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## Financial literacy and fintech adoption in Japan

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**ADB Working Paper Series**

**FINANCIAL LITERACY AND FINTECH  
ADOPTION IN JAPAN**

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and Trinh Q. Long

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**Abstract**

Rapid developments in financial technology (fintech) are expected to contribute to improvements in financial inclusion and well-being. This paper investigates how financial literacy and other factors contributed to the adoption of fintech services in Japan, using data from a survey conducted by the Bank of Japan, including 25,000 individuals aged from 18 to 79. We constructed a financial literacy index from 25 questions relating to financial decision-making skills and financial knowledge. We then analyzed the relationship of this index with the extensive and intensive usage of two types of fintech services—electronic money, and mobile payment apps—and holdings of crypto assets, a type of fintech product. We find that higher financial literacy is positively associated with a higher likelihood of using fintech services but negatively correlated with holding crypto assets. The empirical results also suggest that those with greater financial literacy tend to use fintech services, especially electronic money, more frequently. We also find that the use of fintech services differs for people with different behavioral traits and that greater financial literacy could encourage risk-averse persons to adopt fintech.

**Keywords:** financial literacy, financial behavior, financial inclusion, household saving, fintech, crypto assets, Japan

**JEL Classification:** D14, G11, J26

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# 1. INTRODUCTION

In recent decades, the progress of financial technology (fintech) has helped consumers to access financial markets and services much more easily than before. The number of financial products offered has increased, and, at the same time, such products have become more complex. This requires consumers to have adequate knowledge and ability to make financial decisions, especially in the context where they are increasingly expected to make their own financial decisions regarding retirement and other major financial activities (Vlaev and Chater 2007). This suggests that an adequate level of financial literacy is essential.

Rapid developments in financial technology (fintech) highlight the need to improve financial literacy in order to use innovative financial products and services. With the development of information and communication technology (ICT), there has been a growing breed of fintech companies that provides services through internet- and mobile-based platforms, including Uber, Grab, and Airbnb. Recent literature has shown that fintech services (especially mobile money) have helped to increase financial inclusion in developing economies where the traditional bank-based financial system is underdeveloped (Suri 2017). Other studies have identified factors that affect the adoption of mobile- and internet-based financial services (Jack, Ray, and Suri 2013; Afawubo et al. 2020). However, we are not aware of any papers that investigate the role of financial literacy in the adoption of fintech products, either in developed or in developing countries.

This study examines the effects of financial literacy on the adoption of fintech in Japan, using data from a survey conducted by the Bank of Japan, involving 25,000 individuals aged from 18 to 79. We constructed a financial literacy index from 25 questions related to financial decision-making skills and financial knowledge, which comprises knowledge of basic financial transactions, basic economic and financial concepts, credit/loans, insurance and wealth building. We then analyzed the relationship between this index and the extensive and intensive usage of two types of fintech services—electronic money and mobile payment apps—and holdings of crypto assets, a type of fintech product.<sup>1</sup> We also investigated how herd behavior and risk aversion may affect the adoption of fintech and how financial literacy could alter the relationship between these behavioral traits and fintech adoption.

We find that higher financial literacy is positively associated with a higher likelihood of using fintech services but negatively correlated with holdings of crypto assets. We also find that the adoption of fintech services differs for people with different behavioral traits. The results that financial literacy plays a moderating role in the relationship between behavioral traits and fintech adoption.

The paper extends the literature in several ways. First, it examines the impact of financial literacy on fintech adoption in a developed country. The previous literature usually viewed fintech as an alternative for accessing financial markets. Thus, most earlier studies focused on how the adoption of fintech could help to reduce frictions in financial markets in developing countries. In developed countries, some studies have examined the factors that caused the take-up of fintech services such as peer-to-peer (P2P) lending or crowd funding in the United States (US) or the United Kingdom (UK), however, to our knowledge, there is no study that links financial literacy and the extensive and intensive use of fintech services. Morgan and Trinh (2018) studied the relationship between

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<sup>1</sup> There are number of broad areas in fintech services, such as payments, asset management, alternative finance and insurance, but, due to data limitations, we could only focus on fintech services relating to payments in this study.

financial literacy and fintech in the Lao People's Democratic Republic, but the analysis was limited to the awareness of fintech services, not actual usage of services.

Second, this study examines the effects of financial literacy on an individual's decisions to engage in risky financial behavior. Although fintech developed very rapidly, its regulation has tended to lag behind, thus increasing the potential risks for those who use such products and services. Moreover, using the internet for financial access incurs additional risks such as fraud, phishing, loss of information privacy and exposure to biased selection processes. The previous literature has examined the effect of financial literacy on investment in risky assets such as stocks or derivatives, but not on the use of fintech services.

Third, our study examines the role of behavioral traits (more specifically, herding behavior and risk aversion) in risky financial behavior by examining how financial literacy could alter the relationship between behavioral traits and fintech usage.

Japan is an interesting case for examining the role of financial literacy and fintech adoption. As a highly developed economy, Japan has an adequate foundation (in terms of financial regulation, financial structure and technical knowledge) for the adoption of fintech (Fahey 2019), but the uptake is still limited, especially when compared with the People's Republic of China (PRC) and to some extent the Republic of Korea. Ernst and Young (2019) show that, compared with many developed and emerging economies, the fintech adoption rate in Japan was low (about 34% in 2019 vs. 87% in PRC, 67% in the Republic of Korea and 46% in the US). Moreover, the gap in the adoption rate between Japan and the global average is widening, from 19 percentage points in 2017 to 26 percentage points in 2019 (Ernst and Young 2019). Furthermore, according to the Central Council for Financial Services Information (2016) the financial literacy of Japan is slightly lower than in the US, Germany and the UK. Understanding the relationship between financial literacy and fintech adoption in Japan should therefore be of interest not only to researchers but also policy makers.

The paper is organized as follows. Section 2 discusses the literature on the determinants of financial literacy and their effects on fintech adoption. Section 3 describes the data and our empirical approach. Section 4 briefly presents the status of financial literacy and fintech adoption in Japan. Section 5 documents our empirical results, followed by the conclusions and policy implications in Section 6.

## **2. LITERATURE REVIEW**

### **2.1 Measuring Financial Literacy**

There is already a long history of efforts to develop quantifiable measures of financial literacy based on empirically testable surveys. One of the earliest examples is that of the Jump\$tart Coalition for Personal Financial Literacy program for high school and college students in the US in 1997, which Mandell (2009) described. Lusardi and Mitchell (2006) added a set of financial literacy questions to the 2004 Health and Retirement Study (HRS), a survey of US households aged 50 and older, which served as a model for later surveys. The three core questions in the original survey aimed to assess understanding of some key financial concepts: compound interest, real rates of return, and risk diversification. Later surveys, including the OECD/INFE survey (OECD/INFE 2016), have built on this basis but added questions about financial attitudes, financial behavior, and financial experience.

## 2.2 Importance of Financial Literacy for Financial Well-being

A well-developed literature has tried to link measures of financial literacy with other economic and financial behaviors, dating to Bernheim (1995, 1998) in the US, in response to the increasing shift toward defined-contribution pension plans. This area of research received a further boost after the global financial crisis of 2008–2009, which drew attention to numerous scams inflicted on individual borrowers and investors in the US and other countries. Hilgert, Hogarth, and Beverly (2003) found a strong correlation between financial literacy and daily financial management skills, while other studies found that the more numerate and financially literate are more likely to participate in financial markets, invest in stocks, and engage in precautionary saving (Christelis, Jappelli, and Padula 2010; van Rooij, Lusardi, and Alessie 2011; de Bassa Scheresberg 2013). The more financially savvy are also more likely to undertake retirement planning, and those who plan accumulate more wealth (Lusardi and Mitchell 2011). Research has corroborated these results in a number of countries. Mahdzan and Tabiani's (2013) study is an example of this kind of research in Malaysia.

