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Windfall gains and stock market participation: Evidence from shopping receipt lottery ☆

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ABSTRACT

This paper utilizes receipt lotteries in Taiwan, along with comprehensive administrative data, to examine the effect of cash windfalls on stock market participation and portfolio diversification, which can help us understand whether wealth levels serve as the explanation for the limited participation and under-diversification puzzles in stock markets. The results indicate that each million TWD (approximately 33,000 USD) windfall gain from winning receipt lotteries increases the probability of stock market participation by 1.09 percentage points. This effect is primarily driven by individuals who were not participating in the stock market prior to winning. For existing participants, each million TWD windfall increases the total value of stocks by 142,552 TWD, attributed to both an increase in their number of shares and higher average prices of the stocks they hold. Additionally, we find that individuals do not significantly diversify their portfolios after winning the lottery, suggesting that wealth level is not the primary reason for under-diversification.

1. Introduction

Limited stock market participation (Haliassos and Bertaut, 1995; Guiso and Sodini, 2013) and under-diversification in portfolios (Blume and Friend, 1975; Goetzmann and Kumar, 2008; Calvet et al., 2007) are two well-documented puzzles in the literature on stock markets. Many factors have been identified to explain these phenomena. Regarding limited participation, individuals may choose not to invest in the stock market because they lack sufficient wealth to cover fixed participation costs (Vissing-Jorgensen, 2003; Gomes and Michaelides, 2005; Paiella, 2007), which suggests that stock market participation should increase with wealth levels. However, the endogenous relationship between wealth and stock market participation makes it challenging to establish causality. For instance, wealthy people might participate in stock markets because the equity risk premiums increase with wealth (Vissing-Jorgensen, 2003), or the stock market itself might play a role in wealth accumulation (Favilukis, 2013).[1]

Furthermore, individuals who do participate in the stock market often hold under-diversified portfolios, despite financial theory suggesting that they should maintain diversified portfolios to maximize risk-adjusted returns and achieve mean–variance efficiency (Markowitz, 1952). The reasons for under-diversifying have been widely studied, with one possible factor being individual wealth. Roche et al. (2013) argue that an individual's financial wealth-to-income ratio plays a critical role in portfolio decisions. When individuals face financial constraints, they may optimally choose to concentrate their portfolios. However, the empirical evidence on the relationship between wealth and portfolio diversification presents mixed results. While several studies using survey data have demonstrated that diversification tends to increase with portfolio size or wealth (Kelly, 1995; Polkovnichenko, 2005; Ivković et al., 2008), these same studies also document significant under-diversification among wealthy households (Kelly, 1995;

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[1] It could also be innate attributes of individuals, such as IQ or cognitive ability, that drive both stock market participation and wealth generated from investments (e.g., Grinblatt et al., 2011, 2012; Conlin et al., 2015; Kuo et al., 2015).

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Polkovnichenko, 2005). Due to the lack of exogenous change in household wealth, the causal relationship between wealth and portfolio diversification remains unclear.

In this paper, we use Taiwan's receipt lottery as an exogenous wealth shock to investigate whether wealth can affect stock market participation and portfolio diversification decisions. Despite the importance of understanding the causal relationship between wealth and investment behavior, studies using exogenous wealth shocks remain limited. Two notable exceptions leverage the administrative data from Nordic countries. Andersen and Nielsen (2011) study unexpected inheritances in Denmark, finding that inherited wealth increases stock market participation. Similarly, Briggs et al. (2021) examine Swedish lottery winners and document that winning participants are more likely to enter the stock market. Both papers analyze causal effects of wealth on stock market participation — the extensive margin of stock market investment. We extend this emerging literature by examining not only participation decisions but also portfolio diversification choices (the intensive margin).

To estimate the causal impact of wealth on stock market participation and portfolio diversification, we exploit detailed administrative data on more than 1 million winners of the Taiwan receipt lottery and follow them over 10 years. Beyond just observing participation decisions, our unique dataset also includes comprehensive information on individuals' stockholdings. We begin with a staggered difference-in-differences (DID) design with binary treatment. This specification compares winners of large prizes (above 100,000 TWD, around 3300 USD) with two control groups — small prize winners (below 100,000 TWD) and future winners who have not yet won but will win prizes in later years. This baseline model helps demonstrate how we exploit the variation in lottery prize amounts and winning timing to identify wealth effects. Building on this baseline analysis, our main specification further exploits continuous variation in prize amounts to estimate per-dollar effects, facilitating comparisons with existing literature. Our research design leverages three sources of variation: (1) observation times (pre- and post-winning); (2) the timing of the lottery win; and (3) the amount of prizes. This expanded specification allows us to control for potential time-varying heterogeneity through interaction terms that capture differential trends between current and future winners, as well as between individuals who win larger versus smaller prizes. The key identification assumption is that, among current and future winners who receive similar amounts of prize, the timing of their winnings is determined by chance rather than by systematic differences in their receipt collection or prize claiming behaviors over time. In other words, while some individuals win large prizes earlier and others later, this timing difference should not be correlated with time-varying patterns in their lottery participation intensity. Under this assumption, our research design allows us to estimate the causal effects of lottery wealth on stock market behaviors.

We obtain three key findings. First, winning a lottery prize of 1 million TWD (approximately 33,000 USD) significantly increases stock market participation by 1.09 percentage point. Not surprisingly, this effect is largely driven by individuals who were not participating in the stock market prior to their lottery win. In other words, the windfall gain from the lottery encourages people who were previously not investing in the stock market to start doing so. On the other hand, for individuals who were already stock market participants before winning the lottery, we find that receiving a large windfall has little impact on their decision to continue participating.

Second, since the causal effects appear to be driven entirely by positive impacts on individuals who did not participate in the stock market before winning the lottery, we conducted a series of heterogeneity analyses focusing on this subgroup. To begin with, our results suggest that the effect is mainly driven by those winning sufficiently large prizes (i.e., more than 1 million TWD, with an average amount of 4.09 million TWD). For those winning less than 1 million TWD, the windfall has a negligible impact on their decision to participate in the stock market. Furthermore, we find that the effect is more pronounced among individuals who own a house or have no debt. These patterns suggest that lottery winners might allocate their funds to other investment opportunities. For example, they may choose to invest their winnings in real estate or use the money to pay off debt, which could potentially crowd out the demand for stock investments.

Third, among individuals already participating in the stock market in the year before winning, we observe significant increases on the intensive margin but no significant diversification in their portfolios. Each million TWD windfall increases the total value of stocks by 142,552 TWD, implying that approximately 14.3% of the windfall is invested in the stock market. Based on the decomposition, lottery winners both increase their number of shares and hold stocks with higher average prices. For diversification, we calculate the Herfindahl–Hirschman Index (HHI) for each individual's portfolio and find that individuals do not significantly diversify their portfolios after winning the lottery. This implies that wealth level is not the primary reason for under-diversification.

Our paper makes two contributions to the existing literature. First, our study complements the limited research on the causal effect of wealth on stock market participation using exogenous wealth shocks, and is the first to investigate whether unexpected windfall gains affect stock market participation outside of Nordic countries.[2] Our analysis leverages a unique setting – the Taiwan receipt lottery, which is designed to encourage consumers to obtain receipts for every purchase, thereby reducing the avoidance of sales and corporate income taxes. Unlike typical lotteries, almost every individual in Taiwan who makes a purchase and receives an invoice automatically participates in this lottery. This feature helps mitigate concerns about selection bias due to lottery participation, a challenge that Briggs et al. (2021) addressed by focusing on "big prize pools" with more widespread participation. According to government statistics, about 70% of the winning invoices have been redeemed,[3] implying that the majority of the population keeps the invoices and regularly matches them with the announced winning numbers. Moreover, our study provides insights from a market where individual investors play a predominant role, contrasting sharply with developed markets in the United States and Europe where institutional traders dominate.[4] Between 1995 and 1999, individual investors accounted for approximately 90% of all trading volume in Taiwan (Barber et al., 2009). Although this proportion has decreased, individual investors still represented 58% of all transactions in 2023. Similar patterns are observed in China, Korea, and India, where individ-

[2] Our paper also contributes to the literature on the determinants of stock market participation. For example, several recent studies find that cognitive abilities, IQ, and human capital play a role in explaining stock market participation (e.g., Christelis et al., 2010; Grinblatt et al., 2011; Athreya et al., 2023; Vestman, 2019; Georgarakos and Pasini, 2011). Asides from the individuals' characteristics, the previous literature also indicates that social interaction, trust, information sharing, and internet access affect stock market participation (e.g., Hong et al., 2004; Guiso and Jappelli, 2005; Bogan, 2008; Brown et al., 2008; Guiso et al., 2008; Georgarakos and Pasini, 2011; Kaustia and Knüpfer, 2012; Li, 2014; Banyen and Nkuah, 2015; Changwony et al., 2015). While these studies present plenty of endogenous characteristics related to stock market participation, our paper extends this line of research by examining the impact of wealth on stock investment decisions using the exogenous cash windfalls that almost every citizen would have a chance to win.

[3] The receipt lottery winning and prize redemption analysis is available at: https://www.einvoice.nat.gov.tw/portal/ods/ODS303E/main/CDF0EF68-72D2-4AF2-BAA1-15E8BE7311DD/58.

[4] Developed capital markets in the United States and Europe are predominantly fueled by institutional traders. For instance, Grinblatt and Keloharju (2000) find that individual investors constituted merely 7.3% of trading volume for the top 16 Finnish stocks, which collectively represented 52% of the Finnish stock market capitalization during 1995–1996.

ual investors also play a major role.[5] Despite differences in lottery types and market characteristics, our estimates of stock market participation closely align with those of Briggs et al. (2021).

