Internet Use and Risky Financial Market Participation: Evidence from China

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Abstract
The information and communication technology promotion policies have been implemented and enforced in both developed and developing countries. China has the most Internet users worldwide. Although it is assumed that the Internet use may affect the risky financial market participation, the empirical evidence on the issue is scarce. Using a national longitudinal data, this study investigates the impact of Internet use on individuals’ participation in risky financial markets in China after considering the endogeneity issues. Three key findings emerged. First, Internet use has a significantly positive effect on participation in risky financial markets. Second, the positive effect of Internet use is greater for the group aged 30–49 years, the middle and the highly educated group, urban hukou residents, and women as compared to their counterparts. Third, the positive effect of Internet use on risky financial participation may be through three channels—increase in income, information obtaining, and reduction of transaction costs.

Keywords: internet use, risky financial market, participation in risky financial market, share of risky financial assets, China

1. Introduction
This study attempts to explore the association between Internet use and risky financial market participation for China. Household savings and investments in financial markets influence a country’s or the world’s economic growth. Consequently, empirical studies on individuals’ financial market participation behavior, household financial asset allocation, and the determinants of individuals’ or households’ financial behavior have attracted worldwide attention. The set of factors that affects individuals’ participation in financial markets are as follows: individual attributes, such as age, education, and sex (Angrisani et al., 2018; Campbell, 2006; Cooper & Zhu, 2017; Ge et al., 2021; Grinblatt et al., 2011; Zhou et al., 2017; Zhou & Xiao, 2018), income factors, such as household income/wealth and ownership housing (Chen & Ji, 2017; Chetty et al., 2017; Cooper & Zhu, 2017; Ge et al. 2021), social capital (Brown et al., 2008; Fafchamps & Gubert, 2007; Ge et al., 2021; Hong et al., 2004), financial literacy (Balloch et al., 2015; Zou & Deng, 2019), risk preference (Charness, 2012; Arnold et al., 2022) or uncertainty aversion preference (Dimmock et al., 2016), and institutional factors (Cooper & Zhu, 2017). However, most of the previous studies have focused on developed countries, and the evidence for developing countries or emerging economies is scarce, where financial markets are not developed, and the awareness of participation in such markets is lower (Zhou et al., 2017).

Additionally, with the progress in information and communication technology (ICT) since the 1970s, Internet usage has expanded worldwide, both in developed and developing countries (OECD, 2018). According to the Statistical Report on the Development of the Internet in China No. 45 (CNNIC, 2020), the number of Internet users in China reached 989 million in June 2020; this included 680 million urban residents and 309 million rural residents, with an Internet penetration rate of 76.4% and 52.3%, respectively. China has become the country with the largest number of Internet users worldwide. Internet use is predicted to affect the consumption behavior of individuals or households, including investing in risky financial goods.

Does Internet use affect an individual’s risky participation in the market? Regarding the association between Internet use and risky market participation, it is argued that the Internet may reduce transaction and information search costs, which may lead to an increase in the probability of owning risky financial assets (Bogan, 2008; Liang & Guo, 2015). Bogan (2005) and Liang and Guo (2015) find that Internet use positively affects the
probability of participation in the stock market. In contrast, as there is a trade-off relationship of time between Internet use for work/study, investing in risky financial markets, and leisure (for example, entertainment), more Internet use for work/study or leisure may reduce investments in risky financial goods. Additionally, when an individual finds more negative information (for example, stock investment failure) from a website, the one may reduce investments in risky financial goods. As there are both positive and negative effects, the effects of Internet use on individuals’ participation in risky financial markets are unclear from a theoretical economics perspective; and thus, it should provide more empirical evidence on the issue. However, empirical studies on the effect of Internet use on risky financial market participation are scarce, especially for China that is a country with the most Internet user worldwide. To the best of our knowledge, only Liang and Guo (2015) have focused on this issue in China.

This study contributes to the literature as follows: First, the direct analysis on the Internet use on risky financial market participation is scare, and the previous study (e.g., Liang & Guo, 2015) did not investigate the effects of Internet use on the share of risky financial assets. It can be thought that the Internet use not only affect the probability of participation in risky financial markets (external margin effect) but also affect the volume of owning risky financial assets (internal margin effect). We also analysis the internal margin effect to take the robustness check. Second, we first investigate the channels of the impact of Internet use on risky financial market participation for China. Third, as the endogeneity problem has not been addressed in the literature for China, a measurement bias might exist in the results. We use three-wave national longitudinal survey data, the lagged variable (LV) model, and the fixed effects (FE) or random effects (RE) model to address both the reverse causality and individual heterogeneity issues (i.e., individual differences in personality, unobservable preference). Fourth, although Bimber (2000), DiMaggio et al. (2001), and Fatehkia et al. (2018) reported there are gaps concerning Internet (digital) access and usage among age and sex groups, differences in the effects of Internet use by these groups were not considered in previous studies. This study can fill this gap. In this study, we considered the heterogenous group and investigated the differences by sex and age, and education groups. Because the society and labor market in China are segmented by the population registration system (hukou) (Cai, 2016), we also compare the effect of Internet use between urban and rural hukou group. Fifth, the Chinese government has been promoting digital economy since 2015. As the previous study use data of 2011, it is not clear whether Internet use affects the current period. We use the current data of 2014, 2016, and 2018 to investigate the effects of Internet use, and the latest survey data in 2018 can provide new information on the issue. These results may provide further evidence on this issue. These results can provide rich evidence to understand individuals’ participation behavior in risky financial markets and discuss policies to develop the digital economy and security markets in China.