On the liability side of the household balance sheet, Moore (2003) found that the least financially literate are more likely to have more expensive mortgages. Campbell (2006) showed that those with a lower income and less education are less likely to refinance their mortgages during periods of falling interest rates. Stango and Zinman (2009) found that those who are unable to calculate interest rates correctly generally borrow more, and accumulate less wealth.

## 2.3 Financial Literacy and Fintech Adoption

The likelihood of participating in risky financial behavior is crucially affected by the costs and benefits of acquiring information (Hsiao and Tsai 2018). Vissing-Jorgensen (2003) and Guiso and Jappelli (2005) suggest that awareness and understanding of financial products will affect decisions about whether or not to use that product. Individuals with higher financial literacy may have lower fixed costs associated with acquiring and processing financial information than those with lower financial literacy, which would make it easier for the former to participate in risky financial activities. Van Rooij et al. (2011) show that financial literacy has a positive correlation with investment in stocks. Similar to stock market participation, the adoption of fintech products also has risks. According to Morgan, Huang and Trinh (2019), in addition to traditional risks using financial services, there are additional risks when one uses digital financial services. Such risks are more diverse and harder to spot than those associated with traditional financial products and services, including phishing, pharming, spyware, and SIM card swaps. Digital footprints may also be a source of risk. This suggests that higher financial literacy could also facilitate the use of fintech products and services, although we are not aware of any studies on this topic. The literature has also shown that an individual's financial decisions are affected by their behavioral traits (Van Rooij, Lusardi, Alessie 2011; Xiao and O'Neil 2018).



### **3. DATA, FINANCIAL LITERACY, AND FINTECH ADOPTION IN JAPAN**

#### **3.1 Data Source**

The Bank of Japan's Financial Literacy Survey aims to understand the current state of financial literacy: the financial knowledge and financial decision-making skills, of individuals aged between 18 and 79 in Japan. The first survey was carried out in 2011 by the Central Council for Financial Service Information (CCFSI), followed by second and third rounds in 2016 and 2019, respectively. The samples in 2016 and 2019 surveys were in proportion to Japan's demographic and economic structure (CCFSI 2016; 2019). For purpose of this study, we could only use data from 2019, since questions on fintech use were only included in that year's survey.

The survey included 25 questions on financial literacy, including true/false questions on financial knowledge and financial decision-making skills, and questions on characteristics of behavior and attitude. About half of the questions were similar to those in surveys conducted by the US Financial Industry Regulatory Authority Investor Education Foundation and the Organisation for Economic Co-operation and Development (CCFSI 2016; 2019) Information on gender, age, place of residence, occupation, annual income, as well as the experience of receiving financial education, was also collected. Finally, information on the use of fintech services and products was included.

Column 1 of Table 1 presents the descriptive statistics of the sample. About 49.5% of respondents were male. About 15% of the sample were under age 30, and 33.7% were aged over 60. Only 35% of the sample had at most a high school degree, much fewer than those who had a university degree or higher (42.1%). This suggests that the level of education in Japan education is relatively high. One-third were company employees. It should be noted that there was a high proportion of part-time workers and homemakers (34%). This is partly due to the low labor participation rate found among Japanese women. Most respondents who reported their income had an annual income less than 5 million Japanese Yen (or about \$46,600 at the exchange rate of 107.2).

#### **3.2 Measuring Financial Literacy in Japan**

We relied on the set of 25 questions to calculate the index of financial literacy. This set consists of 18 true/false questions on financial knowledge, and seven questions on financial decision-making skills.<sup>2</sup> The 18 questions on financial knowledge consist of three questions on basic financial transactions, similar to the three foundation questions proposed by Lusardi and Mitchell (2007), six questions on basic economic and financial knowledge and nine questions on the basic knowledge of wealth building, insurance, lending and borrowing. The seven questions on financial decision-making skills include two questions on household budget management, two questions on life planning skills, and three questions on using outside expertise. The financial literacy score (index) is calculated as the number of correct answers. The maximum possible score of a respondent is therefore 25. It should be noted that some of the questions are rather difficult, assuming a higher level of knowledge than, for example, in the OECD/INFE survey. For ease of interpretation, we calculate the z-score of the financial

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<sup>2</sup> For details, please refer to Appendix A for the list of questions.

literacy score. We also construct our financial literacy index based on principal component analysis as a robustness check.

### 3.3 State of Financial Literacy in Japan

Table 1 (Columns 2-8) presents the average values of the financial literacy index and various subcomponents of the index. The average financial literacy score was 14.1 (standard deviation: 6.9). This figure is slightly higher than that of the 2016 survey (Yoshino, Morgan, and Trinh 2017), however, only 33.3% of respondents were able to answer at least 18 questions correctly, which, according to the CCFSI, is the minimum desirable level.

The survey shows a large gap between men and women. Men have an average financial literacy score of 14.9, while that of women is only 13.4. Similarly, nearly 40% of men have the minimum desirable financial literacy, while this figure for women is only 26.8%. This result is consistent with previous findings on the differences in financial literacy between men and women (e.g., Bucher-Koenen et al. 2017).

Older people have higher financial literacy. For example, the average financial score of those under 30 is 10.7, while that of those over age 60 is 16.1. Among those under age 30, less than 15% achieved the desirable level of financial literacy, while the share among those over age 60 was 50%. Older individuals also have higher scores than younger ones in almost all sub-components of financial literacy. In particular, those over age 50 have a much higher understanding of credit/loans, insurance and wealth building.

Those with higher education had higher financial literacy and financial knowledge scores. While the average financial literacy score of those with only junior high school education was 9.4, those with a graduate degree had an average score of 17.3. For each subcomponent of financial literacy, those with higher education are performed better than those with less education.

The financial literacy score also differs by occupation. Teachers and self-employed persons had the highest score for financial literacy (16.3). Company employees also have financial literacy scores higher than average. Students, part-time workers and government officials have only average scores, and home makers and the unemployed have below-average financial literacy scores.

Financial literacy is also positively correlated with income, and this relationship also holds for each of the four sub-components of financial literacy. While only 35% of those with income less than 5 million JPY per year could answer 18 questions correctly, the figure for those with an income higher than 5 million is about 50%.