Second, our paper contributes to the literature on portfolio under-diversification in stock market investments (Blume and Friend, 1975; Kelly, 1995; Barber and Odean, 2000; Polkovnichenko, 2005; Goetzmann and Kumar, 2008; Calvet et al., 2007) by providing one of the first causal evidence on whether wealth affects investors' portfolio diversification decisions. While prior studies suggest that investors with higher income or wealth tend to hold more diversified stock portfolios, our findings challenge the causality of this relationship. Specifically, we find that receipt lottery winners maintained similar levels of portfolio concentration even after experiencing substantial wealth windfalls, suggesting that increased wealth alone may not lead to better diversification practices. This aligns with existing evidence that many wealthy households still maintain poorly diversified equity portfolios. Furthermore, our analysis reveals that lottery winners tend to expand their existing stock positions rather than diversifying into new securities, consistent with previous findings that investors prefer to invest in familiar stocks (Grinblatt and Keloharju, 2001; Huberman, 2001).

The remainder of this paper is organized as follows. Section 2 provides background information on the Taiwan receipt lottery. In Section 3, we discuss our data and the sample selection process. Section 4 presents our empirical strategy. In Section 5, we present the main results, examine the robustness of our findings, and conduct a series of subgroup analyses. Section 6 compares our main results with the findings from typical lotteries, and Section 7 provides concluding remarks.

2. Background: Taiwan receipt lottery

In this section, we discuss the institutional details of the Taiwan Receipt Lottery (RL), also known as the Uniform Invoice Lottery. This background information serves two purposes: first, it outlines the key features of our sample used for empirical analysis; second, it highlights how this lottery system differs from typical lotteries.

To foster value-added tax (VAT) compliance among businesses, the RL was launched by the government on January 1, 1951.[6] This bimonthly lottery incentivizes consumers to request receipts when shopping at VAT-compliant stores, thereby discouraging tax evasion practices. Whenever a consumer purchases any goods or services, he or she receives a receipt with an eight-digit lottery number printed at the top. The numbers on the receipts are administered and distributed to businesses by the Ministry of Finance, and consumers have no choice in selecting their own. Figure A.1 in the Online Appendix displays an example of a typical receipt with the lottery number highlighted. On the 25th of every odd month, the Ministry of Finance randomly draws winning numbers across different prize categories. Table A.1 details the prize rules for the RL.

It is worth mentioning that during our sample period (i.e. 2004–2018), two other lottery games were also operated by the Taiwanese government: the Public Welfare Lottery and the Taiwan Sports Lottery. The Public Welfare Lottery operates similarly to typical lotteries, where winning is based on chance and players can select tickets or numbers. The Taiwan Sports Lottery, however, differs in that its odds are not entirely random, as winning is influenced by players' ability to analyze sports data. Online Appendix B provides detailed background information about these two lottery games.

Unlike these two lotteries and many typical lotteries worldwide, the RL is uniquely featured by its universal reach, as almost all people in Taiwan can participate through their daily consumption receipts. The RL has several distinct characteristics that set it apart from typical lotteries. Firstly, participants cannot choose their numbers; instead, the lottery numbers are automatically generated on receipts issued for purchases. This eliminates the element of number selection strategy often associated with other lotteries. Secondly, participation is essentially free and tied to everyday transactions, as opposed to requiring a separate purchase of lottery tickets. Lastly, the RL serves a dual purpose of encouraging consumers to request receipts, thereby aiding in tax enforcement, while also providing a chance to win prizes. According to the survey from Pollster, 92% of people choose to keep their receipts for the RL prizes[7]. Moreover, government statistics reveal a high engagement rate with the RL, with approximately 70% of winning invoices being claimed. This substantial redemption rate suggests that a majority of Taiwan's population actively participates in the lottery by retaining their receipts and regularly checking them against the published winning numbers. We mainly utilize the sample of RL winners for our empirical analysis. In Section 6, we analyze the stock market participation of Public Welfare Lottery (i.e., a typical lottery) winners and compare the findings with those from RL winners.

3. Data and sample

3.1. Data

We implement our empirical analysis using several administrative records provided by the Fiscal Information Agency (FIA): (1) Income registry file, (2) Firm registry file, (3) Wealth registry file, and (4) Individual registration file. All files contain individual identifiers (i.e. scrambled personal IDs), which allow the data to be linked at the individual level.

Our lottery data comes from the income registry file, which records all annual payments made to individuals. This file includes various income types, categorized into two main groups: (1) Self-reported information: Such as rental income, business income, and agricultural income; (2) Third-party reported information: Including wages, interest, pensions, and lottery winnings.

Importantly, our records only cover lottery winners who received prizes exceeding 2000 TWD (approximately 60 USD). This threshold exists because only prizes above this amount are taxable (at a 20% rate) and must be reported to the FIA. The income registry file contains three key pieces of information: (1) The taxpayer's ID (i.e., the winner), (2) The amount of the lottery prize, and (3) The ID of the bank where the prize was redeemed. Since each lottery game has designated banks for prize redemption, we can use the bank ID to identify RL winners and calculate individuals' annual lottery income.

The wealth registry file provides detailed information on stock holdings, including the corporations in which individuals hold shares, the number of shares held, stock prices, and the total value of stocks.[8] It is important to note that this data only includes information on listed stocks held directly by individuals. Mutual funds, which represent a small portion of the securities market, are excluded.[9] Using this data,

[5] Similarly, in China, individual investors make up nearly 90% of daily trading volume on the Shanghai Stock Exchange from 2013 to 2015 (Titman et al., 2022). In Korea, from 2007 to 2010, individual investors accounted for an average of 83.5% of sell trades and 84.1% of buy trades (Wang et al., 2017). In India, their trading ranges from 35% to 45% of market turnover between 2003 and 2023 (NSE Market Pulse Report, 2023).

[6] Taiwan's VAT rate is 5% and paid by sellers and service providers.

[7] The Pollster Online Survey is conducted by Pollster Technology Marketing Ltd. during the period from June 6 to June 9, 2009. The sample size is 9929. The details can be referred to the following link: https://www.pollster.com.tw/Aboutlook/lookview_item.aspx?ms_sn=308.

[8] We obtain stock market prices by merging the data from the Taiwan Economic Journal. https://schplus.tej.com.tw.

[9] According to the Taiwan Stock Exchange Corporation's annual report, the market trading value of mutual funds (such as Exchange Traded Fund)

we can calculate an individual's stock portfolio in terms of total value, number of shares held, and average price of stocks. This detailed stock holding information allows us to track changes in both stock market participation and portfolio composition among lottery winners. The wealth registry file also contains information on other forms of wealth, such as houses and land, which serves as a foundation for our subgroup analysis.

Furthermore, the firm registry file contains essential information about business ownership, including the owners' ID and the type of business. We use this file to determine an individual's status as a business owner, which is used for our subgroup analysis. Lastly, the individual registration file provides basic demographic information about the sample, such as gender, year of birth, birthplace, current residence, and year of marriage.

3.2. Sample

Several restrictions were implemented to construct the main sample. First, we selected individuals who first won RL lottery prizes of at least 2000 TWD during our study period, which is the lowest prize amount observable in the FIA data. Second, we limited the sample to individuals aged 20–60 at the time of lottery winning to capture the primary age group likely to participate in the stock market. Finally, we tracked these individuals for 10 years, from 4 years before to 5 years after winning. The sample period spans from 2004 to 2018. The final sample contains over 1,058,944 prize winners, encompassing a wide range of windfall amounts.

Table 1 compares the characteristics of the RL lottery winners estimation sample to the Taiwanese population aged 20–60 during the sample period. These characteristics are measured in the year before the lottery win, and all monetary values are adjusted to 2016 TWD using the CPI. Winners are largely similar to the general population in major demographic attributes, such as age, residence, earnings, savings, and homeownership. A notable difference is that a higher proportion of winners are female (66% vs. 49%) compared to the general population. This could be because more females tend to claim RL prizes. Additionally, we find that slightly more winners are married (55% vs. 50%). In a robustness check, we re-weight the sample to align these characteristics (i.e., age, gender, and marital status) with those of the overall Taiwanese population and demonstrate that the main estimate remains robust when using this re-weighted sample.

Table 1
Descriptive statistics for lottery winners and population.

	(1) Winners	(2) Population
Age	37.468	38.148
	(10.625)	(12.102)
Urban residence	0.713	0.695
	(0.452)	(0.461)
Female	0.656	0.490
	(0.475)	(0.500)
Married	0.552	0.495
	(0.497)	(0.500)
Employed	0.796	0.757
	(0.403)	(0.429)
Earnings	273.991	287.994
	(450.921)	(2106.499)
Stocks	446.753	682.429
	(8601.559)	(46,009.059)
Savings	552.524	569.292
	(2309.280)	(3163.742)
Homeowner	0.351	0.324
	(0.477)	(0.468)
Have mortgage	0.130	0.113
	(0.336)	(0.317)
Own business	0.167	0.108
	(0.373)	(0.311)
Stock participation rate	0.305	0.270
	(0.461)	(0.444)
# of observation	1,058,944	16,165,234

Note: This table displays the winners' and population's characteristics, as well as the outcome variables we are interested in: stock market participation. The population data are aged from 20 to 60 during 2008 to 2012, and we randomly assign one year of 2008–2012 as a placebo winning year in the analysis. Urban residence refers to individuals living in Taipei City, New Taipei City, Taoyuan City, Taichung City, Tainan City, and Kaohsiung City, which are the most populous cities in Taiwan. Married is defined as having the status of being in a marital relationship. Employed is defined as having a positive wage income. Earnings refer to the sum of wage income, business income, and professional income. Stocks represent the total value of an individual's stock portfolio. Earnings, income, stocks, and savings are measured in thousands of units, adjusted for CPI, and displayed in 2016 TWD (1 TWD ≈ 0.033 USD). Homeowner and Have mortgage refer to individuals who own houses and those who have housing loans, respectively. Own Business is defined as an individual who owns a business. Stock participation rate is defined as the proportion of individuals who participate in the stock market in the year right before the lottery-winning year ($s = -1$). Standard deviations are in parentheses.