The empirical results indicate that Internet use has a significantly positive effect on participation in risky financial markets for China. The positive effect of Internet use is greater for the group aged 30–49 years, the middle and the highly educated group, urban hukou residents, and women as compared to their counterparts. Furthermore, the positive effect of Internet use on risky financial participation may be through three channels—increase in income, information obtaining, and reduction of transaction costs.

2. Literature Review

2.1 Channels of the Impact of Internet Use on Risky Financial Market Participation

Internet use can affect consumption (here, owning risky financial assets or risky financial assets’ volumes) through the following channels:

(i) Income increase channel: Internet use has been reported to affect employment (Atasoy, 2013; Alam & Mamun, 2017; Deyyling, 2017) and income (Krueger, 1993; Miller & Mulvey, 1997; Pabolonia & Zoghi, 2005), which are related to income Y or wealth Α. Therefore, it can be predicted that Internet use can affect an individual’s participation in risky financial markets through the income increase channel.

(ii) Reduced transaction and information costs channel: According to the transaction costs and information costs hypothesis, Internet use may reduce transaction costs or information costs owing to the availability of online stock trading and obtaining more information on risky financial goods (Bogan, 2008; Liang & Guo, 2015), which may promote participation in risky financial markets. On the contrary, negative information (e.g., failure in stock investment, fraud) on websites may reduce the probability of participation in risky financial markets. These factors are related to uncertainty, and risk aversion preference, which may affect an individual’s consumption behavior. Leland (1968) and Blanchard and Mankiw (1988) investigate the relationship between uncertainty and saving. Dimmock et al. (2016) find that uncertainty aversion (ambiguity aversion) is negatively associated with stock market participation in the United States. Cardak and Wilkins (2009) report that
uncertainty factors (labor income uncertainty and health risk) has significantly negative effects on risky asset holdings in Australia.

Both channels may influence uncertainty or risk-aversion preferences. As uncertainty or risk-aversion preferences differ by person, even under the same conditions of liquidity constraints and uncertainty, individual heterogeneity should be considered in the analyses.

Regarding empirical studies on the association between Internet use and participation in risky financial markets, Bogan (2008) finds that Internet/computer use substantially raises households’ stock market participation rates in the U.S. by reducing transaction costs. Using data from a German longitudinal household survey, Glaser and Klos (2013) find that Internet use positively affects households’ stock market participation, and the positive effects differ depending on financial literacy levels in Germany. Using data from the China Household Finance Survey 2011, and the ordinary least squares (OLS) method and a probit regression model, Liang and Guo (2015) investigate the substitution relationship between Internet use and social interaction and their effects on stock market participation, finding that the former positively affects the probability of participation in the stock market in China.

Other studies related to this issue have also been conducted. First, Grossman and Stiglitz (1980) indicate that information plays a key role in financial markets. As Internet use may reduce information costs (Bogan, 2008; Liang & Guo, 2018) and increase informational openness, it may reduce ambiguity aversion preference. Dimmock et al. (2016) find that ambiguity aversion negatively affects stock market participation.

Second, Balloch et al. (2015) and Zou and Deng (2019) report that financial literacy significantly affects participation in risky financial markets. As Internet use may increase the availability of financial knowledge to increase financial literacy, it is predicted that it may affect an individual’s risky financial market participation behavior.

Third, wealth and income positively affect participation in risky financial markets. For example, using data from the Survey of Household Finances and Attitudes of 2009, Wei et al. (2019) find that wealthy people tend to own high-yield assets, such as stocks, in China. Using data from the China Family Panel Studies (CFPS) of 2014-2018, Ge et al. (2021) report that wealth positively affects households’ participation in risky financial markets.

In sum, the empirical studies on the impact of Internet use on individuals’ risky financial market participation is scare for both developed and developing countries. Although Liang and Guo (2015) have analyzed this issue for China, they have not addressed endogeneity problems (e.g., reverse causality and individual heterogeneity problems); therefore, there may be bias in the results; the effects of Internet use on participation in risky financial markets have not been investigated, and they have not considered the differences of Internet use effect by age and sex group. This study fills these gaps in literature to elucidate the issue.

3. Empirical Study Methodology

3.1 Empirical Model

Regarding the empirical analysis, as the basic model, the logit regression model has been utilized to investigate the probability of holding risky financial assets, and the Tobit regression model has been used to analyze the share of risky financial assets, which is expressed in Equation (1):

$$ RFP_i = a + \beta INT_i + \gamma X_i + \varepsilon_i $$  \hspace{1cm} (1)

where RFP is the dependent variable of risky financial market participation (the probability of owning risky financial assets or the share of risky financial assets); \( i \) represents the individual; INT represents Internet use; \( X \) represents factors (i.e., demographics, income, social capital, financial literacy, etc.) that affect an individual’s risky financial market participation; \( \beta \) and \( \gamma \) are the estimated coefficients; and \( \varepsilon \) is a random error item.

There still exists the endogeneity problem in Equation (5). Two methods were used to address this problem. First, as \( \varepsilon_i \) includes individual-specific and time-invariant factors (\( v_i \)) and idiosyncratic error (\( u_i \)), the individual heterogeneity problem may occur in the estimated results when \( v_i \) is maintained. We use the FE or RE model to address this problem, which is expressed in Equation (2):

$$ RFP_{it} = a + \beta INT_{it} + \gamma X_{it} + v_i + u_{it} $$  \hspace{1cm} (2)

Second, regarding the reverse causality problem (for example, participation in risky financial markets may obtain capital gains, which may increase the incentives to use the Internet), the lagged items of the Internet use variables were used to address the problem through the lagged variable (LV) model. For example, Internet use in the previous survey year (for example, Internet use in 2014 or Internet use in 2016) was used to investigate its
influence on risky financial market participation in the current survey year (e.g., the probability of holding risky financial assets in 2018 or the share of risky financial assets in 2016). The LV model can be expressed as follows:

$$RFP_{it} = a + \beta INT_{it-n} + \gamma X_{it} + \epsilon_{it},$$

where the subscript $t-n$ indicates the lagged time variable.