**Table 1: Descriptive Statistics and Financial Literacy in Japan**

	Sample Share (1)	Financial Literacy (Max: 25) (2)	% Desirable Financial Literacy (3)	Financial Knowledge			
				Basic Transactions (Max: 3) (4)	Basic Economic and Finance Knowledge (Max 6) (5)	Credit/ Loan; Insurance and Wealth Building (Max 9) (6)	Financial Decision-making Skill (Max 7) (7)
Whole sample	100%	14.15 [6.87]	33.3%	2.22 [1.12]	2.99 [1.93]	4.91 [2.84]	4.03 [2.14]
Gender							
Men	49.5%	14.88 [7.09]	40.0%	2.18 [1.15]	3.48 [1.90]	5.26 [2.88]	3.96 [2.20]
Women	50.6%	13.43 6.58	26.9%	2.26 1.08	2.51 1.84	4.56 2.76	4.10 2.08
Age							
<=30	15.0%	10.68 [6.64]	19.1%	2.03 [1.19]	2.00 [1.77]	3.28 [2.69]	3.37 [2.20]
30>=40	16.0%	12.73 [6.94]	29.5%	2.16 [1.15]	2.47 [1.91]	4.24 [2.87]	3.86 [2.19]
40>=50	19.1%	13.76 [6.99]	37.0%	2.18 [1.14]	2.83 [1.92]	4.79 [2.90]	3.96 [2.18]
50>=60	16.1%	15.09 [6.55]	42.9%	2.27 [1.09]	3.24 [1.85]	5.41 [2.69]	4.18 [2.09]
60>=70	19.2%	16.10 [6.28]	50.7%	2.32 [1.07]	3.61 [1.77]	5.79 [2.55]	4.38 [2.03]
>70	14.5%	16.19 [6.10]	50.8%	2.35 [1.03]	3.71 [1.77]	5.75 [2.48]	4.38 [1.98]
Education							
Primary/secondary/ others	2.9%	9.35 [6.68]	14.5%	1.69 [1.28]	1.80 [1.74]	3.13 [2.69]	2.74 [2.12]
High school	32.4%	12.91 [6.75]	30.0%	2.12 [1.16]	2.61 [1.88]	4.44 [2.82]	3.74 [2.11]
Specialized college	11.2%	12.37 [6.56]	26.1%	2.11 [1.16]	2.36 [1.77]	4.22 [2.76]	3.69 [2.12]
Junior college/tech college	11.3%	14.13 [6.53]	37.0%	2.27 [1.08]	2.81 [1.84]	4.91 [2.72]	4.14 [2.08]
University	38.2%	15.78 [6.64]	49.9%	2.35 [1.05]	3.53 [1.88]	5.52 [2.75]	4.38 [2.09]
Graduate school	3.9%	17.25 [6.63]	60.5%	2.42 [1.03]	4.11 [1.73]	6.05 [2.72]	4.67 [2.17]
Occupation							
Company employee	33.2%	15.28 [6.97]	40.2%	2.30 [1.14]	3.46 [1.93]	5.34 [2.87]	4.19 [2.19]
Gov't employee	3.0%	14.35 [6.65]	54.1%	2.17 [1.08]	3.15 [1.84]	5.06 [2.71]	3.97 [2.14]
Teacher	1.2%	16.28 [6.42]	52.8%	2.36 [0.99]	3.69 [1.78]	5.81 [2.70]	4.43 [2.03]
Self-employed	6.7%	16.28 [6.75]	39.4%	2.43 [1.14]	3.55 [1.87]	5.69 [2.74]	4.62 [2.12]
Part-timer	15.4%	14.36 [6.73]	29.7%	2.16 [1.12]	3.20 [1.84]	5.08 [2.80]	3.92 [2.12]
Homemaker	19.3%	12.81 [6.44]	37.6%	2.19 [1.07]	2.39 [1.87]	4.36 [2.68]	3.88 [2.03]
Student	4.9%	14.28 [6.56]	18.2%	2.29 [1.20]	2.80 [1.75]	4.94 [2.60]	4.25 [2.21]
Unemployed/other	16.3%	10.65 [6.94]	47.6%	2.04 [1.08]	2.17 [1.93]	3.12 [2.86]	3.32 [2.12]
Yearly income (JPY)							
Less than 5 million	47%	13.68 [6.74]	34.8%	2.19 [1.13]	2.87 [1.89]	4.70 [2.79]	3.92 [2.12]
From 5 million to 10 million	27%	15.95 [6.29]	49.2%	2.38 [1.02]	3.45 [1.85]	5.66 [2.60]	4.45 [2.04]
More than 10 million	7%	17.06 [6.27]	57.5%	2.39 [1.02]	3.91 [1.78]	6.16 [2.52]	4.60 [2.10]
Don't report	18%	11.54 [7.13]	25.7%	1.99 [1.23]	2.27 [1.91]	3.83 [2.93]	3.46 [2.19]

Note: Standard errors are in brackets.

Source: Author calculations.

### 3.4 State of Fintech Adoption in Japan

Table 2 presents the situation regarding the adoption of fintech payment services and crypto assets in Japan by gender, age, education, occupation and income. A total of 35.8% of individuals in the sample use electronic money for payment.<sup>3</sup> Nearly one third (10.3%) use it almost every day. The proportion of individuals who use mobile payment apps is rather limited, however, at only 8%. Of these, only 2.1% use them daily. This suggests that Japan lags behind some other countries in the penetration of mobile fintech. The penetration of crypto assets is also rather limited in Japan—only 7.8% of individuals in the sample held crypto assets.

Of those who used electronic money, although men and women do not differ much in terms of the extent of usage, men used this payment method more intensively. Nearly 60% of those who used electronic money were male. The gender differences in both the extensive and intensive usage of mobile payment apps are much higher: 68% of those who use this method and 76% who use it daily are male. Men also account for 80% of individuals holding crypto assets.

People aged over age 70 account for nearly 11% of those who use electronic money, and surprisingly those under age 30 account for only 13.4%. Most of the people who use electronic money are between 40 and 70 years old. These middle-aged groups have also adopted this payment method most intensively, accounting for more than 50% of those who used it daily. While the elderly accounted for the lowest share of people using mobile payment apps, the younger age group (including those who are under 50) accounted for nearly 70% of those who adopted mobile payment apps. This proportion is also observed in the intensity of the usage. This also helps to explain why younger persons accounted for a small share of those use electronic money—they may use mobile payment apps instead of electronic money for their payment. Younger persons also accounted for 70% of those who hold crypto assets.

Those with a higher education level accounted for a large share of those who used electronic money and mobile payment apps (in terms of both extensity and intensity), and were more likely to hold crypto assets. Half of those who adopted fintech had at least graduated from university, while the share of those who had just finished primary education or junior high school was only 1.9%–2-7%. This figure, however, should be interpreted cautiously, since we ignore the distribution of education in our sample.

Company employees made up a large share of those who adopted fintech, at about 50% of all company employees. The proportion of part-time employees and homemakers who use electronic money or mobile payment apps was also high, especially for electronic money.

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<sup>3</sup> According to the Bank of Japan (2019), electronic money is a type of money that requires users to load a certain value before use (pre-paid type) and in which a contactless integrated circuit (IC) chip is embedded. There are eight electronic money service providers: Rakuten Edy, Inc., “Rakuten Edy”; public transportation service providers such as railway companies (East Japan Railway Company, “Suica”; Hokkaido Railway Company, “Kitaca”; Kyushu Railway Company, “SUGOCA”; PASMO Co., Ltd, “PASMO”; and West Japan Railway Company, “ICOCA”), and retail companies (AEON Co., Ltd, “WAON”; and Seven Card Service Co., Ltd, “nanaco”).

**Table 2: Distribution of Fintech Adoption Among Total Users**  
(% of total)

	Use Electronic Money	Use Electronic Money Almost Every Day	Use Payment Apps (Mobile)	Use Payment Apps (Mobile) Almost Every Day	Holding Crypto Assets
Whole sample	35.8	10.3	8.0	2.1	7.8
Gender					
Male	50.65	59.46	67.99	76.19	70.14
Female	49.35	40.54	32.01	23.81	29.86
Age group					
<=30	13.41	17.13	22.28	23.05	22.92
30>=40	16.55	18.49	24.74	24.19	23.90
40>=50	20.95	22.41	23.48	22.67	22.05
50>=60	18.75	19.07	15.45	16.19	15.01
60>=70	19.52	15.03	10.39	10.67	10.89
>70	10.82	7.88	3.66	3.24	5.24
Education level					
Primary/secondary/others	1.91	1.86	2.16	2.67	2.06
High school	26.89	24.74	25.54	27.43	22.71
Specialized college	10.71	10.17	10.09	8.38	10.17
Junior college/tech college	11.46	9.05	7.43	4.95	8.07
University	43.73	47.53	47.97	49.33	49.74
Graduate school	5.30	6.64	6.82	7.24	7.25
Occupation					
Company employee	38.93	49.98	53.49	60.76	52.42
Gov't employee	3.66	3.77	4.67	4.57	5.04
Teacher	1.41	1.67	1.66	1.71	1.23
Self-employed	6.22	5.59	6.77	5.90	7.09
Part-timer	15.53	14.33	11.89	10.29	9.40
Homemaker	17.38	9.86	7.53	3.05	9.25
Student	4.94	6.72	6.67	6.29	6.99
Unemployed/other	11.94	8.08	7.33	7.43	8.58
Yearly income (JPY)					
Less than 5 million	43.42	42.83	40.29	38.67	43.53
From 5 million to 10 million Y	31.69	32.58	34.72	33.90	35.25
More than 10 million	10.22	11.61	13.30	15.81	12.90
Don't report	14.68	12.97	11.69	11.62	8.32

Source: Author calculations.