4. Empirical specifications

In this section, we present our empirical approach to establish causal relationships between lottery winnings and stock market investment behavior. We first develop a baseline specification that clearly illustrates the key sources of identifying variation in our research design. We then extend this framework to a more comprehensive model that exploits continuous variation in prize amounts to estimate per-dollar effects, allowing for direct comparison with existing literature's wealth effect estimates.

4.1. Baseline specification

To identify the causal effect of wealth on investment behavior, we exploit variation in lottery prize amounts across winners. Our baseline specification uses a staggered DID design to address potential confounding factors, such as macroeconomic conditions, that could affect stock market participation patterns over time. The baseline analysis focuses on individuals' first lottery wins and compares large-prize winners (prizes ≥ 100,000 TWD, with an average winning amount of 1.5 million TWD) with two control groups: small-prize winners (prizes < 100,000 TWD, with an average winning amount of 4900 TWD) and future lottery winners who have not yet won but will win prizes in later years. Following Golosov et al. (2024), we include future winners because their current investment behavior cannot be influenced by their future wins. This design allows us to identify the effect of receiving a large wealth shock. Specifically, we estimate the following regression:

$$S_{it} = \sum_{s\neq -1} \lambda_s \cdot Treated_{i,\ell} \times \mathbf{I}[t = \ell + s] + \sum_{s\neq -1} \kappa_s \cdot \mathbf{I}[t = \ell + s] + a_{it} + \theta_t + \nu_i + \varepsilon_{it}, \qquad (1)$$

where S_{it} represents our outcome variables of interest (such as stock market participation or portfolio diversification measures) for individual i in year t. The treatment variable $Treated_{i,\ell}$ is constructed as an interaction between two indicators: $Current_{i,\ell}$ and Big_i. The first indicator, $Current_{i,\ell}$, equals one if individual i wins the first lottery prize in year ℓ (current winner), and zero if the first win occurs in year $\ell + 6$ (future winner). For future winners, we assign a placebo winning year six years prior to their actual win, allowing us to track their behavior during a pre-treatment period when they have not yet won. The second indicator, Big_i, equals one if the individual's prize exceeds 100,000 TWD, and zero for smaller prizes. Therefore, $Treated_{i,\ell}$ equals one only for current winners of large prizes and zero otherwise. The event time dummies $\mathbf{I}[t = \ell + s]$ indicate observations before

accounted for 0.69% of the total market trading value in 2010, increasing to 5.70% by 2018 during our sample period. Detailed statistics can be found at the following link: https://www.twse.com.tw/zh/trading/statistics/index07.html.

and after lottery wins for current winners, and before and after the placebo winning year for future winners, where s ranges from −4 to 5, excluding −1 as the baseline year. We also include winner age fixed effects a_{it} to non-parametrically control for life-cycle patterns in stock market behavior, and year fixed effects θ_t to account for macroeconomic conditions. ν_i represents individual fixed effects, which control for time-invariant individual characteristics that may affect stock investment behaviors, such as risk preferences, financial literacy, and innate investment ability. ϵ_{it} represents the error term.

The coefficients λ_s capture the differential effects of winning a large prize (exceeding 100,000 TWD) relative to our control group at different time horizons around the winning year. This specification allows us to track how the impact of lottery winning evolves over time, from four years before to five years after the lottery win, while controlling for both individual heterogeneity and time trends. To account for potential serial correlation in the error terms for the same individuals over time, we cluster standard errors at the individual level in all regressions. Recent literature has highlighted that traditional two-way fixed effects estimators may produce biased estimates when treatment timing varies and treatment effects are heterogeneous. To address these methodological concerns (Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Sun and Abraham, 2021), we implement the above DID design using both the conventional two-way fixed effects method and the proposed estimators by Callaway and Sant'Anna (2021).

4.2. Main specification

While the previous specification provides a transparent illustration of our identification strategy, it has two main limitations. First, the binary treatment definition masks rich variation in prize amounts that could help us obtain more precise estimates (smaller standard errors) of wealth effects by utilizing the full distribution of lottery prizes. Second, comparing our estimates with existing literature is challenging since prior studies typically report per-dollar effects of wealth shocks (Andersen and Nielsen, 2011; Briggs et al., 2021). Moreover, the baseline model does not fully control for potential differential patterns between individuals who tend to win larger versus smaller prizes, or between current winners and future winners. To address these limitations, our main specification exploits the continuous variation in prize amounts. This empirical strategy builds upon our previous DID framework, but now varies across the distribution of winnings and leverages three sources of variation: (1) observation times (pre- and post-winning); (2) the timing of the lottery win; and (3) the amount of prizes. The expanded model is specified as follows:

$$\begin{aligned} S_{it} = &\sum_{s\neq -1} \gamma_s \cdot Current_{i,\ell} \times Prize_i \times \mathbf{I}[t = \ell + s] + \sum_{s\neq -1} \kappa_s \cdot \mathbf{I}[t = \ell + s] \\ &+ \sum_{s\neq -1} \beta_s \cdot Current_{i,\ell} \times \mathbf{I}[t = \ell + s] + \sum_{s\neq -1} \alpha_s \cdot Prize_i \times \mathbf{I}[t = \ell + s] \\ &+ a_{it} + \theta_t + \nu_i + \epsilon_{it}, \end{aligned} \tag{2}$$

where $Prize_i$ denotes the amount of individual i's first lottery win, measured in millions of TWD (approximately 33,000 USD). All other variables are defined as in Eq. (1). This research design addresses the aforementioned limitations and includes two key interaction terms to control for differential trends in stock investment between different types of winners — those who win now versus later, and those who tend to win larger versus smaller prizes. First, $Current_{i,\ell} \times \mathbf{I}[t = \ell + s]$ controls for differential trends in stock market behaviors between current and future winners over time. Second, $Prize_i \times \mathbf{I}[t = \ell + s]$ controls for differential trends in stock market behaviors between individuals who will win larger versus smaller prizes.[10] With these controls in place, our key identification assumption is that, among current and future winners who receive similar prize amounts, the timing of their winnings should be determined by chance rather than by systematic differences in their receipt collection or prize claiming behaviors over time. In other words, these winners should have similar lottery participation intensity (e.g., remembering to ask for receipts, keeping them until the lottery draw, and checking and claiming prizes) across time, with the only difference being that some are fortunate to win large prizes earlier while others win later.[11]

To summarizes our DID results into a single coefficient, we also estimate a simpler version of Eq. (2) by replacing the series of event time indicators ($\mathbf{I}[t = \ell + s]$) with a single post-period dummy variable $Post_t$:

$$\begin{aligned} S_{it} = &\gamma \cdot Current_{i,\ell} \times Prize_i \times Post_t + \kappa \cdot Post_t \\ &+ \beta \cdot Current_{i,\ell} \times Post_t + \lambda \cdot Prize_i \times Post_t \\ &+ a_{it} + \theta_t + \nu_i + \epsilon_{it}. \end{aligned} \tag{3}$$

This specification maintains the core structure of our main model but consolidates the time dimension into a binary pre/post comparison. The coefficient γ represents the average per-million-TWD effect of lottery winnings on stock investment behaviors after winning. As in our main specification, we include individual fixed effects ν_i to control for time-invariant individual characteristics. For specifications where we omit individual fixed effects, we instead control for pre-determined characteristics through the vector $\boldsymbol{X}_i$. These characteristics are measured just before the lottery win (or placebo win for future winners) and include the winner's earnings, wealth, marital status, gender, and city/county of residence. To ensure our results are robust to recent methodological concerns about staggered treatment timing in DID designs, we also estimate Eq. (3) using the estimator developed by Callaway and Sant'Anna (2021).

5. Results

In this section, we first present the main results on the effects of lottery wealth on stock market participation, followed by an examination of their robustness. Additionally, we split the sample to discuss the heterogeneous effects and analyze the impact of lottery wins on portfolio diversification for individuals who had invested in the stock market prior to winning the lottery.

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[10] Table A.3 in the Online Appendix examine the relationship between prize amounts and pre-lottery characteristics for current and future winners, respectively. In Panel A, it is evident that most current winner's traits are not correlated with lottery prize amount. However, a few characteristics, such as gender, homeownership and earnings, are associated with the lottery prize amount. We find that homeowners, males, and individuals with higher earnings are more likely to win larger prizes. This pattern implies that the amount of lottery winnings may not be entirely random. Interestingly, Panel B suggests that a similar pattern can be found in the sample of future winners. This similarity indicates that the observed relationships between prize amounts and certain characteristics are consistent across both current and future winners. The presence of these patterns in both groups supports the validity of using future winners as a control group, as it allows us to control for differential trends in stock market behaviors between individuals who will win larger versus smaller prizes ($Prize_i \times \mathbf{I}[t = \ell + s]$).

[11] Our specification cannot account for time-varying unobservable characteristics that interact with both prize amounts and winning timing. Consider this scenario: current winners of large prizes may be more engaged in receipt collection and prize claiming during their winning period, which leads to their early wins, while future winners of large prizes become more engaged in these activities only in later periods, resulting in their delayed wins. Although both groups eventually win large prizes, their different timing of wins reflects systematic differences in receipt collection behavior rather than pure randomness. If this is the case, it implies that current and future winners of similar prize amounts may differ in their time-varying characteristics, violating our identification assumption and potentially biasing our estimates of the wealth effect.