Considering that the effects of Internet use may differ by group, we perform the analyses using the interaction of Internet use and different group dummy variables, as expressed by Equation (4).

$$RFP_{it} = a + \beta INT_{it-n} + \beta G_j \sum_j^K Group_{ij} + \beta G_j \sum_j^K Group_{ij} + \beta INTG_j \sum_j^K Group_{ij} \times INT_{it-n} + \epsilon_{it},$$

where $\sum_j^K Group_j$ represents group $j$, $\sum_j^K Group_j \times INT_{it-n}$ is the interaction of Internet use in the prior survey year (i.e., $t-1$) and different groups, and when the coefficients ($\beta_{INTG_j}$) are statistically significant, it is shown that there are differences in Internet use effects among different groups (for example, younger generation vs. older generation; low education vs. high education).

Lastly, we used the mediation model advocated by Baron and Kenny (1986) to investigate the channels of the influence of Internet use on participation in risky financial markets. The LV$_t$-1 model is used to address the endogeneity problem, which is expressed in Equations (5)-(7):

$$RFP_{it} = a + \beta INT_{it-1} + \gamma X_{it} + \epsilon_{it},$$

$$Me_{it} = a' + \beta' INT_{it-1} + \gamma' X_{it} + \epsilon_{it},$$

$$RFP_{it} = a'' + \beta'' INT_{it-1} + \gamma'' X_{it} + \phi Me_{it} + \epsilon_{it}''. $$

where $Me$ is a mediator variable. When $\beta''$ is statistically significant, as well as $\beta''$ changes (for example, become smaller or non-significant) compared with $\beta$, it indicates that Internet usage affects participation in risky financial markets through the mediator $Me$.

### 3.2 Data and Variables

We used three-wave longitudinal data (2014, 2016, and 2018) from the China Family Panel Studies (CFPS). The CFPS has been a national longitudinal survey project conducted by the Beijing University since 2010. The CFPS collects data at individual, family, and community levels. The baseline national survey was officially launched in 25 provinces/municipalities/autonomous regions, and it successfully interviewed members of 14,960 households, of which 33,600 adults and 8,990 youths were interviewed in the first wave.

The CFPS has five waves from 2010 to 2018, and we used recent three-wave longitudinal survey data (2014, 2016, and 2018) because only these three waves have questionnaire items on Internet use. The samples of CFPS are 37,147 (2014), 36,892 (2016), and 37,354 (2018). We selected samples aged 16 years and over and excluded the missing values. The total number of samples used in the analysis was 37,628 including 15,283 Internet users and 22,344 non-Internet users.

The dependent variable for the probability function of holding risky financial assets is a binary variable equal to one, when an individual owns risky financial assets, including stocks, bonds, and others. In the Tobit regression model, the dependent variable is the share of risky financial assets, that is, the proportion of risky financial assets to total financial assets. Total financial assets comprise risky and non-risky financial assets (i.e., savings and cash). We use total household values and the number of family members to calculate the per capita risky financial assets. When the volume of risky financial assets is greater than zero, the individual is in a household that owns risky financial assets.

The key independent variables were the binary variables of Internet use (1= used the Internet in the survey year, while 0 = did not use the Internet in the survey year). We also constructed a score of frequency of Internet use for work, study, communication with others, and business to conduct robustness checks (Note 1).

We consider the set of control variables used in previous studies as follows.

First, numerous studies (e.g., Campbell, 2006; Cooper & Zhu, 2017; Angrisani et al., 2018) have found that demographic factors (i.e., education, age, health) affect risky financial market participation and we constructed the variables of age, squared age, sex (1= female, 0= male), ethnicity (1= Han majority, 0= ethnic minorities), years of education, health status (1= excellent, good health, 0= otherwise), and number of family members as demographic factors. Regarding the special features in China, we also added party membership (1= Communist
Party of China member, 0=non-CPC member) and hukou (1=urban, 0=rural) dummy variables.

Second, Chen and Ji (2017), Wei et al. (2019), and Ge et al. (2021) report that income or wealth positively affects risky household financial market participation in China. We constructed two types of variables as indices of the income factors. They are: (i) per capita household income and its square, and (ii) owning a housing dummy variable.

Third, Guiso et al. (2004, 2008) and Liang and Guo (2015) find that social networks and trust affect risky financial market participation; thus, based on the CFPS questionnaire, we added three variables in the analysis: monthly communication expense, monthly expense of sending gifts to others monthly (Note 2), and trust strangers (Note 3). It is predicted that an individual with higher expenses for communication and financial support to others and trusting strangers is the one with higher social capital, which may affect the allocation of financial portfolios.

Fourth, Balloch et al. (2015) and Zou and Deng (2019) show that financial literacy positively affects an individual’s or a household’s allocation of financial assets. Based on the question of “In your opinion, your financial knowledge is, compared to the people of your age: 1. Greatly higher than the average level; 2. Slightly higher than the average level; 3. About average level; 4. Slightly lower than the average level; 5. Greatly lower than the average level; and 6. Don’t know”, we constructed the dummy variable of financial literary as “1= when choice options of 1, 2 or 3, 0=otherwise).