More than 40% of those who adopted fintech had an annual income less than 5 million Japanese yen. Those with income less than 10 million but higher than 5 million account for nearly a third of those who adopted fintech extensively and intensively. The figure for those who have an annual income of more than 10 million was about 10.2%–15.0%. The figures for the distribution of fintech adoption presented in Table 2, however, do not take into account the distribution of household income.

Table 3 reports fintech adoption by gender, age groups, level of education, occupation, and household income. It shows that 36.7% of men use electronic money and 34.9% of women. The differences between men and women are more pronounced for the use of mobile payment apps and holding crypto assets. Use of fintech also varies by age. For example, only 31.9% of individuals aged less than 30 use electronic money, while the figure for those who are between age 40 and 50 is about 40%. The proportion of people under age 40 who use mobile payment apps is much higher than that of older persons. The proportion of young people holding crypto assets is also higher than that of older people. It should be noted that older people account for only a small proportion of those who adopt fintech and hold crypto assets.

**Table 3: Fintech Adoption by Gender, Age, Occupation, Education and Income**  
(% of total of group)

	Use Electronic Money	Use Electronic Money Almost Every Day	Use Payment Apps (Mobile)	Use Payment Apps (Mobile) Almost Every Day	Holding Crypto Assets
Whole sample	35.8	10.3	8.0	2.1	7.8
Gender					
Male	36.7	12.4	11.0	3.2	11.0
Female	34.9	8.3	5.0	1.0	4.6
Age group					
<=30	31.9	11.7	11.8	3.2	11.9
30>=40	36.9	11.9	12.3	3.2	11.6
40>=50	39.3	12.1	9.8	2.5	9.0
50>=60	41.6	12.2	7.6	2.1	7.2
60>=70	36.3	8.0	4.3	1.2	4.4
>70	26.7	5.6	2.0	0.5	2.8
Education level					
Primary/secondary/others	23.6	6.6	5.9	1.9	5.5
High school	29.7	7.9	6.3	1.8	5.5
Specialized college	34.1	9.3	7.2	1.6	7.0
Junior college/tech college	36.2	8.2	5.2	0.9	5.5
University	41.0	12.8	10.0	2.7	10.1
Graduate school	48.4	17.4	13.9	3.9	14.4
Occupation					
Company employee	41.9	15.5	12.8	3.8	12.3
Gov't employee	44.1	13.1	12.6	3.2	13.2
Teacher	42.1	14.4	11.0	3.0	8.0
Self-employed	33.0	8.5	8.0	1.8	8.2
Part-timer	36.1	9.6	6.2	1.4	4.8
Homemaker	32.2	5.3	3.1	0.3	3.7
Student	36.0	14.1	10.8	2.7	11.1
Unemployed/other	26.3	5.1	3.6	1.0	4.1
Yearly income (JPY)					
Less than 5 million	32.9	9.4	6.8	1.7	7.2
From 5 million to 10 million	41.8	12.4	10.2	2.6	10.1
More than 10 million	50.2	16.4	14.5	4.6	13.8
Don't report	28.6	7.3	5.1	1.3	3.5

Source: Author calculations.

The proportion of people with higher education and higher income who use fintech is greater than that of people with lower education and lower income level. For example, only 23.6% of people with a primary or secondary education level use electronic money, but the figure for those with a university degree or higher is about 45%. The same pattern is also observed for the use of mobile payment apps and crypto asset holding.

Company employees, government employees and teachers are more likely to adopt fintech than people in other occupational groups. More than 40% of people in those groups use electronic money. Around 12% use mobile payment apps and more than 10% hold crypto assets.

## 4. EMPIRICAL APPROACH

To quantify the effect of financial literacy on the decision to adopt fintech services, we estimated the following equation:

$$FT_{ij} = \beta_0 + \beta_1 FL_i + \beta_2 X_i + \eta_i \quad (1)$$

where the dependent variable  $FT_i$  indicates whether individual  $i$  uses fintech service  $j$  or not;  $FL_i$  is the financial literacy index value of individual  $i$ ;  $X_i$  is a vector of control variables and  $\eta_i$  is the error term. The calculation method for our variable of interest,  $FL_i$ , was described in the previous section. The dependent variable,  $FT_i$ , is a binary variable. We estimated four alternative values of  $FT_{ij}$ : (i) one if individual  $i$  uses electronic money and zero otherwise; (ii) one if individual  $i$  uses mobile payment apps and zero otherwise; (iii) one if individual  $i$  uses either one of two payment services (electronic money or mobile payment apps) and zero otherwise; and (iv) one if individual  $i$  holds crypto assets and zero otherwise.

$X_i$  is a vector of control variables that may influence financial behavior. The control variables used in this study include the individual's age group, gender, level of general education and financial education, income, occupation, and frequency of reading financial and economic news<sup>4</sup>:

- There are six age groups. We use a series of dummy variables which take the value of one if individual  $i$  belongs to a certain age group and zero otherwise. The reference group is those up to age 30.
- Financial education is a binary variable that takes the value of one if individual  $i$  received financial education at school or at work, and zero otherwise.
- For general education, we used a series of dummy variables to indicate the level of individual  $i$ . We used the group with primary and secondary schooling and those who do not report their education level as the reference group.
- There are seven occupational groups. We use a series of dummy variables which take the value of one if individual  $i$  has a certain occupation. The reference group was those who are unemployed or do not report jobs.
- Income is divided into three groups: less than 5 million Japanese Yen per year (around \$46,600), more than 5 million and less than 10 million Japanese Yen per year and more than 10 million Japanese Yen. Those who do not have an income or did not report their income are used as the reference group.

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<sup>4</sup> We cannot have continuous data on age and income, but use age groups and income groups.

- The frequency of information gathering was divided into three groups: those who read news every day, once a week or once a month. The reference group is those who read the financial news almost every day.
- We also controlled for the prefecture in which each individual lives.

Due to the nature of our dependent variable, we used linear probability regression and probit regression to estimate equation (1).

We also analyze how financial literacy affects the intensity of using either electronic money or mobile payment apps. There are four levels of use intensity for each product: (i) using daily; (ii) using once a week; (iii) using once a month and (iv) not using. Since the dependent variable shows the order of frequency of usage, we estimate an ordered probit model with dependent variable as one of four levels of intensity. The dependent variable,  $FT_i^o$ , is an ordered response. The values are as follows: using fintech service every day, 1; using once a week, 2; using once a month, 3; and did not use, 4. We assume the existence of a latent continuous exact variable  $FT_i^*$  which determines the order of the intensity of using fintech services. The underlying process is characterized by

$$FT_{ik}^* = \alpha_0 + \alpha_1 FL_i + \alpha_2 X_i + \epsilon_i$$

of which  $FT_{ik}^*$  is the observed category of response corresponding to the  $k^{\text{th}}$  order of intensity of fintech usage;  $FL_i$  is the financial literacy index; and  $X_i$  is a vector of control variables. All independent variables in this equation are the same as in equation (1).

## 5. ESTIMATION RESULTS

The main research question in this paper is whether financial literacy affects the adoption of fintech services (in terms of both extensity and intensity of usage). Table 4 presents the estimation results regarding the extensive use of fintech services. The dependent variable in Column 1 is whether an individual uses electronic money or not; in Column 2 whether an individual uses mobile payment apps or not; in Column 3 whether an individual uses either electronic money or mobile payment apps or not, and in Column 4 whether an individual holds crypto assets or not. We use the probit estimation method in this table (marginal effects are reported). For a robustness check, we also use linear probability estimation methods.<sup>5,6</sup>

Our empirical results show that the financial literacy index has a positive effect on using electronic money, using mobile payment apps and using at least one of two fintech services. More specifically, after controlling for age, education, occupation, income and other factors, a one standard deviation increase in financial literacy increases the likelihood of using electronic money by 6 percentage points, the likelihood of using mobile payment apps by 0.8 percentage points and using at least one of two fintech services by 6.4 percentage points. Financial literacy, however, has a negative effect on holding crypto assets. If an individual's financial literacy increases by one standard deviation, their likelihood of holding crypto assets reduces by about 1.7–1.9 percentage

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<sup>5</sup> The results from the linear probability model are quantitatively similar to those from the probit estimation. Please refer to Appendix 2 for estimation results using OLS estimation.