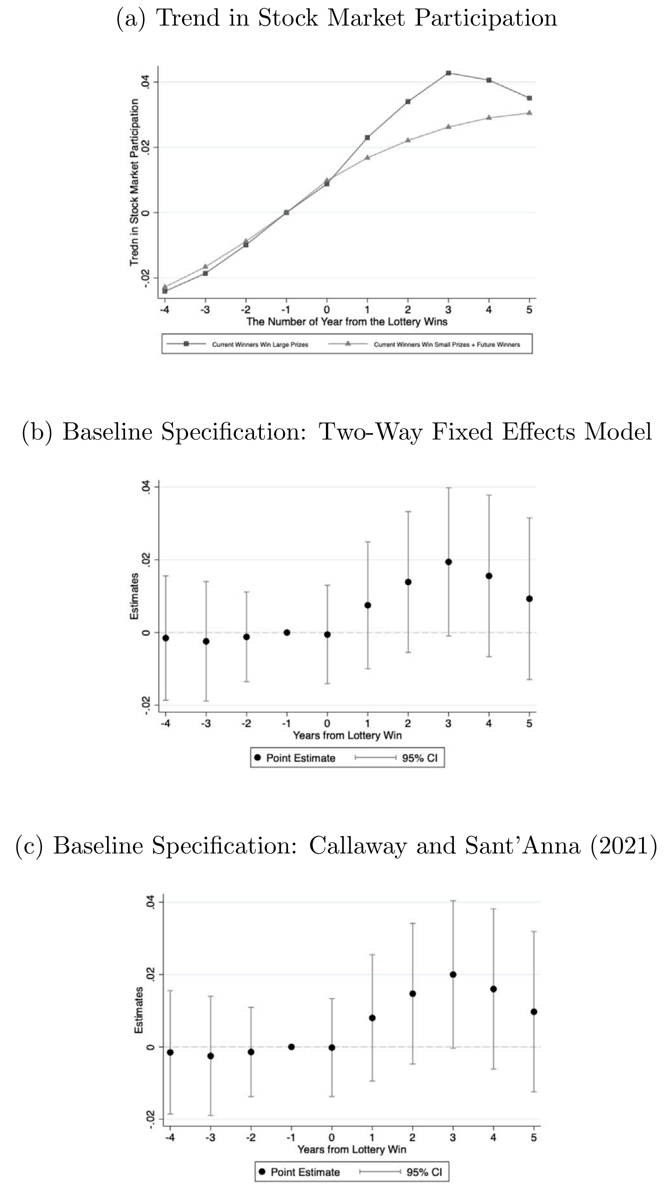

Fig. 1. Raw data and baseline specification. Note: Fig. 1(a) compares the trend in the stock market participation rates between two groups: current winners with lottery winnings of at least 100,000 TWD (black squares) and a combined group of current winners with smaller winnings (below 100,000 TWD) and future winners (grey triangles). The vertical axis displays the outcomes relative to the baseline year (one year previous to the (placebo) lottery-winning year) for each group. The horizontal axis refers to the number of years from the (placebo) lottery-winning year. Figs. 1(b) and 1(c) displays the estimated coefficient λ_s of $Treated_{i,\ell} \times \mathbf{I}[t = \ell + s]$ based on Eq. (1) for the whole sample. The estimates are shown from four years before to five years after the time of the lottery wins (s = −4 to 5). The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. In Fig. 1(b), we present results based on conventional two-way fixed effects model. Fig. 1(c) presents the results using the method proposed by Callaway and Sant'Anna (2021). The horizontal axis indicates the years relative to the lottery wins, while the circles denote point estimates, with vertical lines around the symbols indicating 95% confidence intervals.

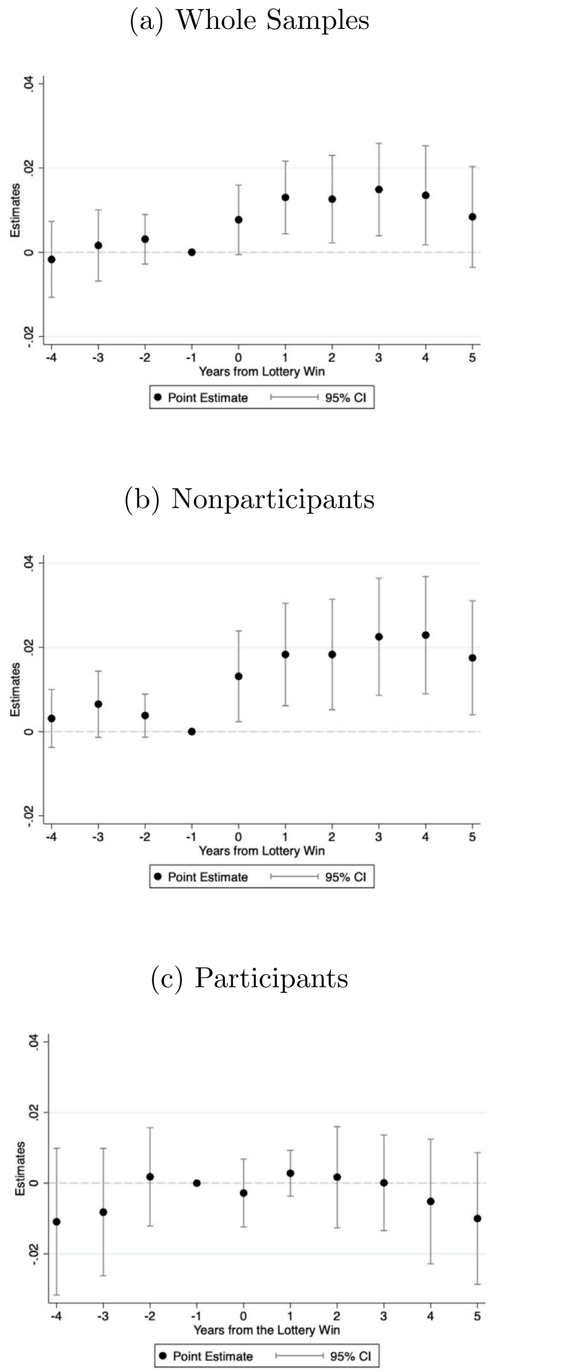

Fig. 2. Main specification. Note: This figure displays the estimated coefficient γ_s of $Current_{i,\ell} \times Prize_i \times \mathbf{I}[t = \ell + s]$ based on Eq. (2) for the whole sample, pre-lottery nonparticipants, and pre-lottery participants. The estimates are shown from four years before to five years after the time of the lottery wins (s = −4 to 5). The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. The horizontal axis shows years from lottery wins. Circle symbols represent the point estimates, and the vertical lines overlaying the circle symbols denote the 95% confidence intervals.

5.1. Effects of lottery wealth on stock market participation

5.1.1. Graphical evidence

Fig. 1(a) plots the trends in stock market participation rates for two groups: the treatment group, which includes winners of prizes exceeding 100,000 TWD, and the control group, which includes both winners of prizes below 100,000 TWD and future lottery winners in the years before their wins. The data spans from 4 years before to 5 years after winning the lottery ($s = -4, \dots, -1, 0, 1, \dots, 5$). The year $s = 0$ refers to the winning year for the current winners, while it serves as a "placebo" winning year for future winners in our control group. During the pre-lottery-winning period ($s < 0$), the trends in stock market participation are almost identical between these two groups. One year after winning a large prize, we observe that the treatment group's stock market participation rate increases by 1–2 percentage points. Fig. 1(b) presents the results based on Eq. (1) using conventional two-way fixed effects model. The results confirm parallel pre-trends between the two groups, followed by a positive effect on stock market participation after winning a large prize. The estimated coefficients indicate a 1–2 percentage point increase in stock market participation, consistent with the magnitude we observe in the raw data plotted in Fig. 1(a). The estimates are measured with considerable imprecision, and only the third-year post-win estimate achieves marginal statistical significance (p-value is 0.07). Fig. 1(c) shows that our results are robust to using the alternative difference-in-differences estimator proposed by Callaway and Sant'Anna (2021), with very similar point estimates. The close correspondence between these two sets of estimates suggests that the concerns about bias in two-way fixed effects estimates are likely less severe in our setting.

5.1.2. Main estimates

Building upon these baseline findings, we now exploit the continuous variation in prize amounts to estimate the per-million-TWD effect of lottery winnings on stock market participation. This specification also allows us to control for potentially different time trends between current and future winners, as well as time-varying patterns across the prize amount distribution. Fig. 2(a) illustrates the dynamic pattern of estimates from Eq. (2). The estimated coefficients, $\hat{\gamma}_s$, for the pre-lottery-winning period ($s < 0$) are statistically insignificant, supporting the parallel trends assumption. The estimates become significant from the second year after winning ($s = 1$), ranging from 1 to 2 percentage points, and the effect persists for at least 4 years, until $s = 4$.

We divide the data into two groups based on stock market participation status one year before lottery wins (baseline year)[12]: participants and nonparticipants. The results reveal a striking contrast between these groups. Fig. 2(b) demonstrates a pronounced dynamic pattern for nonparticipants, with effects substantially larger than those observed in the overall sample (Fig. 2(a)). In contrast, Fig. 2(c) shows small and insignificant effects for participants. Notably, these findings indicate that nonparticipants are the primary drivers of the overall windfall effect.

To concisely summarizes our results, Table 2 presents estimated coefficients for $Current_{i,\ell} \times Prize_i \times Post_t$ from Eq. (3). We begin with Column (1), which presents the estimate from a basic DID regression without controlling for fixed effects or covariates. Column (2) then incorporates year fixed effects to account for time-specific factors. Columns (3) and (4) progressively add more controls: Column (3) introduces fixed effects for the winner's age, while Column (4) further includes pre-winning characteristics. These additions aim to control for potential confounding factors related to individual demographics and baseline conditions. Finally, Column (5) includes individual fixed effects to control for time-invariant unobserved factors, providing the most comprehensive specification in our analysis.