Fifth, regional dummy variables (east, central, and west) were constructed to control for the influence of regional disparities in the financial market. Year dummy variables were used to control for the influence of the business cycle and changes in the macroeconomic environment by period.

Sixth, considering the influence of individual heterogeneity, such as differences in risk aversion preference on financial market participation behavior (Charness, 2012; Arnold et al., 2022), we added the money value (Note 4) and time discount preference (Note 5) variables to take robustness checks.

Seventh, Angrisani et al. (2018), Bai et al. (2021), and Ma (2022) find that social insurance affects individuals or households’ participation in risky financial markets we added the enrolment in pension (Note 6) and medical insurances (Note 7) to take the robustness checks.

Appendix Table A1 summarizes the descriptive statistics of the total sample, the group with risky financial assets, and the non-ownership group. Differences remained in the mean values of the variables between the two groups. Thus, these variables should be considered in the empirical analysis. When we do not control for other factors, the shares of risky financial assets are higher for the Internet user group than for the non-user group.

4. Results

4.1 Basic Results

We first applied the analyses using the Logit regression model and different variables, and the results are summarized in Appendix Tables A2 and A3. The results show that in Table A2, with the addition of variables, the magnitude of the coefficient Internet use decreased from 1.349 (Model 1) to 0.953 (Model 3), but they are all statistically significant at the 1% level, and the value of Pseudo R2 is highest in Model 3 (0.329); in Table A3, with the addition of variables, the magnitude of the coefficient Internet use decreased from 0.567 (Model 1) to 0.350 (Model 3), but they are all statistically significant at the 1% level, and the value of Pseudo R2 is highest in Model 3 (0.359). The results suggest that Model 3, including the whole dependent variables, is appropriate. Therefore, we applied the following analyses using variables similar to those in Model 3.

Table 1 reports the results of the association between Internet use and the probability of owning risky financial assets, using six models based on the logit regression model. Model 1 is analyses based on cross-sectional data, while Models 2–4 are based on longitudinal data. The coefficients of Internet use were significant at 1% levels in Models 1–4. The results indicate that after addressing the endogeneity problems in Models 2–4, there is a significant positive relationship between Internet use and the probability of owning risky financial assets (see Models 2–4). These results are consistent with those of previous studies (Bogan, 2008; Glaser & Klos, 2013; Liang & Guo, 2015).
Table 1. Summary of results of Internet use and probability of owning risky financial assets

<table>
<thead>
<tr>
<th></th>
<th>(1) Logit</th>
<th>(2) RE</th>
<th>(3) LV_t-1</th>
<th>(4) LV_t-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet use</td>
<td>0.953***</td>
<td>1.281***</td>
<td>0.769***</td>
<td>1.152***</td>
</tr>
<tr>
<td></td>
<td>11.63</td>
<td>9.22</td>
<td>9.32</td>
<td>9.40</td>
</tr>
<tr>
<td>Demographic variable</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Income</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Social capital</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Financial literacy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observation</td>
<td>37,628</td>
<td>37,628</td>
<td>29,264</td>
<td>14,022</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-4629.547</td>
<td>-4309.152</td>
<td>-4188.397</td>
<td>-1938.346</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>0.329</td>
<td>0.320</td>
<td>0.313</td>
<td></td>
</tr>
<tr>
<td>BP test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chibar2(01)</td>
<td>2361.800</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prob&gt;chibar2</td>
<td>0.000</td>
<td></td>
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<tr>
<td>LR test</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>chibar2(01)</td>
<td>640.79</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prob&gt;chibar2</td>
<td>0.000</td>
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</tr>
</tbody>
</table>

Note. *** p<0.01, ** p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The demographic variables including age, squared age, years of education, sex, ethnicity (han), party membership, urban hukou, health status, and number of family members, income variables including household income, owning housing, social capital variables including communication expense monthly, gift expense monthly, and trust strangers, financial literacy, and region dummy variables including east, central and west regions were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time; LV_t-2: using lagged Internet use variable at t-2 time.

Table 2 displays the results of the association between Internet use and the share of risky financial assets using the six models based on the Tobit regression model. The coefficients of Internet use were significant at 1% levels in Models 1–4. The results indicate that, after addressing the endogeneity problems in Models 2–4, there is a significant positive causal relationship between Internet use and the share of risky financial assets. These are the new findings regarding this issue.

Table 2. Summary of results of Internet use and share of risky financial assets

<table>
<thead>
<tr>
<th></th>
<th>(1) Tobit</th>
<th>(2) RE</th>
<th>(3) LV_t-1</th>
<th>(4) LV_t-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet use</td>
<td>0.350***</td>
<td>0.016***</td>
<td>0.297***</td>
<td>0.432***</td>
</tr>
<tr>
<td></td>
<td>11.18</td>
<td>9.70</td>
<td>9.59</td>
<td>9.34</td>
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<tr>
<td>Demographic variable</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Income</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Social capital</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Financial literacy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Region</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observation</td>
<td>37,628</td>
<td>37,628</td>
<td>29,264</td>
<td>14,022</td>
</tr>
<tr>
<td>Uncensored</td>
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<td>Left-censored</td>
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<td>Group</td>
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<td>18,696</td>
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</tr>
<tr>
<td>Log likelihood</td>
<td>-4629.547</td>
<td>-4309.152</td>
<td>-4343.030</td>
<td>-1968.463</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>0.329</td>
<td>0.304</td>
<td>0.313</td>
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<tr>
<td>BP test</td>
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<tr>
<td>chibar2(01)</td>
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<tr>
<td>Prob&gt;chibar2</td>
<td>0.000</td>
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</tbody>
</table>

Note. * p<0.01, ** p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The demographic variables including age, squared age, years of education, sex, ethnicity (han), party membership, urban hukou, health status, and number of family members, income variables including household income, owning housing, social capital variables including communication expense monthly, gift expense monthly, and trust strangers, financial literacy, and region dummy variables including east, central and west regions were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time; LV_t-2: using lagged Internet use variable at t-2 time.
The results in Tables 1 and 2 suggest that the positive effects (e.g., reduction of transaction costs, obtaining more information, and learning more financial knowledge) of Internet use on the allocation of risky financial assets may be greater than the negative effects (e.g., reduction of time use on participation in financial markets, and negative information on stock market failure).