<sup>6</sup> Alternatively, we calculate the financial literacy index using principal component analysis as a robustness check. The estimation results using this type of index are quantitatively similar to the results presented in this section. The results are available upon request.



points. This suggests that people with better financial literacy are more skeptical about holding crypto assets, presumably reflecting their price volatility.

The relationships between the decision to adopt fintech services and the other control variables are consistent with our expectations. Individuals who had received financial education either at their company or at school were more likely to use electronic money, mobile payment apps and to hold crypto assets. While men are less likely to use electronic money than women, they are more likely to use mobile payment apps and hold crypto assets than women. Age is generally positively correlated with the use of electronic payments, but negatively corrected with the use of payment apps and holding crypto assets. The contradictory effects of financial literacy and financial education on holding crypto assets are a puzzle. It may be that financial education increases confidence and thereby encourages people to try different financial products, while financial literacy makes people more skeptical about crypto assets. We believe this is one of the first examples of evidence about the relationship between financial literacy and holding crypto assets.

**Table 4: Financial Literacy and Decision to Adopt Fintech Services and Products**

	Using Electronic Money (1)	Using Mobile Payment Apps (2)	Using Either Electronic Money or Mobile Payment Apps (3)	Holding Crypto currency (4)
Financial literacy	0.060*** [0.003]	0.007*** [0.002]	0.064*** [0.003]	-0.017*** [0.002]
Financial education	0.040*** [0.011]	0.020*** [0.006]	0.048*** [0.011]	0.066*** [0.005]
Male	-0.038*** [0.007]	0.032*** [0.004]	-0.028*** [0.007]	0.040*** [0.004]
Age group (Reference group: <=30)				
30 <= 40 yrs	0.038*** [0.012]	-0.016* [0.008]	0.027** [0.012]	-0.012 [0.008]
40 <= 50	0.050*** [0.012]	-0.045*** [0.008]	0.028** [0.012]	-0.034*** [0.007]
50 <= 60	0.063*** [0.012]	-0.068*** [0.008]	0.032*** [0.012]	-0.050*** [0.007]
60 <= 70	0.031*** [0.012]	-0.090*** [0.008]	-0.003 [0.012]	-0.067*** [0.007]
>70	-0.040*** [0.013]	-0.109*** [0.008]	-0.079*** [0.013]	-0.080*** [0.008]
Education (reference group: Primary and junior high school)				
High school	-0.003 [0.019]	-0.005 [0.012]	0.001 [0.019]	-0.002 [0.010]
Specialized college	0.016 [0.020]	-0.012 [0.012]	0.018 [0.020]	0.002 [0.011]
Junior college/tech college	0.024 [0.020]	-0.008 [0.013]	0.025 [0.020]	0.014 [0.011]
University	0.045** [0.019]	-0.005 [0.012]	0.042** [0.019]	0.015 [0.010]
Graduate school	0.079*** [0.024]	-0.002 [0.014]	0.080*** [0.024]	0.032** [0.013]

*continued on next page*

Table 4 continued

	Using Electronic Money (1)	Using Mobile Payment Apps (2)	Using Either Electronic Money or Mobile Payment Apps (3)	Holding Crypto currency (4)
Income (JPY) (Reference group: No income)				
<2.5 million	0.090*** [0.018]	0.028*** [0.008]	0.098*** [0.018]	0.005 [0.011]
>=2.5 million & <5 million	0.098*** [0.018]	0.036*** [0.009]	0.110*** [0.018]	-0.008 [0.011]
>=5 million & <7.5 million	0.111*** [0.019]	0.041*** [0.009]	0.120*** [0.019]	0.005 [0.012]
>=7.5 million & <10 million	0.120*** [0.020]	0.052*** [0.010]	0.135*** [0.020]	0.008 [0.012]
>=10 million & <15 million	0.145*** [0.022]	0.069*** [0.012]	0.156*** [0.022]	0.023* [0.014]
>=15 million	0.172*** [0.028]	0.096*** [0.017]	0.184*** [0.028]	0.052*** [0.018]
Don't report income	0.060*** [0.018]	0.022*** [0.009]	0.065*** [0.018]	-0.037*** [0.011]
Occupation (Reference group: Unemployed/Don't report)				
Company employee	0.100*** [0.010]	0.036*** [0.006]	0.108*** [0.010]	0.031*** [0.006]
Govt employee	0.100*** [0.020]	0.022** [0.010]	0.094*** [0.020]	0.029*** [0.010]
Teacher	0.061** [0.028]	0.023 [0.015]	0.068** [0.028]	-0.006 [0.012]
Self-employed	0.038*** [0.013]	0.027*** [0.008]	0.040*** [0.014]	0.025*** [0.008]
Part-timer	0.083*** [0.011]	0.019*** [0.007]	0.088*** [0.012]	0.005 [0.006]
Homemaker	0.036*** [0.011]	-0.002 [0.006]	0.039*** [0.011]	0.014** [0.007]
Student	0.167*** [0.019]	0.028*** [0.010]	0.158*** [0.019]	0.005 [0.009]
Frequency of news acquired (Reference group: Almost every day)				
Once a week	-0.010 [0.009]	-0.010* [0.005]	-0.006 [0.009]	-0.011** [0.005]
Once a month	-0.045*** [0.011]	-0.026*** [0.006]	-0.040*** [0.011]	-0.013* [0.007]
Less often than once a month	-0.063*** [0.009]	-0.040*** [0.005]	-0.066*** [0.009]	-0.052*** [0.005]
Never	-0.090*** [0.009]	-0.054*** [0.005]	-0.096*** [0.009]	-0.071*** [0.005]
Don't answer	-0.085 [0.110]	0.129 [0.101]	-0.038 [0.114]	-0.062*** [0.011]
Prefecture dummies	Yes	Yes	Yes	Yes
Number of observations	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate the significance level at 10%, 5%, 1%, respectively. Standard errors are in brackets.

Source: Author estimation.

We did not find any differences, however, in the adoption of electronic payments among those who have education levels lower than a bachelor's degree. University graduates and those with graduate degrees tends to adopt electronic money more than those with junior high school education or less (or not reporting their education level). The effects of education on holding crypto assets are also similar to those relating to using electronic money. On the other hand, the level of education is not significantly related to the use of mobile payment apps.

Those with higher incomes tend to have a higher likelihood of using either electronic money or mobile payment apps, and holding crypto assets, although the results are only significant for those with an annual income of more than 10 million JPY.

All groups of employed persons have a higher likelihood of using fintech than do the unemployed. The same pattern is also observed for mobile payment apps, except for teachers and homemakers, whose likelihood of using mobile payment apps is no different from people in the reference group. Company employees, government employees, the self-employed and homemakers are more likely to hold crypto assets, while teachers, part-time workers and students are less likely to hold crypto assets than the unemployed and those who did not report their occupation.

We find that those who are less likely to read economic and financial news are less likely to adopt fintech services. Indeed, the more frequently one reads the news, the smaller are the differences in the likelihood of using fintech services or holding crypto assets compared to those who read it daily.