Panel A of Table 2 presents results for the entire sample, including both stock market participants and nonparticipants prior to winning lottery prizes. The result in Column (5) indicates that a one million TWD (approximately 33,000 USD) windfall gain increases the probability of stock market participation by roughly 1.09 percentage points. The estimates in Columns (1)-(4) closely align with those in Column (5).

Panels B and C of Table 2 present results for nonparticipants and participants, respectively. For individuals who did not participate in the stock market before winning the lottery, each million TWD increases the participation probability by 1.42 percentage points. In contrast, the windfall effect is statistically insignificant for individuals who were already participating in the stock market. These findings indicate that the overall effect shown in Panel A is primarily driven by nonparticipants. This result aligns with findings from Andersen and Nielsen (2011) and Briggs et al. (2021) using data from Nordic countries. In the subsequent analysis, we further explore the heterogeneous effects on nonparticipants in Section 5.3. For participants, we examine their diversification behavior after winning the lottery in Section 5.4.

Table 2
Effect of windfall gains on stock market participation.

	(1)	(2)	(3)	(4)	(5)
A. Whole sample					
$Current \times Prize \times Post$	0.0100**	0.0102**	0.0108**	0.0108**	0.0109**
	[0.0047]	[0.0047]	[0.0046]	[0.0046]	[0.0046]
# of observations			10,589,440		
B. Nonparticipants					
$Current \times Prize \times Post$	0.0144**	0.0133**	0.0137**	0.0137**	0.0142**
	[0.0060]	[0.0060]	[0.0060]	[0.0060]	[0.0060]
# of observations			7,355,940		
C. Participants					
$Current \times Prize \times Post$	0.0013	0.0047	0.0047	0.0047	0.0054
	[0.0067]	[0.0068]	[0.0066]	[0.0066]	[0.0066]
# of observations			3,233,500		
Basic controls	√	√	√	√	√
Year fixed effect		√	√	√	√
Age fixed effect			√	√	√
Pre-winning characteristics				√	
Individual fixed effect					√

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of lottery wins on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. Panel A includes all samples (average outcome: 0.305). Panel B includes individuals who did not participate in the stock market one year before winning the lottery (average outcome: 0). Panel C includes individuals who did participate in the stock market one year before winning the lottery (average outcome: 1). Column (1) includes a set of variables consisting of a dummy for the post-winning period $Post_t$, the interaction between the post-winning dummy and $Current_{i,\ell}$, and post-winning dummy interaction with the $Prize_i$. Column (2) additionally includes calendar year fixed effects. Column (3) additionally includes individual age fixed effects. Column (4) additionally includes pre-winning characteristics: a set of variables consisting of winner's earnings, winner's homeownership, marital status, gender, and cities/counties of residence. These covariates are measured in the year right before the lottery-winning year($s = -1$). Column (5) controls for individual fixed effects. Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

5.2. Robustness checks

In this subsection, we conduct several robustness checks on our main results. First, we examine whether the estimated windfall effect varies according to the range of lottery prizes. Our main results are based on a broad range, including individuals who won lottery prizes of at least 2000 TWD, which is the smallest prize observable in our dataset. In Columns (1) and (2) of Table 3, we focus on winners of prizes of at least 5000 TWD and 30,000 TWD, respectively. Despite the narrower range of lottery prizes, the estimates for the whole sample in Panel A are quite similar to those in Column (5) of Table 2. Similarly, for participants and nonparticipants, the estimates in Panels B and C of Table 3 closely align with those in Table 2. These results demonstrate that the estimated effect remains robust across various ranges of lottery prizes.

To further ensure our results are not chance findings, we conduct a series of falsification tests. Specifically, we randomly re-assign the lottery prizes to individuals in the original sample. Then, we use these "pseudo" prizes to redefine the variable $Prize_i$ in Eqs. (2) and (3) and estimate them. We repeat the above permutation procedures 1000 times to obtain the distribution of pseudo estimates. For the main results, Fig. 3(a) shows the real estimates (red vertical line) and the histogram of pseudo estimates $\hat{\gamma}$ from Eq. (3) based on the permutation. This reveals that the real estimate is much larger than those obtained from the permutation, suggesting the significance of our results. Fig. 3(b) shows the permutation for the dynamic DID estimates

[12] For future winners, we use the status from one year before their 'placebo' winning year to split the sample.

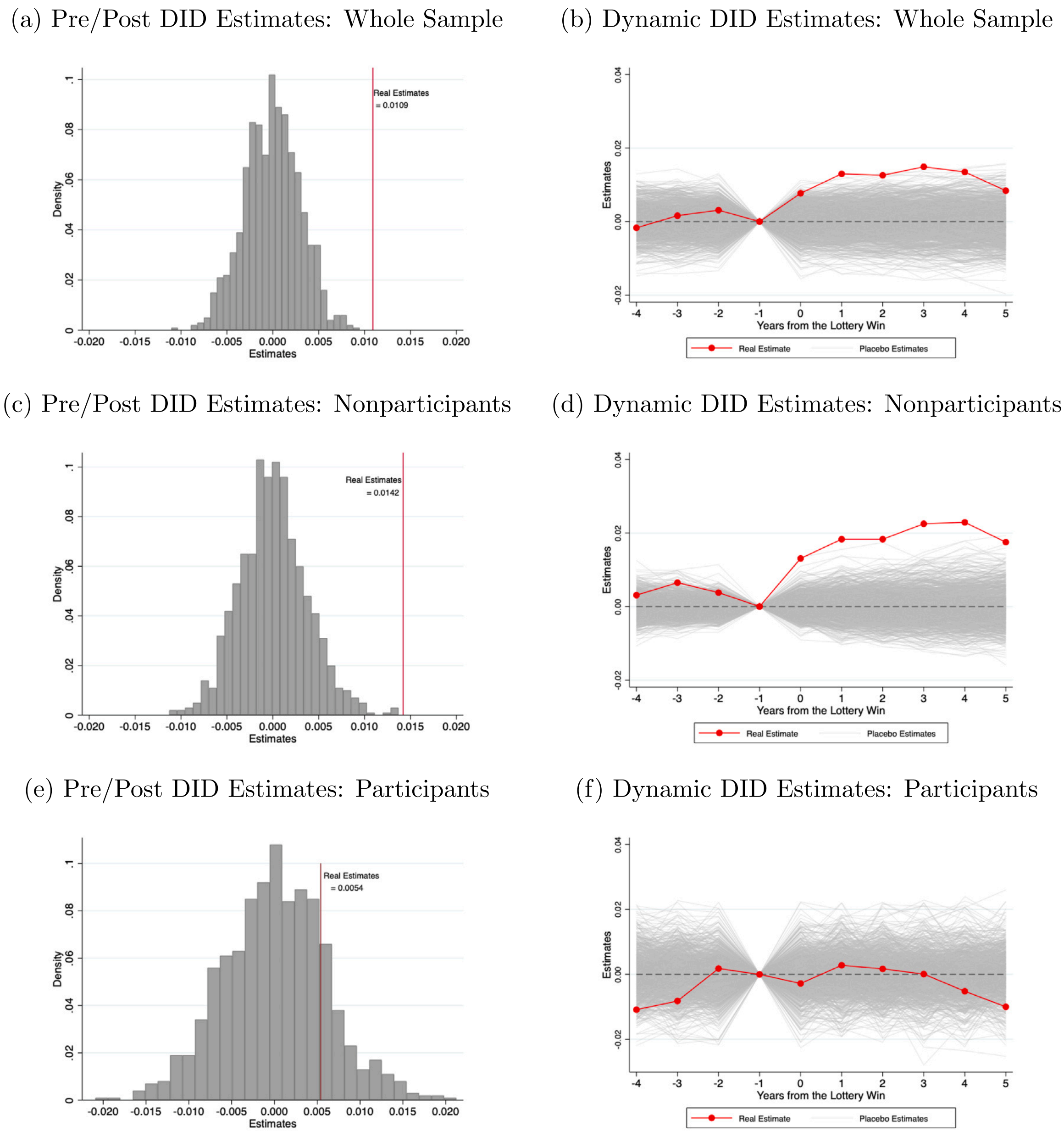

Fig. 3. Falsification tests. Note: These figures display the results of falsification tests. We randomly re-assign lottery prizes to individuals in the original sample and use these "pseudo" prizes to redefine the variable $Prize_i$ in Eqs. (2) and (3). We repeat this permutation procedure 1000 times to obtain the distribution of pseudo estimates. Figs. 3(a), 3(c), and 3(e) show the real estimate (red vertical lines) and the distribution of 1000 pseudo estimates from Eq. (3). Figs. 3(b), 3(d), and 3(f) show the real estimates (red lines with circle symbols) and the pseudo estimates (grey lines) from Eq. (2) for the dynamic DID setting. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

in Eq. (2). Similarly, we observe that the real estimates (red line) are much larger than those from the permutation (grey lines) during the post-lottery-winning period ($s \geq 0$), demonstrating the significance of the dynamic DID estimates. Additionally, the real estimates (red line) fall between those from the permutation (grey lines) during the pre-lottery-winning period ($s < 0$), demonstrating the validity of the control group. We also conduct falsification tests for both nonparticipants and participants. Figs. 3(c) and 3(d) demonstrate that the results remain significant for nonparticipants, while Figs. 3(e) and 3(f) indicate that the results are insignificant for participants.

Next, we reweight the population for estimation, as the lottery winners in our sample could be different from those of the general population. Compared to the general population, Table 1 indicates that winners are slightly younger. Additionally, our sample of winners includes a higher proportion of females and married individuals. To address this concern, we adjust the sample weights to align these attributes more closely with those found in the general population of Taiwan.[13] Following the re-weighting process, the estimate in Column (3) of Table 3 remains consistent with those in the main results.