4.2 Robustness Checks

We use five methods to perform robustness checks. First, we changed the definition of Internet use by using the frequency of Internet use for work, study, business, and communication in three models (logit, FE, and LV_t-1), and the results are similar to those in Tables 1 and 2.

Second, regarding the influence of time preference, we added the time preference variable and reran the analyses. The results show that Internet use positively affects both the probability of owning risky financial assets and their volume, which are similar to those in Tables 1 and 2.

Third, we added the money value variable to rerun the analyses; all coefficients of Internet use were statistically significant at the 1% level, which is similar to those in Tables 1 and 2.

Fourth, we added the public pension and medical insurance enrolment dummy variables to rerun the analyses; all coefficients of Internet use are statistically significant at the 1% level.

Fifth, as in the public sector (e.g., government organization, state-owned enterprises), the mandatory retirement age is 60 years for male cadres and workers, 55 years for female cadres, and 50 years for female workers. We used the samples aged 16–50 to reduce the influence of mandatory retirement. The results suggest that Internet use positively and significantly affects participation in risky financial markets.

The results confirmed the results in Tables 1 and 2, and the conclusion that Internet use may promote participation in risky financial markets is robust.

Table 3. Summary of results of robustness checks

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<tr>
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<td>10.73</td>
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<td>RE</td>
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</tr>
<tr>
<td>Logit/Tobit</td>
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</tr>
<tr>
<td>RE</td>
<td>1.203</td>
<td>***</td>
<td>6.91</td>
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<tr>
<td>LV_t-1</td>
<td>0.594</td>
<td>***</td>
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Note. ** p<0.01, * p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The demographic variables including age, squared age, years of education, sex, ethnicity (han), party membership, urban hukou, health status, and number of family members, income variables including household income, owning housing, social capital variables including communication expense monthly, gift expense monthly, and trust strangers, financial literary, and region dummy variables including east, central and west regions were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time.
4.3 Considering Heterogeneous Groups

There may be differences in the effects of Internet use among different groups. We applied the estimations using the interaction between Internet use and different group dummy variables. We use two models (RE and LV_t-1) to address endogeneity problems. The results are presented in Tables 4 (by age), 5 (by education), 6 (by urban and rural hukou), and 7 (by gender).

Table 4. Summary of results of Internet use and probability of risky financial assets by age group

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<td></td>
<td>RE</td>
<td>LV_t-1</td>
<td>RE</td>
<td>LV_t-1</td>
</tr>
<tr>
<td>Internet</td>
<td>1.296 ***</td>
<td>0.544 ***</td>
<td>-0.011 *</td>
<td>0.207 ***</td>
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<tr>
<td></td>
<td>5.36</td>
<td>6.17</td>
<td>-1.78</td>
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<td>Age (Ref. Age 60+)</td>
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<tr>
<td>Age 16-29</td>
<td>-2.479 ***</td>
<td>-2.697 ***</td>
<td>-0.001</td>
<td>-0.912 ***</td>
</tr>
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<td></td>
<td>-2.68</td>
<td>-2.66</td>
<td>-0.13</td>
<td>-3.16</td>
</tr>
<tr>
<td>Age 30-49</td>
<td>-1.038 ***</td>
<td>-1.184 ***</td>
<td>0.006</td>
<td>-0.392 ***</td>
</tr>
<tr>
<td></td>
<td>-4.13</td>
<td>-6.39</td>
<td>1.16</td>
<td>-6.62</td>
</tr>
<tr>
<td>Age50-59</td>
<td>-0.327</td>
<td>-0.457 ***</td>
<td>0.003</td>
<td>-0.198 ***</td>
</tr>
<tr>
<td></td>
<td>-1.61</td>
<td>-3.69</td>
<td>0.95</td>
<td>-4.49</td>
</tr>
<tr>
<td>Internet × Age 16-29</td>
<td>0.311</td>
<td>1.605</td>
<td>0.009</td>
<td>0.486 ***</td>
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<td>0.33</td>
<td>1.59</td>
<td>1.23</td>
<td>1.70</td>
</tr>
<tr>
<td>Internet × Age 30-49</td>
<td>0.002</td>
<td>0.819 ***</td>
<td>0.013 **</td>
<td>0.247 *</td>
</tr>
<tr>
<td></td>
<td>0.01</td>
<td>4.42</td>
<td>2.00</td>
<td>4.18</td>
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<tr>
<td>Internet × Age50-59</td>
<td>-0.297</td>
<td>0.471 ***</td>
<td>0.012 *</td>
<td>0.200 ***</td>
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<tr>
<td></td>
<td>-0.96</td>
<td>3.34</td>
<td>1.74</td>
<td>3.88</td>
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<td>Control variables</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</table>

Note. *** p<0.01, ** p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The control variables including demographic variables (years of education, sex, ethnicity, party membership, urban hukou, health status, and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literary, and region dummy variables (east, central and west regions) were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time.