**Table 5: Financial Knowledge, Financial Decision-making Skills and Adoption of Fintech Services**

	Using Electronic Money (1)	Using Payment Apps (2)	Using Either Electronic Money or Payment Apps (3)	Holding Crypto Assets (4)
Financial knowledge	0.079*** [0.007]	0.025*** [0.004]	0.083*** [0.007]	0.034*** [0.004]
Financial decision-making skills	0.014 [0.014]	-0.034*** [0.009]	0.018 [0.014]	-0.151*** [0.009]
Financial education	0.041*** [0.012]	0.030*** [0.008]	0.049*** [0.012]	0.107*** [0.009]
Male	-0.043*** [0.008]	0.030*** [0.004]	-0.033*** [0.008]	0.029*** [0.004]
Number of observations	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in brackets. In the regressions, we control for age, education, occupation, income, frequency of acquiring news, and prefecture.

Source: Author estimation.

As mentioned earlier, our financial literacy score consists of two major components: financial knowledge and financial decision-making skills. Table 5 shows the estimation results for the relationship between fintech adoption and each of the two sub-components of financial literacy.<sup>7</sup> The results suggest that financial knowledge is positively associated with the likelihood of adopting all types of fintech services. While financial knowledge has positive effects on the adoption of all fintech services, financial decision-making skills do not have a statistically significant effect on the use of electronic money, and have a negative effect on using mobile payment apps or holding crypto assets. It should be noted that, because the one standard deviation of financial knowledge is 5.15, much higher than that of financial decision-making skills (2.14), the overall effect of financial literacy is positive for using mobile apps and negative for holding crypto assets.

Table 6 presents the marginal effects of financial literacy and other factors on the frequency of using electronic money (Columns 1-4) and using mobile payment apps (Columns 5-8). The results are obtained from estimating the ordered probit regression presented in Equation (2). Our estimation results show if an individual's financial literacy increases by one standard deviation, their likelihood of using electronic money every day increases by 3.2 percentage points. Under the same condition, their likelihood of using electronic money once a week increases by 3.4 percentage points and once a month by 0.4 percentage points. Their likelihood of not using electronic money, as expected, is reduced by 7 percentage points. A similar pattern is observed for the effects of financial literacy on using mobile payment apps. Higher financial literacy encourages individuals to use electronic money more frequently, but appears to discourage people from using mobile payment apps more frequently. Financial literacy was not strongly related to using mobile payment apps daily, only once a week or once a month.

Table 6 also shows the effects of financial education on the frequency of using electronic money and mobile payment apps. Those with financial education have a higher likelihood of using electronic money every day or once a week than those without financial education by 2.1 or 2.2 percentage points, and the likelihood of not using electronic money is lower than that of their counterparts by 4.6 percentage points. Financial education also has positive effects on the frequency of using mobile payment apps. However, similar to the effect of financial literacy, financial education is more likely to increase the likelihood of using mobile payment apps once a week or once a month. It did not seem to encourage individuals to use this method of payment every day.

For all four frequencies of use, middle-age individuals (age 40–60) are more likely to use electronic money than younger ones. On the other hand, for all four frequencies, younger people (i.e., those under 30 years old) tend to use mobile payment apps more than older ones. People in all age groups tend more to use mobile payment apps once a week or once a month, rather than daily.

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<sup>7</sup> For brevity, we only present our major results in this table. This is because the results of other control variables are not significantly different from those presented in Table 4. Full estimation results are available upon request.

**Table 6: Financial literacy and the frequency of using fintech services**

	Electronic Money				Payment Apps			
	Almost Every Day (1)	Once a Week (2)	Once a Month (3)	Never (4)	Almost Every Day (5)	Once a Week (6)	Once a Month (7)	Never (8)
Financial literacy	0.032*** [0.001]	0.034*** [0.002]	0.004*** [0.000]	-0.070*** [0.003]	0.002*** [0.001]	0.004*** [0.001]	0.005*** [0.001]	-0.011*** [0.003]
Financial education	0.021*** [0.005]	0.022*** [0.005]	0.002*** [0.001]	-0.046*** [0.010]	0.008*** [0.002]	0.015*** [0.003]	0.017*** [0.003]	-0.040*** [0.008]
Age (Reference group: Those aged less than 30)								
30>=40	0.010* [0.005]	0.010* [0.005]	0.001* [0.001]	-0.021* [0.011]	-0.007** [0.003]	-0.010** [0.004]	-0.009** [0.004]	0.025** [0.010]
40>=50	0.015*** [0.005]	0.016*** [0.005]	0.002** [0.001]	-0.032*** [0.011]	-0.020*** [0.003]	-0.033*** [0.004]	-0.032*** [0.004]	0.085*** [0.010]
50>=60	0.022*** [0.005]	0.022*** [0.005]	0.002*** [0.001]	-0.045*** [0.011]	-0.028*** [0.003]	-0.052*** [0.004]	-0.053*** [0.004]	0.133*** [0.010]
60>=70	0.004 [0.005]	0.005 [0.005]	0.001 [0.001]	-0.010 [0.011]	-0.035*** [0.003]	-0.070*** [0.004]	-0.077*** [0.004]	0.182*** [0.010]
>70	-0.024*** [0.005]	-0.030*** [0.006]	-0.006*** [0.001]	0.060*** [0.012]	-0.040*** [0.003]	-0.086*** [0.004]	-0.105*** [0.004]	0.232*** [0.010]
Male	-0.016*** [0.003]	-0.018*** [0.003]	-0.002*** [0.000]	0.036*** [0.007]	0.005*** [0.001]	0.010*** [0.002]	0.011*** [0.002]	-0.026*** [0.005]
Education (Reference group: Primary & junior high school)								
High school	0.009 [0.007]	0.011 [0.009]	0.002 [0.002]	-0.022 [0.019]	-0.002 [0.003]	-0.004 [0.006]	-0.004 [0.006]	0.010 [0.015]
Specialized college	0.016** [0.008]	0.019* [0.010]	0.003 [0.002]	-0.039* [0.020]	-0.005* [0.003]	-0.010* [0.006]	-0.011* [0.006]	0.027* [0.016]
Junior college/tech college	0.021*** [0.008]	0.025** [0.010]	0.004** [0.002]	-0.049** [0.020]	-0.006* [0.003]	-0.011* [0.006]	-0.012* [0.006]	0.029* [0.016]
University	0.029*** [0.007]	0.034*** [0.010]	0.005** [0.002]	-0.068*** [0.019]	-0.005 [0.003]	-0.010* [0.006]	-0.010* [0.006]	0.025* [0.015]
Graduate school	0.048*** [0.010]	0.050*** [0.011]	0.005** [0.002]	-0.103*** [0.022]	-0.005 [0.004]	-0.009 [0.007]	-0.010 [0.007]	0.025 [0.018]
Income (JPY) (Reference group: No income)								
<2.5 million	0.033*** [0.006]	0.043*** [0.009]	0.009*** [0.003]	-0.085*** [0.018]	0.007*** [0.002]	0.015*** [0.005]	0.018*** [0.006]	-0.040*** [0.013]
>=2.5 million & <5 million	0.035*** [0.006]	0.046*** [0.009]	0.010*** [0.003]	-0.090*** [0.018]	0.009*** [0.002]	0.019*** [0.005]	0.024*** [0.006]	-0.052*** [0.013]
>=5 million & <7.5 million	0.040*** [0.007]	0.051*** [0.010]	0.010*** [0.003]	-0.101*** [0.019]	0.010*** [0.002]	0.021*** [0.005]	0.026*** [0.006]	-0.057*** [0.013]
>=7.5 million & <10 million	0.047*** [0.007]	0.057*** [0.010]	0.010*** [0.003]	-0.114*** [0.019]	0.013*** [0.002]	0.027*** [0.005]	0.032*** [0.007]	-0.073*** [0.015]
>=10 million & < 15million	0.053*** [0.008]	0.064*** [0.010]	0.011*** [0.003]	-0.127*** [0.021]	0.019*** [0.003]	0.038*** [0.006]	0.043*** [0.007]	-0.101*** [0.016]
>=15 million	0.072*** [0.012]	0.079*** [0.012]	0.010*** [0.003]	-0.162*** [0.025]	0.033*** [0.006]	0.059*** [0.009]	0.062*** [0.009]	-0.154*** [0.023]
Don't report income	0.019*** [0.006]	0.027*** [0.009]	0.007** [0.003]	-0.053*** [0.018]	0.005** [0.002]	0.010** [0.005]	0.013** [0.006]	-0.028** [0.013]
Number of observations	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in brackets. In the regressions, we also control for occupation, frequency of acquiring news, and prefecture.