[13] We use the post-stratification weighting technique and match the age, gender and marital status of population for our lottery sample and the population, the latter of which is defined as individuals aged 20 to 60 from 2008 to 2012 (same as our winning years for current winners and pseudo years for future winners) in Taiwan. This leads to 11 million observations during winning years. We use their characteristics as one year prior to the winning years. Table A.4 of Online Appendix compares the characteristics of lottery winners and the population after reweighting, demonstrating that the reweighted sample better resembles the population characteristics.

Table 3
Robustness check.

	(1) Above 5K TWD (165 USD)	(2) Above 30K TWD (1000 USD)	(3) Population Reweighted	(4) CS DID
A. Whole sample				
$Current \times Prize \times Post$	0.0109***	0.0113**	0.0109**	0.0190***
	[0.0047]	[0.0048]	[0.0046]	[0.0070]
# of observations	1,249,700	121,720	10,589,440	10,589,440
B. Nonparticipants				
$Current \times Prize \times Post$	0.0140**	0.0141**	0.0142**	0.0280**
	[0.0060]	[0.0061]	[0.0060]	[0.0090]
# of observations	862,770	83,780	7,355,940	7,355,940
C. Participants				
$Current \times Prize \times Post$	0.0048	0.0054	0.0054	0.0014
	[0.0067]	[0.0069]	[0.0066]	[0.0059]
# of observations	386,930	37,940	3,233,500	3,233,500

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of lottery wins on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. All specifications include the same covariates and fixed effects shown in Column (5) of Table 2. Columns (1) and (2) report the estimates using different definitions of winning prizes: at least 5000 TWD (approximately 165 USD) and 30,000 TWD (approximately 1000 USD), respectively. Column (3) reports the estimate based on re-weighting the winners to match the distribution of age, gender, and marital status in the population. Column (4) reports the estimate based on a two-step estimation strategy with the bootstrap procedure (CS-DID) proposed by Callaway and Sant'Anna (2021). Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

Furthermore, our sample includes individuals who received lottery prizes in various years. Recent studies (De Chaisemartin and d'Haultfoeuille, 2020; Callaway and Sant'Anna, 2021; Goodman-Bacon, 2021; Baker et al., 2022; Sun and Abraham, 2021) suggest that conventional DID estimates might be biased if treatment effects are heterogeneous among different treated cohorts. To address this concern, we apply a two-step estimation strategy with a bootstrap procedure proposed by Callaway and Sant'Anna (2021). Specifically, for each winner cohort, we compare the current winner cohort with the corresponding future winner cohort to obtain the estimate separately. For instance, for those who received the lottery prize in 2008, we compare them (current winners) with those who won the lottery prize in 2014 (corresponding future winners) and are assigned a 'placebo' winning year of 2008. Then, we calculate the average windfall effect across all winner cohorts, weighted by the sample size of each cohort. We estimate the standard error using 1000 bootstrap iterations (re-sampling with replacement within lottery cohorts). The results in Column (4) of Table 3 indicate that our main findings are robust to this concern. The estimated effect for the whole sample (Panel A) remains statistically significant and is even larger. This estimate also suggests that the effect of lottery wins is primarily driven by nonparticipants (Panel B).

5.3. Heterogeneous effects

In this section, we only focus on nonparticipants and explore the heterogeneous effects of cash windfalls based on the following three aspects: (1) the amount of lottery prizes; (2) individuals' financial features; and (3) individuals' demographic features.

5.3.1. Effects by prize size

In our main results, we estimate the linear effect of windfall gains (per million TWD) on stock market participation. However, this approach assumes a constant marginal effect across all prize amounts, which may not accurately capture the relationship between windfall size and behavioral changes. To address this potential limitation and determine whether the effect differs across prize thresholds, we employ a discrete design that evaluates the impact of varying prize amounts on stock market participation.

This approach allows us to investigate whether there are non-linear effects in the relationship between lottery winnings and stock market participation. For instance, smaller prizes might not be sufficient to overcome participation costs to entering the stock market, while larger prizes might have diminishing marginal effects. By examining different prize categories, we can identify potential threshold where the windfall effect becomes significant or changes in magnitude.

To implement this analysis, we modify Eq. (3) by replacing the continuous variable $Prize_i$ with a binary indicator, $Large_i$, representing a large prize. The revised regression model is as follows:

$$\begin{aligned} S_{it} &= \gamma \cdot Current_{i,\ell} \times Large_i \times Post_t + \kappa \cdot Post_t \\ &+ \beta \cdot Current_{i,\ell} \times Post_t + \lambda \cdot Large_i \times Post_t \\ &+ a_{it} + \theta_t + v_i + \varepsilon_{it} \end{aligned} \tag{4}$$

We define individuals who won less than 5 thousand TWD as the baseline group and use various definitions of a large prize: (1) 5 thousand to 100 thousand TWD; (2) 100 thousand to 1 million TWD; (3) above 1 million TWD.[14] As in our main analysis, we employ future winners as control groups to mitigate potential biases.

The coefficient γ can be interpreted as the effect of winning a large prize (according to the specified definitions) on stock market participation, relative to those who won a small prize (less than 5 thousand TWD). This approach enables us to capture potential non-linearities and threshold effects in the relationship between lottery winnings and stock market participation, providing a more comprehensive understanding of whether different levels of windfall gains influence financial behavior.

Table 4 illustrates the heterogeneous windfall effect on stock market participation based on the size of the lottery win. In Column (1), receiving a large prize amount between 5 thousand and 100 thousand TWD yields an almost negligible and insignificant windfall effect on stock market participation. In Column (2), when we consider a large prize ranging from 100 thousand to 1 million TWD, the windfall effect increases but remains insignificant. This suggests that smaller windfalls may not be sufficient to overcome the barriers to stock market entry. It is only when the prize exceeds 1 million TWD that we observe a significant effect. As shown in Column (3), receiving a prize larger than 1 million TWD, compared to winning a smaller prize of less than 5 thousand TWD, leads to an increase in the probability of participating in the stock market by approximately 4.95 percentage points. The average prize for those receiving an amount larger than 1 million TWD is around 4.09 million TWD, which implies that the marginal effect of a 1 million TWD windfall is around 1.21 percentage points (= 4.95/4.09). Compared to the main results of 1.42 percentage points in Table 2, this is slightly smaller, suggesting that the marginal effect diminishes as the prize increases (Briggs et al., 2021).

5.3.2. Effects by winners' financial characteristics

To further understand how individuals' financial characteristics affect the windfall effect, we analyze their financial features from one year before their lottery wins to split the sample.[15] These characteristics include homeownership, mortgage status, and business ownership. We employ the same framework as Eq. (3) for each subgroup, focusing solely on nonparticipants.

Columns (1) and (2) of Table 5 demonstrate that receiving cash windfalls significantly increases stock market participation for homeowners, while having an insignificant impact on non-homeowners.

[14] Since we only have two types of prizes above 1 million TWD—special prize (10 million) and grand prize (2 million)—and the variation in prizes is limited, it is difficult to define additional categories above 1 million TWD to explore the nonlinear effect of larger prizes.

[15] For future winners, we use their financial data from one year before their 'placebo' winning year to split the sample.

Table 4
Effects by amount of prizes.

	(1) 5K to 100K TWD (165 to 3300 USD)	(2) 100K to 1M TWD (3300 to 33,000 USD)	(3) Above 1M TWD (Above 33,000 USD)
$Current \times Large \times Post$	−0.0012	0.0039	0.0495**
	[0.0016]	[0.0150]	[0.0229]
# of observations	7,342,160	6,501,870	6,498,250

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Large_i \times Post_t$ based on Eq. (4), representing the effect of winning the large prize on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participate in stock market in a given year t. All specifications include the same covariates and fixed effects shown in Column (5) of Table 2. The baseline group is defined as those who won less than 5000 TWD (approximately 165 USD). A large prize is defined as follows: 5 thousand to 100 thousand TWD (approximately 165 to 3300 USD) with an average prize of 10.18 thousand TWD (approximately 340 USD) in Column (1), 100 thousand to 1 million TWD (approximately 3300 to 33,000 USD) with an average prize of 225 thousand TWD (approximately 7400 USD) in Column (2), and prizes exceeding 1 million TWD (33,000 USD) with an average prize of 4.09 million TWD (approximately 135,000 USD) in Column (3). Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

Table 5
Subgroup analysis: By financial features.

	(1)	(2)	(3)	(4)	(5)	(6)
	Homeowner		Have mortgages		Own business	
	No	Yes	No	Yes	No	Yes
$Current \times Prize \times Post$	0.0087	0.0235*	0.0268**	0.0102	0.0146**	0.0122
	[0.0061]	[0.0121]	[0.0121]	[0.0068]	[0.0066]	[0.0144]
# of observations	5,560,190	1,795,750	1,078,470	6,277,470	6,253,360	1,102,580

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of lottery wins on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. All specifications include the same covariates and fixed effects shown in Column (5) of Table 2. Columns (1) and (2) classify individuals based on homeownership status before the lottery win: Column (1) includes non-homeowners, and Column (2) includes homeowners. Columns (3) and (4) categorize individuals based on mortgage status: Column (3) includes those without a mortgage, while Column (4) includes those with a mortgage. Columns (5) and (6) categorize individuals based on entrepreneurship status: Column (5) includes non-entrepreneurs, while Column (6) includes entrepreneurs. Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

Table 6
Subgroup analysis: By demographic features.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Age		Gender		Married		Urban residence	
	Below 40	Above 40	Male	Female	No	Yes	No	Yes
$Current \times Prize \times Post$	0.0132*	0.0154*	0.0016	0.0231***	0.0189**	0.0116	0.0041	0.0198**
	[0.0077]	[0.0093]	[0.0066]	[0.0087]	[0.0096]	[0.0079]	[0.0060]	[0.0082]
# of observations	4,566,827	2,751,064	2,617,060	4,738,880	3,594,310	3,733,208	2,244,470	5,111,470

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of lottery wins on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. All specifications include the same covariates and fixed effects shown in Column (5) of Table 2. Columns (1) and (2) categorize individuals based on age in the year before a lottery win: Column (1) includes individuals under 40, while Column (2) includes individuals 40 and above. Columns (3) and (4) categorize individuals by gender: Column (3) includes males, while Column (4) includes females. Columns (5) and (6) categorize individuals based on marital status: Column (5) includes singles, while Column (6) includes married individuals. Columns (7) and (8) categorize individuals based on residence: Column (7) includes rural residents, while Column (8) includes urban residents. Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

This finding suggests that non-homeowners may prioritize using windfall gains to invest in real estate, aligning with studies indicating that investing in real estate can crowd out stock market participation (Grossman and Laroque, 1990; Flavin and Yamashita, 2011; Vestman, 2019).