Table 5. Summary of results of Internet use and probability of risky financial assets by education group

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<td>RE</td>
<td>LV_t-1</td>
<td>RE</td>
<td>LV_t-1</td>
</tr>
<tr>
<td>Internet</td>
<td>0.783 ***</td>
<td>0.575 ***</td>
<td>0.004 *</td>
<td>0.221 ***</td>
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<td>2.97</td>
<td>6.46</td>
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<td>6.69</td>
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<td>Education (Ref. Low)</td>
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<td>Middle</td>
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<td>0.309 ***</td>
<td>0.003</td>
<td>0.093 **</td>
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<td>3.26</td>
<td>2.67</td>
<td>1.52</td>
<td>2.33</td>
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<td>High</td>
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<td>-0.213</td>
<td>0.001</td>
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<td>-0.60</td>
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<td>0.27</td>
<td>-0.84</td>
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<tr>
<td>Internet × Middle</td>
<td>0.614</td>
<td>0.705 ***</td>
<td>0.010 ***</td>
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<td>2.09</td>
<td>6.44</td>
<td>3.73</td>
<td>6.98</td>
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<tr>
<td>Internet × High</td>
<td>2.502 ***</td>
<td>1.811 ***</td>
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<td>5.69</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</table>

Note. *** p<0.01, ** p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The control variables including demographic variables (age, squared age, sex, ethnicity, party membership, urban hukou, health status, and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literary, and region dummy variables (east, central and west regions) were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time.
Table 6. Summary of results of Internet use and probability of risky financial assets by *hukou*

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<td>R</td>
<td>LV_t-1</td>
<td>RE</td>
<td>LV_t-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>1.235 ***</td>
<td>0.565 ***</td>
<td>0.003 *</td>
<td>0.220 ***</td>
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<td>1.64</td>
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<td>Urban</td>
<td>1.508 ***</td>
<td>0.785 ***</td>
<td>0.002</td>
<td>0.237 ***</td>
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<td></td>
<td>7.20</td>
<td>6.98</td>
<td>0.84</td>
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<tr>
<td>Internet × Urban</td>
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<td>0.024 ***</td>
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Note. *** p<0.01, ** p<0.05, * p<0.1. BP test: Breusch and Pagan Lagrangian multiplier test. The control variables including demographic variables (age, squared age, years of education, sex, ethnicity, party membership, health status, and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literacy, and region dummy variables (east, central and west regions) were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time.

Table 7. Summary of results of Internet use and probability of risky financial assets by gender

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<td>RE</td>
<td>LV_t-1</td>
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<tr>
<td>Internet</td>
<td>1.532 ***</td>
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<td>0.014 ***</td>
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<td></td>
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<td>Internet × female</td>
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Note. *** p<0.01, ** p<0.05. BP test: Breusch and Pagan Lagrangian multiplier test. The control variables including demographic variables (age, squared age, years of education, ethnicity, party membership, health status, urban *hukou* and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literacy, and region dummy variables (east, central and west regions) were estimated, but the results are not presented in this table. These results are available upon request. RE: random effects model; LV_t-1: using lagged Internet use variable at t-1 time.

First, regarding the Internet use effect by age group (see Table 4), it was shown that the effect differs by age. To compare the older generation group (the group aged 60 and over), the coefficients of Internet use and age group dummy are positive values and significant at the 1–10% level, which suggests the positive effect of Internet use on participation in risky financial markets is significant for younger and middle generations than for older generations.

Comparing the magnitude and significance of the coefficients, the results indicate that the positive effect of Internet use is largest for the group aged 30–49. In China, the first email was sent out in 1987 (Lu & Wang, 2020), and the group aged 30–49 years is the generation who learned Internet knowledge in early childhood or teenage period, and the working group in the labor market that may have higher incomes, more financial knowledge, and more interest in participating in risky financial markets.

Additionally, for both probabilities of owning risky financial assets and their volume, the coefficients of Internet and age group dummy variables are almost non-significant in the results of the RE model, while most of them are statistically significant at the 1–10% level in the LV model, which suggests that individual heterogeneity may affect the differences of Internet use effect among age groups greatly.

Second, considering the heterogeneous effects by education group, the results in Table 5 show that Internet use positively affects risky financial market participation (both probability and volume). Compared to the low education group (primary school and less), the positive effects of Internet use are greater for the middle education (junior and senior high school) and high-education (college and university and above) groups; it is the
greatest for the high-education group. It is shown that the Internet use effect differs by education group, and it increases as the years of education increase.

The results can be explained as follows: the Internet use skills may be higher for the highly educated group, which causes a higher efficiency of Internet use for the group. Because there is not information on the Internet use skill in the questionnaire items of the CFPS, we could not take detailed analysis on the issue that should be considered in the future research.

Third, the results in Table 6 show that Internet use effect differs by urban and rural hukou groups: to compare to rural hukou group, the positive effects of Internet use are greater for the urban hukou group, it is the greatest for the high-education group.

One reason for this may be that the development of Internet facilities in rural areas has lagged behind that in urban areas (CNNIC, 2020). Additionally, as there is a large education gap between urban and rural residents (Zhang, 2017). Therefore, Internet use skills are higher for urban residents than for rural residents, which leads to a difference in the Internet use effects between these two groups.

Finally, regarding the difference by gender, most results in Table 7 show that the positive effects of Internet use are greater for women than for men.

The reasons for this are as follows. It is argued that the gender digital gap in Internet access arose in developed countries in the early stages of ICT development (Bimber, 2000; DiMaggio et al., 2001; Fatehkia et al., 2018). It has been argued that women in developing countries have significantly lower Internet access than men (Alozie & Akpan-Obong, 2017; OECD, 2018). In China, the proportion of Internet user was also smaller for women then men in 2020 (CNNIC, 2020). This suggests that there still exists a gender gap in Internet use in the current period. Therefore, there may be a sorting effect: women using the Internet may have higher skills that may increase the efficiency of Internet use in participation in risky financial markets.