Source: Author estimation.

## 5.1 Behavioral Traits, Financial Literacy and Fintech Adoption

In this section, we examine how an individual's behavioral traits affect their decision to adopt fintech services and how financial literacy could affect the effects of behavioral traits. We consider two types of behavior traits: herd behavior and risk aversion. For herd behavior we use information from the question "How much do you agree or disagree that each of the following statements applies to you personally?: When there are several similar products, I tend to buy what is recommended as the best-selling product, rather than what I actually think is a good product". People are considered to have herd behavior if they answer, "very much agree" or "somewhat agree" and not to have herd behavior otherwise. Of 25,000 individuals in our data, 18.7% are considered to have herd behavior. For risk aversion, we use information from the question: "Suppose that if you invested 100,000 yen there was an equal probability that you would either get a gain of 20,000 yen or a loss of 10,000 yen. Would you make the investment?" People are viewed as risk averse if they answered "yes". In our sample, 77.3% are risk averse.

Table 7 presents our estimation results using Equation (1) augmented with behavioral dummy variables (herd behavior or risk aversion) and the interaction terms between the behavioral variables and the financial literacy score. The dependent variables are the four binary variables which indicate an individual's adoption of fintech services or holding crypto assets. The results show that, even when controlling for behavioral variables, financial literacy still affects the decision to adopt fintech services. For example, if the financial literacy score increases by one standard deviation, the likelihood of using electronic money increases by 6.2 (3.8) percentage points in the regression that we control for herd behavior (risk aversion).

We find that behavioral traits affect the decision to adopt fintech services. The likelihood of those who have herd behavior using electronic money is 1.7 percentage points higher than for their non-herding counterparts. The increases in likelihood of using mobile payment apps, using either electronic money or payment apps and holding crypto assets are 3.5, 2.5, and 6.0 percentage points, respectively, which implies that their financial decisions are strongly affected by their peers. The effect is the reverse for risk aversion. Those who are risk averse are 3.8 percentage points less likely to use electronic money than those who are not risk averse. For risk-averse individuals the likelihoods of using mobile payment apps, using either electronic money or payment apps and holding crypto assets are 2.9, 3.2, and 5.3 percentage points lower than for non-risk-averse persons, respectively.

The effects of behavioral traits on the adoption of fintech may differ by the level of financial literacy in some cases. For those with herd behavior, a higher financial literacy score does not change the effects of herd behavior on using fintech services, but reduces the likelihood of holding crypto assets. Financial literacy could mitigate the negative effects of risk aversion on the adoption of fintech services and holding crypto assets. For example, if their financial literacy score increases by one standard deviation, the likelihood of a risk-averse person using electronic money increases by 1.2 percentage points.

**Table 7: Herd Behavior, Risk Aversion and Fintech Adoption**

	Using Electronic Money (1)	Using Payment Apps (2)	Using Either Electronic Money or Payment Apps (3)	Holding Crypto Assets (4)	Using Electronic Money (5)	Using Payment Apps (6)	Using Either Electronic Money or Payment Apps (7)	Holding Crypto Assets (8)
Financial literacy	0.062*** [0.004]	0.011*** [0.002]	0.067*** [0.004]	-0.014*** [0.002]	0.038*** [0.007]	0.011** [0.005]	0.039*** [0.007]	-0.072*** [0.006]
Herd behavior	0.017** [0.008]	0.035*** [0.005]	0.025*** [0.008]	0.060*** [0.005]				
Financial literacy * herd behavior	-0.007 [0.008]	-0.009 [0.005]	-0.009 [0.008]	-0.015*** [0.005]				
Risk aversion					-0.025*** [0.004]	-0.029*** [0.003]	-0.032*** [0.004]	-0.053*** [0.003]
Financial literacy * risk aversion					0.012*** [0.004]	0.010*** [0.003]	0.014*** [0.004]	0.030*** [0.003]
Number of observations	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in bracket. In the regressions, we control for age, education, occupation, income, frequency of acquiring news, and prefecture.

Source: Author estimation.

Table 8 reports how herd behavior and risk aversion affect the frequency of use of electronic money (Panel A) and mobile payment apps (Panel B). Even when we control for herd behavior and risk aversion, the effect of financial literacy on the usage frequency of electronic money is still positive and significant. Regardless of whether we control for risk aversion or herd behavior, those with higher financial literacy have a higher likelihood of using electronic money almost every day, or at least once a week, and are less likely to never use it. People with higher financial literacy are also more likely to use mobile payment apps more frequently than those who have lower financial literacy. The effect of financial literacy on the frequency of using mobile payment apps loses its significance when we control for risk aversion, however.

Our empirical results suggest that that people with herd behavior are likely to use electronic money more frequently and those with risk aversion are likely to use this service less frequently. This implies that peer effects may have a strong effect on the frequency of electronic money use, while risk aversion may hinder individuals from using this service frequently. We also see a similar pattern for the use of mobile payment apps. It should be noted that there is a difference in the use frequency of both electronic money and mobile payment apps for those who have herd behavior and those who have risk aversion. While people with strong herd behavior or strong risk aversion tend to use electronic money every day and about once a week, they are more likely to use mobile payment apps once a week or once a month.

We are also interested in whether financial literacy affects fintech adoption for those who have herd behavior and for those who have risk aversion. For those who have herd behavior, higher financial literacy does not change the frequency of their using electronic money, but reduces the likelihood of using mobile payment apps. For those who are risk averse, higher financial literacy is associated with a higher usage of fintech services (both electronic money and mobile payment apps).

**Table 8: Frequency of Fintech Adoption: Role of Herd Behavior and Risk Aversion**

	Almost Every Day (1)	Once a Week (2)	Once a Month (3)	Never (4)	Almost Every Day (5)	Once a Week (6)	Once a Month (7)	Never (8)
Panel A: Electronic money								
Financial literacy	0.033***	0.036***	0.004***	– 0.073***	0.019***	0.020***	0.002***	– 0.041***
	[0.002]	[0.002]	[0.000]	[0.003]	[0.003]	[0.003]	[0.000]	[0.006]
Herd behavior	0.010***	0.011***	0.001***	– 0.022***				
	[0.003]	[0.004]	[0.000]	[0.007]				
Financial literacy * herd behavior	–0.005	–0.006	–0.001	0.012				
	[0.003]	[0.004]	[0.000]	[0.007]				
Risk aversion					– 0.013***	– 0.014***	– 0.002***	0.028***
					[0.002]	[0.002]	[0.000]	[0.003]
Financial literacy * risk aversion					0.008***	0.008***	0.001***	– 0.017***
					[0.002]	[0.002]	[0.000]	[0.003]
Panel B: Mobile payment apps								
Financial literacy	0.003***	0.006***	0.007***	– 0.016***	–0.001	–0.003	–0.003	0.007
	[0.001]	[0.001]	[0.001]	[0.003]	[0.001]	[0.002]	[0.002]	[0.005]
Herd behavior	0.008***	0.015***	0.016***	– 0.039***				
	[0.001]	[0.002]	[0.002]	[0.006]				
Financial literacy * herd behavior	–0.003**	–	–	0.015***				
	[0.001]	[0.002]	[0.002]	[0.006]				
Risk aversion					– 0.006***	– 0.012***	– 0.014***	0.033***
					[0.001]	[0.001]	[0.001]	[0.003]
Financial literacy * risk aversion					0.002***	0.004***	0.004***	– 0.010***
					[0.001]	[0.001]	[0.001]	[0.003]
Number of observations	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate the significant level at 10%, 5%, 1%. Standard errors are in brackets. In the regressions, we control for age, education, occupation, income, frequency of acquiring news, and prefecture.