The impact of existing financial obligations is further highlighted in Columns (3) and (4). Here, we observe that lottery prizes significantly increase stock market participation among winners without mortgages, while having a negligible effect on those with outstanding home loans. This suggests that mortgage holders are more inclined to use their windfalls for debt reduction rather than entering the stock market, underscoring how current financial commitments can shape the allocation of unexpected gains. These results are largely consistent with the findings in Briggs et al. (2021).

Lastly, Columns (5) and (6) indicate that the estimated windfall effect on stock market participation is statistically insignificant among lottery winners who own businesses. This pattern suggests that business owners may require additional funds for their enterprises, potentially diverting windfall gains away from stock market investments. In summary, our findings reveal that individuals with alternative investment opportunities or financial obligations tend to experience a diminished windfall effect on stock market participation. Whether it is the opportunity to invest in real estate for non-homeowners, the obligation to repay mortgages, or the potential to reinvest in one's business, these competing financial priorities appear to moderate the impact of lottery winnings on stock market entry.

5.3.3. Effects by winners' demographic characteristics

In addition to financial characteristics, we explore the windfall effect across various demographic features, including age, gender, marital status, and residential location (urban or rural). We apply the same identification strategy as before, focusing on nonparticipants.

Table 6 presents the results of each subgroup analysis. Columns (1) and (2) show that receiving cash windfalls significantly impacts stock market participation for both younger (below 40) and older (above 40) individuals. Although the effect on older individuals is slightly larger, the two estimates are not statistically distinguishable.

The literature (Haliassos and Bertaut, 1995; Vissing-Jorgensen, 2003) explains stock market non-participation by two types of costs: fixed entry costs and ongoing participation costs. If fixed entry costs are significant, the effect on young people should be larger since they can benefit more from participating in the stock market over a longer life expectancy, given the one-time participation costs. However, if participation costs must be paid in each period, the effects should be similar across different age groups. Our results align more with the argument of each-period participation costs, rather than the theory of fixed entry costs.

For gender, Columns (3) and (4) interestingly demonstrate that female recipients show a significant increase in stock market participation, while males show no significant impact. This disparity could suggest either lower participation costs for women or, if costs are similar across genders, might be explained by unobserved spending patterns among men, such as increased expenditures on leisure activities or dining out, which could divert funds from stock market investments. According to Boertien (2012), consumption patterns following lottery wins differ significantly between males and females based on the British Household Panel Survey. Specifically, men showed a notable increase in spending on leisure activities and dining out, whereas women tended to save their prizes and allocate them towards purchasing consumer durables.

For marital status, Columns (5) and (6) suggest that single individuals exhibit a significant increase in stock market participation upon receiving windfalls, whereas married recipients show no significant change. This phenomenon could be explained by competing financial priorities for married people, such as saving for future education expenses for children (Bulman et al., 2021), which could limit the resources available for stock market investments.

Lastly, Columns (7) and (8) highlight the impact of residential location. Urban residents display a significant increase in stock market participation after receiving windfalls, while rural residents show no significant change. This difference can be attributed to lower participation costs in urban areas, where residents have easier access to stock exchanges and more convenient financial services, thereby facilitating stock market engagement. Hong et al. (2004) support this observation, finding that urban residents have higher stock market participation rates, which may suggest lower participation costs in urban areas.

5.4. Effects of windfall gains on diversification of stock holdings

For lottery winners who were already participating in the stock market, cash windfalls do not significantly affect their decision to continue investing (the extensive margin). However, these windfalls may influence the intensity of their participation (the intensive margin), such as by altering the amount invested or diversifying their portfolio. We examine whether lottery winnings affect the amount participants decide to invest in the stock market. This analysis employs the same empirical framework as Eq. (3), but replaces the dependent variable with the total value of an individual's stock portfolio.[16] The estimate, $\hat{\gamma}$, represents the increase in the total stock portfolio value in response to a one million TWD lottery prize for the lottery winners. Results presented in Panel A of Table 7 indicate that each million TWD windfall increases the total value of stocks by 142,552 TWD. This implies that approximately 14.3% of the windfall is invested in the stock market.

We further analyze the increase in stock value by decomposing it into two components: changes in the number of shares held and changes in the average prices of the stocks.[17] Results presented in Panels B and C of Table 7 reveal that lottery winners both increase their number of shares and hold stocks with higher average prices. Specifically, each million TWD windfall leads to an average increase of 2301 shares in the winner's portfolio. Concurrently, the average price of stocks in their portfolio rises by 3.14 TWD.

While an increase in the number of shares held by lottery winners is expected, the rise in average stock prices is particularly noteworthy. This increase may stem from two possible sources: (1) Winners may now have the financial capacity to invest in higher-priced stocks that were previously unaffordable. (2) They may choose to invest more in their existing stock holdings, but only in those showing an upward price trend. From a diversification perspective, these two strategies have opposing effects. The former enhances portfolio diversification by adding new, potentially higher-value stocks. In contrast, the latter may reduce diversification by concentrating investments in a smaller number of appreciated stocks.

To further investigate the windfall effect on diversification and determine whether high transaction costs or small portfolio size are the key factors affecting the level of diversification, we calculate the Herfindahl–Hirschman Index (HHI) for each individual's portfolio and examine how it changes following a lottery win.[18] Using the same empirical setting as in Eq. (3), Panel D of Table 7 shows a negative but statistically insignificant change in the HHI following a lottery win. This suggests that individuals do not significantly diversify their portfolios after winning the lottery, consistent with findings that even wealthy households do not diversify their portfolios well (Kelly, 1995; Polkovnichenko, 2005; Goetzmann and Kumar, 2008). While some studies show that the level of diversification increases with income and wealth (Kelly, 1995; Polkovnichenko, 2005; Ivković et al., 2008; Goetzmann and Kumar, 2008; Calvet et al., 2007), our results, based on exogenous wealth shocks, suggest that this correlation may not reflect a causal relationship.

In addition, we further examine the value, number of shares, and average price of "new" stocks added to winners' portfolios after winning the lottery to better understand the story behind the wealth effect on diversification. The results are presented in Table A.5 in the Appendix. A new stock is defined as one not held by the individual in the year preceding their lottery win. The findings indicate that each million TWD in lottery winnings increases the total value of new stocks by 61,189 TWD, accounting for approximately 43% of the total increase in stock value. This suggests that lottery winners tend to allocate their windfall gains relatively evenly between new and existing stocks. For investments in existing stocks, this is consistent with prior research showing that people tend to invest in familiar stocks (Grinblatt and Keloharju, 2001; Huberman, 2001). Regarding new stocks, the results further reveal that both the number of shares acquired and the average price of new stocks increase after receiving lottery prizes. This implies that some of the newly acquired stocks may be higher-priced, suggesting that lottery winners are able to access a broader range of investment opportunities.

6. Comparison with typical lotteries

In this section, we compare our main results from receipt lotteries (RL) with estimates based on typical lotteries, incorporating findings from the Public Welfare Lottery (PWL) in Taiwan and existing literature. Specifically, we first utilize data from PWL winners and employ the same DID design to estimate the impact of cash windfalls on stock market participation. Subsequently, we compare the main results in Table 2 with the findings from PWL and those from Briggs et al. (2021).

Table 8 presents the results for PWL winners. To ensure a fair comparison with RL, where the maximum prize is 10 million TWD, we

[16] The portfolio value is calculated by multiplying the market price of each stock by the number of shares an individual holds.

[17] The average price of stocks held by an individual is calculated as the weighted average price, with weights based on the value of each stock holding.

[18] The HHI is calculated as $\sum_{i=1}^{N} s_i^2$, where s_i is the proportion of the portfolio value invested in stock i, and N is the total number of stocks in the portfolio. A lower HHI indicates greater diversification.

Table 7
Effects of windfall gains on stock investment and diversification.