4.4 Channels of Internet Use Effects on Participation in Risky Financial Markets

We investigated three channels of the Internet use effect on participation in risky financial markets based on the mediation model: (i) income increase channel; (ii) information obtaining channel; and (iii) reduction of transaction cost channel. The results are summarized in Tables 8–10.

First, for the income increase channel (Table 8), the results in Models 1 and 2 show that Internet use significantly increases non-financial assets (the total amount of cash and savings), and to compare the magnitude of the coefficients of Internet use in Models 2 and 4, they become smaller in Models 3 and 6. This suggests that the influence of Internet use on participation in risky financial markets is partly through the channel through which Internet use may increase the amount of cash and savings, which can reduce liquidity constraints when investing in risky financial goods.

Second, in terms of information channels (Table 9), we use the variable of importance of communication as an information obtaining indicator, and it is predicted that when an individual thinks that Internet use is an important method to communicate with others, he or she will pay attention to obtaining information using the Internet. The results in Models 1 and 2 show that Internet use significantly increases the importance of communication, and to compare the magnitude of the coefficients of Internet use in Models 2 and 4, they become smaller in Models 3 and 6, which suggests that the influence of Internet use on participation in risky financial markets is partly through the channel that an individual may obtain more information from others by using the Internet communication function. This may reduce the information cost when participating in risky financial markets (Note 8).

Third, according to the learning-by-doing hypothesis, it is predicted that as the Internet-use skill will increase with the years of use, the transaction cost (e.g., the availability of online stock trading and the convenience of Internet use will increase) will decline year by year; therefore, the positive effect of Internet use will be greater for early Internet users. We used the LV\_t-1 and LV\_t-2 models to investigate the channel and report the results in Table 10. The results indicate that the magnitude of the coefficients of Internet use is greater in the LV\_t-2 model than in the LV\_t-1 model, and they are all significant. This suggests that early Internet users whose transaction costs have declined greatly are much more likely to participate in risky financial markets and have a greater share of risky financial assets.
Table 8. Channels of effects of Internet use on risky financial market participation: income

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<td>Internet_t-1</td>
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<td>0.912</td>
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<td>0.743</td>
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<td>12.08</td>
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<td>11.64</td>
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<td>8.49</td>
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</tr>
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<td>income</td>
<td>0.512</td>
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<td>14.79</td>
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</table>

Note. *** p<0.01, ** p<0.05. LV_t-1 model was used. In model 1 and Model 4, the control variables include age, squared age, years of education, ethnicity, party membership, health status, urban hukou, region and year dummy variables; In Models 2-3, and Models 5-6, the control variables include the demographic variables (age, squared age, years of education, ethnicity, party membership, health status, urban hukou and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literary, and region dummy variables (east, central and west regions). These variables were estimated, but the results are not presented in this table. These results are available upon request.

Table 9. Channels of effects of Internet use on risky financial market participation: information

<table>
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<td>Internet_t-1</td>
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<td>***</td>
<td>0.912</td>
<td>***</td>
<td>0.876</td>
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<tr>
<td></td>
<td>42.56</td>
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<td>Communication</td>
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<td></td>
<td>0.023</td>
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</table>

Note. *** p<0.01, ** p<0.05. LV_t-1 model was used. In model 1 and Model 4, the control variables include age, squared age, years of education, ethnicity, party membership, health status, urban hukou, region and year dummy variables; In Models 2-3, and Models 5-6, the control variables include the demographic variables (age, squared age, years of education, ethnicity, party membership, health status, urban hukou and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literary, and region dummy variables (east, central and west regions). These variables were estimated, but the results are not presented in this table. These results are available upon request.

Table 10. Channels of effects of Internet use on risky financial market participation: transaction cost

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<td>Internet_t-1</td>
<td>0.912</td>
<td>***</td>
<td>0.363</td>
<td>***</td>
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<td></td>
<td>11.46</td>
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<td>11.63</td>
<td></td>
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<td>Internet_t-2</td>
<td>1.269</td>
<td>***</td>
<td>0.494</td>
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<td></td>
<td>10.92</td>
<td></td>
<td>10.65</td>
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</tbody>
</table>

Note. *** p<0.01, ** p<0.05. LV_t-1 and LV_t-2 models were used. The control variables include the demographic variables (age, squared age, years of education, ethnicity, party membership, health status, urban hukou and number of family members), income variables (household income, owning housing), social capital variables (communication expense monthly, gift expense monthly, and trust strangers), financial literary, and region dummy variables (east, central and west regions). These variables were estimated, but the results are not presented in this table. These results are available upon request.

5. Conclusions

Using three-wave longitudinal data from the CFPS and panel data analysis methods (e.g., RE, LV) to address the endogeneity problem, this study investigated the causal association between Internet use and participation in risky financial markets in China for the first time.

Three main findings emerged. First, after addressing the endogeneity problem, Internet use has a significantly positive effect on participation in risky financial markets (both ownership and volume). Robustness checks confirm these conclusions. Second, the effects of Internet use on participation in risky financial markets differ by group. The positive effect of Internet use is greater for the group aged 30–49 years, the middle- and highly-educated group, urban hukou residents, and women than their counterparts. Third, the positive effect of
Internet use may be through three channels (the income increase channel, the information obtaining channel, and the reduction of transaction costs channel).

