy (t-2)	-0.012***	-0.011***	-0.013***
Moderator	0.045***	-0.018**	-0.025***
FL $\times$ Moderator	-0.009**	0.004	0.005
Observations	17,785	17,785	17,785
Panel B. Problem Gambling			

Panel A. Gambling Participation			
	Risk-taker	Trust	Long-term
	Risk-taker	Trust	Long-term
Financial literacy (t-2)	-0.018***	-0.017***	-0.019***
Moderator	0.072***	-0.021*	-0.032**
FL × Moderator	-0.015***	0.006	0.007
Observations	6,664	6,664	6,664

Notes: Robust standard errors clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix Table A9. Marginal Effects of Financial Literacy on Problem Gambling

Group	AME of Financial Literacy
Non-risk-takers	-0.018***
Risk-takers	-0.033***
Low trust	-0.021***
High trust	-0.015***
Short-term oriented	-0.024***
Long-term oriented	-0.017***

Notes: Robust standard errors clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix Table A10. Weighted Robustness

Variable	Unweighted	Weighted
Financial literacy -> Participation	-0.021***	-0.020***
Financial literacy -> Problem gambling	-0.016***	-0.015***
Full controls	Yes	Yes
Wave and state FE	Yes	Yes
N (participation model)	17,785	17,785
N (problem-gambling model)	6,664	6,664

Notes: Entries are average marginal effects from the preferred probit specifications. Weighted models apply the relevant HILDA longitudinal survey weights; unweighted models reproduce the estimates reported in Tables 2 and 3. All specifications include the full set of controls and wave and state fixed effects. N denotes person-wave observations. Robust standard errors clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix Table A11. Heckman Selection Equation

Panel A. Selection Equation: Gambling Participation	
Variable	Average marginal effect
Financial literacy	-0.021***
Major city	0.043***
Age	0.022***
Male	0.090***
Controls	Yes
Wave and state FE	Yes
N	17,785
Panel B. Exclusion-Restriction Check: Problem Gambling	
Variable	Estimate
Major city	-0.003
Standard error	(0.006)
Controls	Yes
Wave and state FE	Yes
N (gamblers only)	6,664

Notes: Panel A reports average marginal effects from the probit participation equation used in the selection model. Panel B reports the major-city estimate from the baseline problem-gambling model among gambling participants. All specifications include the full set of controls and wave and state fixed effects. N denotes person-wave observations. Robust standard errors clustered at the individual level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Major-city residence significantly predicts gambling participation ($p < 0.01$) but is not significantly associated with problem-gambling severity among gamblers, supporting its relevance and plausibility as an exclusion restriction.