	(1)	(2)	(3)	(4)	(5)
A. Value of an individual's stock portfolio					
$Current \times Prize \times Post$	138,936***	140,912***	142,243***	142,243***	142,552***
	[42,476]	[42,3996]	[42,3286]	[42,3286]	[42,4256]
B. Shares held in an individual's portfolio					
$Current \times Prize \times Post$	2170**	2225**	2279**	2279**	2301**
	[1060]	[1063]	[1058]	[1058]	[1064]
C. Average share price of an individual's stock portfolio					
$Current \times Prize \times Post$	3.0885***	3.0509***	3.0442***	3.0442***	3.1417***
	[1.0592]	[1.0587]	[1.0595]	[1.0595]	[1.0785]
D. HHI of an individual's stock portfolio					
$Current \times Prize \times Post$	−16.9583	−24.6665	−28.1127	−28.1127	−39.0216
	[56.8551]	[57.3175]	[57.0668]	[57.0668]	[54.6822]
# of observations			3,233,500		
Basic controls	√	√	√	√	√
Year fixed effect		√	√	√	√
Age fixed effect			√	√	√
Pre-winning characteristics				√	
Individual fixed effect					√

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of lottery wins on the outcome of interest. The outcome variables indicate various characteristics of the stock portfolio for individual i in a given year t. Panels A to C include the values, shares, and average prices of an individual's stock portfolio. Panel D shows the HHI of an individual's stock portfolio. Column (1) includes a set of variables consisting of a dummy for the post-winning period $Post_t$, the interaction between the post-winning dummy and $Current_{i,\ell}$, and post-winning dummy interaction with the $Prize_i$. Column (2) additionally includes calendar year fixed effects. Column (3) additionally includes individual age fixed effects. Column (4) additionally includes pre-winning characteristics: a set of variables consisting of winner's earnings, winner's homeownership, marital status, gender, and cities/counties of residence. These covariates are measured in the year right before the lottery-winning year($s = -1$). Column (5) controls for individual fixed effects. Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

Table 8
Effect of windfall gains on stock market participation: Public welfare lottery.

	(1)	(2)	(3)	(4)	(5)
A. Whole sample					
$Current \times Prize \times Post$	0.0067***	0.0065***	0.0065***	0.0065***	0.0064***
	[0.0019]	[0.0019]	[0.0019]	[0.0019]	[0.0019]
# of observations			6,709,230		
B. Pre-lottery nonparticipants					
$Current \times Prize \times Post$	0.0078***	0.0090***	0.0089***	0.0089***	0.0091***
	[0.0022]	[0.0022]	[0.0022]	[0.0022]	[0.0022]
# of observations			4,547,440		
C. Pre-lottery participants					
$Current \times Prize \times Post$	0.0050	0.0021	0.0018	0.0018	0.0014
	[0.0038]	[0.0038]	[0.0038]	[0.0038]	[0.0037]
# of observations			2,161,790		
Basic controls	√	√	√	√	√
Year fixed effect		√	√	√	√
Age fixed effect			√	√	√
Pre-winning characteristics				√	
Individual fixed effect					√

Note: This table reports estimated coefficients γ of $Current_{i,\ell} \times Prize_i \times Post_t$ based on Eq. (3), representing the effect of PWL wins on the outcome of interest. The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. Panel A includes all samples (average outcome: 0.322). Panel B includes individuals who did not participate in the stock market one year before winning the lottery (average outcome: 0). Panel C includes individuals who did participate in the stock market one year before winning the lottery (average outcome: 1). Column (1) includes a set of variables consisting of a dummy for the post-winning period $Post_t$, the interaction between the post-winning dummy and $Current_{i,\ell}$, and post-winning dummy interaction with the $Prize_i$. Column (2) additionally includes calendar year fixed effects. Column (3) additionally includes individual age fixed effects. Column (4) additionally includes pre-winning characteristics: a set of variables consisting of winner's earnings, winner's homeownership, marital status, gender, and cities/counties of residence. These covariates are measured in the year right before the lottery-winning year($s = -1$). Column (5) controls for individual fixed effects. Standard errors are clustered at the individual level and reported in squared brackets. *** significant at the 1 percent level, ** significant at the 5 percent level, and * significant at the 10 percent level.

exclude PWL winners with prizes exceeding this amount. The estimates in Panel A suggest that winning 1 million TWD in the PWL increases the probability of stock market participation by 0.64 percentage points, while the same amount won in the RL increases participation by 1.09 percentage points. Although the PWL effect is smaller, this difference is not statistically significant (p-value is 0.381), suggesting comparable impacts between the two lotteries. In both lotteries, we find that the effects of windfalls are primarily driven by individuals who were not participating in the stock market before winning (see Panels B and C in Tables 2 and 8). Fig. 4 demonstrates that the cash windfalls from PWL have a similar persistent effect on stock market participation as those from RL. These results highlight the remarkable similarities

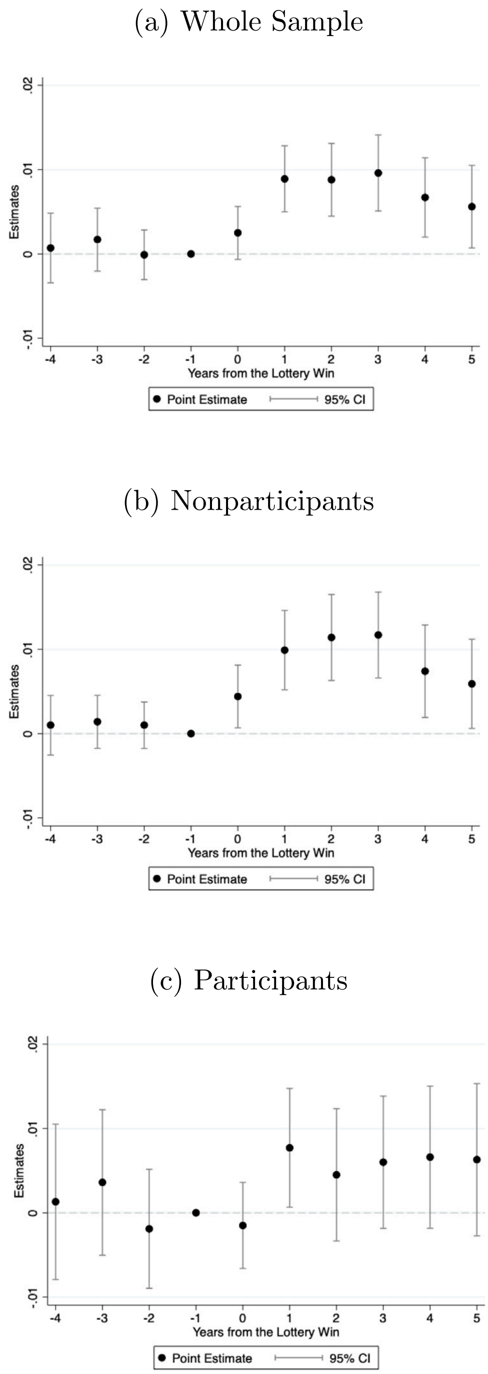

Fig. 4. Main specification: Public welfare lottery. Note: This figure displays the estimated coefficient γ_s of $Current_{i,\ell} \times Prize_i \times \mathbf{I}[t = \ell + s]$ based on Eq. (2) for the Public Welfare Lottery. The estimates are shown from four years before to five years after the time of the lottery wins (s = −4 to 5). The outcome variable is a dummy variable indicating whether an individual i participates in the stock market in a given year t. The horizontal axis shows years from lottery wins. Circle symbols represent the point estimates, and the vertical lines overlaying the circle symbols denote the 95% confidence intervals.

between PWL and RL in terms of their effects on stock market participation, including the magnitude of the impact, the primary influence on nonparticipants, and the persistence of the effect over time.

Furthermore, our findings closely align with those of Briggs et al. (2021), who studied typical lottery winners. Despite differences in context (Sweden vs. Taiwan) and lottery types, the results are quite similar. Briggs et al. (2021) estimate that for every 150,000 USD won, stock market participation increases by 3.9 percentage points across their full sample. Our main estimate shows that winning 1 million TWD in the RL increases stock market participation by 1.09 percentage points. To facilitate a direct comparison, we rescale our estimates to reflect the effect of a windfall measured in units of 150,000 USD, suggesting an increase in stock market participation by 5.17 percentage points.[19] Notably, both studies find that the windfall effect is primarily driven by individuals who were not participating in the stock market before winning the lottery. This similarity in results, despite differences in cultural and economic contexts, suggests a robust relationship between lottery winnings and increased stock market participation across different settings.

7. Conclusion

This study investigates the impact of cash windfalls from RL on stock market participation and portfolio diversification. Our findings reveal that each million TWD (approximately 33,000 USD) windfall gain significantly increases the probability of stock market participation by 1.09 percentage points, predominantly driven by individuals who were not previously participating in the stock market. For existing participants, the windfall results in a substantial increase in the total value of their stock holdings, attributed to both an increase in the number of shares and higher average stock prices. Furthermore, our findings reveal that individuals do not substantially diversify their portfolios after winning the lottery, indicating that wealth level is unlikely to be the main cause of under-diversification.

Future research could explore whether financial constraints differentially affect the extent of underdiversification driven by familiarity bias and skewness preference. Biases contributing to underdiversification include overinvestment in company stocks (Benartzi, 2001; Poterba, 2003), profession-related stocks (Massa and Simonov, 2006), industry-related stocks (Dø skeland and Hvide, 2011), and local stocks (Huberman, 2001; Ivković and Weisbenner, 2005; Feng and Seasholes, 2004; Seasholes and Zhu, 2010). Additionally, some investors underdiversify due to skewness preference (Mitton and Vorkink, 2007; Barberis and Huang, 2008; Kumar, 2009). The impact of financial constraints on these forms of underdiversification remains unclear.

Another avenue for future studies involves using the windfall gains from this study to evaluate how relaxing financial constraints affect household investment decisions and subsequent welfare outcomes. While easing financial constraints may encourage diversified portfolios and enhance household well-being, Calvet et al. (2007) find that financially sophisticated households, characterized by income, wealth, and education, tend to invest more efficiently but also more aggressively, resulting in volatile portfolios and potentially increased welfare losses from suboptimal investments.

CRediT authorship contribution statement

Tzu-Chang Forrest Cheng: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Hsuan-Hua Huang:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tse-Chun Lin:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Tzu-Ting Yang:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jian-Da Zhu:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

[19] We adjusted our estimated coefficients using the 2010 average exchange rate of 31.64 TWD/USD for comparability, as Briggs et al. (2021) reported their prize effect using the 2010 exchange rate.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jbankfin.2024.107378.

Data availability

The data that has been used is confidential.

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