The policy implications of these results are as follows. First, the results show that Internet use can significantly promote participation in risky financial markets. It is argued that in China, the government has implemented strict regulations for the security market, which may hinder further development of the security market. It is expected that the policies for developing the digital economy may promote the development of the security market, which may improve investments in venture corporations and accelerate economic growth. Second, we found that positive Internet use is smaller in the disadvantaged group (e.g., the older generation, low-education group, and rural *hukou* group) than its counterparts, which suggests that with the development of the digital economy, the issue of the digital division between groups has occurred in China. To reduce the digital disparities among groups, policies for public education or training to rise the skill of Internet usage targeting the low-educated group and rural *hukou* residents, as well as the policy to develop the digital economy in rural areas, should be considered by the Chinese government.

**Acknowledgments**

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**References**


Lu, H., & Kandilov, I. T. (2021). Does mobile Internet use affect the subjective well-being of older Chinese


Notes

Note 1. Based on the fours questions of: “frequency of using Internet to study”, “frequency of using Internet to work”, “frequency of using Internet to socialize”, and “frequency of using Internet to do commercial related activities”, we calculated the score of each question as “7=Everyday, 6=3–4 times per week, 5=1–2 times per week, 4=2–3 times per month, 3= Once per month, 2=Once per a few months, 1=Never” and calculated the total score of four questions as the score of frequency of Internet for business.

Note 2. Based on the question of “How much money on average does your family spend on communication (including land-line phone, mobile phone, the Internet, post, and so on) per month?”, “In the past 12 months, how much financial support did your family give to other people (e.g., friends, colleagues; excluding charitable donations)” and number of family members, we calculated the per capita of amount of expenses on communication or gift.

Note 3. Based on the question of “How much do you trust people you meet for the first time?”, we constructed
the score of trust stranger ranged from 0 (distrust) to 10 (trustworthy).

Note 4. Based on the question of “Spending money makes me more satisfied than saving money: 1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable 4. Somewhat applicable 5. Totally applicable 9. Don’t know”, we constructed the dummy variable of money value as “1= when choice the options of 3, 4 or 5, 0=otherwise”.

Note 5. Based on the question of “I intend to live in the present more and do not consider the future: 1. Totally inapplicable 2. Somewhat inapplicable 3. Generally applicable 4. Somewhat applicable 5. Totally applicable 9. Don’t know”, we constructed the dummy variables of time discount preference as “1= when choice the options of 3, 4 or 5, 0=otherwise”.

Note 6. Based on the question of “Have you enrolled in one or more of the following pension programs?”, we constructed the dummy variable of enrollment in pension insurances as “1= when choice the option items of 1. Retirement pension; 2. Basic Pension Insurance; 3. Supplemental Pension Insurance of the Firm; 4. Commercial Pension Insurance; 5. Rural Pension Insurance; 6. New Rural Pension Insurance (the new one); 7. Urban Resident Pension Insurance; and 8. Other pensions, 0=otherwise.”

Note 7. “What medical insurance do you have?”, we constructed the dummy variable of enrollment of medical insurances as “1= when choice the either one of 1. Public medical care; 2. Urban employee basic medical insurance; 3. urban resident basic medical insurance (including insurance for the elderly and children); 4. supplementary medical insurance; or 5. new rural cooperative medical insurance scheme, 0=otherwise”.

Note 8. It also can be predicted that an individual may obtain financial information by using the Internet, but we could not construct an appropriate indicator to test the channel. The appropriate survey data should be used to test the information channel furthermore in the future research.

Appendix A

Table A1. Descriptive statistics of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (a)</th>
<th>Internet user (b)</th>
<th>Non-user (c)</th>
<th>t-test (b) vs. (c)</th>
<th>p-value</th>
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<td>Owning risky financial assets</td>
<td>0.045</td>
<td>0.087</td>
<td>0.016</td>
<td>0.071 ***</td>
<td>0.000</td>
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<tr>
<td>Share of risky financial assets</td>
<td>0.020</td>
<td>0.039</td>
<td>0.006</td>
<td>0.033 ***</td>
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<td>Age</td>
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<td>53.832</td>
<td>16.784 ***</td>
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<td>Years of education</td>
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<td>10.410</td>
<td>5.378</td>
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<tr>
<td>Female</td>
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<td>0.492</td>
<td>0.526</td>
<td>-0.034 ***</td>
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<tr>
<td>Married</td>
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<td>0.794</td>
<td>0.977</td>
<td>-0.183 ***</td>
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<tr>
<td>Urban</td>
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<td>0.523</td>
<td>0.284</td>
<td>0.239 ***</td>
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<tr>
<td>Han</td>
<td>0.966</td>
<td>0.946</td>
<td>0.980</td>
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<td>Party</td>
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<td>0.047</td>
<td>0.014 ***</td>
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<td>Health</td>
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<td>0.358</td>
<td>0.265</td>
<td>0.093 ***</td>
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<td>Number of family members</td>
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<td>4.390</td>
<td>4.409</td>
<td>-0.019 **</td>
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<td>Household income</td>
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Table A2. Internet use and probability of owning risky financial assets

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<td>Healthy</td>
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<td>Communication expense</td>
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<td>Gift expense</td>
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Note. *** p<0.01, ** p<0.05, * p<0.1. Logit regression model was used.

Table A3. Internet use and share of risky financial assets

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<td>CPC member</td>
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<td>Communication expense</td>
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</tr>
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<td>y2018</td>
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<td>37,628</td>
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<td>Pseudo R²</td>
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</tbody>
</table>

Note. *** p<0.01, ** p<0.05, * p<0.1. Tobit regression model was used.

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