Source: Author estimation.

## 6. CONCLUSIONS

Rapid developments in financial technology (fintech) are expected to contribute to improvements in financial inclusion and well-being. Using a large dataset collected in a survey by the Bank of Japan, including 25,000 individuals aged from 18 to 79, this paper investigated how financial literacy and other factors contributed to the adoption of fintech payment services and assets in Japan. We used information from 25 questions to construct a financial literacy index. This financial literacy measure is more comprehensive than most others that are currently widely used in the literature, as it not only measures financial knowledge (which comprises knowledge of basic financial transactions, basic economic and financial concepts, and understanding of credit/loans, insurance and wealth building) but also financial decision-making skills (such as family budget management, life planning and use of external financial advice). Using probit and ordered probit estimation methods, we examined how financial literacy affects the extensive and intensive usage of electronic money and mobile payment apps and



holding crypto assets, a type of fintech product. We also examine how an individual's behavioral traits—herd behavior and risk aversion—may affect their adoption of fintech, and whether financial literacy could alter the relationship between these behavioral traits and the adoption of fintech.

There are several important results from our empirical evidence. First, we find that financial literacy has a positive effect on using electronic money, using mobile payment apps and using at least one of these two fintech services. However, financial literacy has a negative effect on holding crypto assets. These results are robust even when we control for an individual's behavioral traits, such as herd behavior or risk aversion. We believe this is one of the first examples of evidence about the relationship between financial literacy and holding crypto assets.

Second, financial literacy also affects the intensity of using fintech services. If the financial literacy score increases by one standard deviation, the likelihood of using electronic money every day or once a week increases substantially, while their likelihood of using it only once a month increases only slightly and for the likelihood of not using it decreases. A similar pattern is observed for the effects of financial literacy on using mobile payment apps. Different from electronic money, however, increases in financial literacy mainly increase the likelihood of using mobile payment apps once a week or once a month. In any case, the effect of financial literacy on using mobile payment apps is rather small.

Third, the behavioral traits of herd behavior and risk aversion affect the extensity and intensity of using fintech services. The likelihood of using electronic money, using payment apps and holding crypto assets of is higher for those who have herd behavior than those who do not. The effect of risk aversion is the reverse, as expected. Those who are risk averse are less likely to use electronic money, payment apps or to hold crypto assets than those who are not risk averse. People with strong herd behavior or strong risk aversion also tend to use electronic money every day and once a week, and are more likely to use mobile payment apps once a week or once a month.

Fourth, for those who have herd behavior, higher financial literacy does not change their frequency of using electronic money, but reduces the likelihood of using mobile payment apps. For those who are risk averse, higher financial literacy is associated with the higher use of fintech payment services (both electronic money and mobile payment apps).

Our study has several policy implications. We find a positive relationship between financial literacy and fintech adoption. Given the potential advantages of fintech for promoting financial inclusion and financial well-being, there should be policies to improve financial literacy. One such policy involves carrying out financial education programs at both school and at work. This is important, since financial education not only has direct effects on fintech adoption and usage, but also has indirect effects through financial literacy (Yoshino, Morgan, and Trinh 2018). Because there are differences in the adoption and use of fintech services by age, gender, education, occupation and income, a common policy that aims to promote the uptake of these services may not be efficient. Some groups should be targeted more than the other groups. The study also has some policy implications regarding the design of appropriate policies to promote the cashless economy in a cash-oriented society like Japan.

There are some limitations to our study. Our estimation results may be biased due to possible reverse causality (those who adopted fintech may improve their financial literacy) or omitted variable biases (i.e., unobservable factors that affect both fintech adoption and financial literacy). It is difficult to find instrumental variables that are correlated with financial literacy and do not have any direct effects on the adoption of fintech. The estimates should thus be interpreted with caution. Although financial education and its effects are gaining increasing attention from both researchers and policy makers, we did not focus on examining the effects of financial education in this study. Financial education acts only as control variable in this study. Although our

measure of financial literacy is more comprehensive than most measures used in the literature, it lacks indicators that would be more relevant for digital finance, such as knowledge of digital risks, or control of digital risks. This implies that there is a need for a better measure of digital financial literacy (Morgan, Huang, and Trinh 2019). Data limitations did not allow us to explore the relationship between financial literacy and other aspects of fintech, aside from payment methods and holding crypto assets. They also did not allow us to explore how financial literacy affects the specific (or at least share of) transaction amount that each individual uses for each payment method. These limitations suggest topics for future research.

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## APPENDIX 1: FINANCIAL LITERACY QUESTIONS

Family Budget Management (1)	Q4	Balance management: Which of the following statements on household behavior is inappropriate? Choose only one answer. [Required entry]
	1	Managing income and expenditure by keeping a household account book or similar
	2	Deciding on expenditure after considering whether it is truly necessary and whether there is enough income
	3	Saving some money out of income by transferring a fixed amount of income into a savings account or similar
	4	Frequently using installment payment plans of credit cards in order to defer payment
	5	Don't know
Family Budget Management (2)	Q5	Use of credit card: Which of the following statements on family budget management and credit cards is inappropriate? Choose only one answer. [Required entry]
	1	Using credit cards in a well-planned manner according to income
	2	Any unsettled credit card payment is practically a debt
	3	A credit card fee (interest) is charged for revolving payments but not for installment payments
	4	Failure to pay the credit card charge may cause credit card transactions to be declined
	5	Don't know
Life Planning (1)	Q12	Compound interest: Taro and Hanako are the same age. At age 25 Hanako began saving 100,000 yen per year and continued to save the same amount annually thereafter. Meanwhile, Taro did not save money at age 25, but began saving 200,000 yen per year at age 50. When they are aged 75, which will have more money saved? Choose only one answer.
	1	They would each have the same amount because they put away exactly the same amount
	2	Taro, because he saved more each year
	3	Hanako, because she has put away more money
	4	Hanako, because her money has grown for a longer time at compound interest
	5	Do not know
Life Planning (2)	Q13	Three major expenses of life: What are the so-called three major expenses in life? Choose only one answer. [Required entry]
	1	Living expenses for your lifetime, children's educational expenses, and your medical expenses
	2	Children's educational expenses, costs of buying a house, and living expenses for your retirement
	3	Costs of buying a house, your medical expenses, and costs of nursing care for your parents
	4	Do not know

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**Appendix 1** *table continued*

Knowledge/Basics of Transaction	Q14	Basic attitude to contracts: Which of the following is inappropriate as an action to take when concluding a contract? Choose only one answer
		1 Reconsidering whether the contract is truly necessary
		2 Checking whether cancellation of the contract is possible and whether a penalty is charged for doing so
		3 Concluding a contract based on a detailed explanation from the service provider, and carefully reading the contract document later
		4 Seeking advice from a third party as needed when concluding a contract
		5 Do not know
Knowledge/Basics of Transaction	Q15	Confirmation that the information source and contractor are reliable: Which of the following is inappropriate as a behavior to avoid being involved in financial trouble? Choose only one answer. [Required entry]
		1 Avoiding disclosing your personal information as much as possible
		2 Making an effort to acquire financial and economic knowledge
		3 Trusting and leaving the entire matter to the service provider when it is difficult to make a decision
		4 Checking the user reviews of the product you are planning to purchase
		5 Do not know
Knowledge/Basics of Transaction	Q16	Internet transactions: Which of the following is inappropriate as an action related to internet transactions? Choose only one answer. [Required entry]
		1 I updated the security software to the latest version
		2 I received an e-mail, but I did not open it since it was sent from an unknown address
		3 I made a bank transfer by using a computer at an Internet café
		4 I checked many times to make sure that the information I entered had no errors
		5 Do not know
Knowledge/Basics of Eco & Finance	Q18	Interest Rates (NA): Suppose you put 1 million yen into a savings account with a guaranteed interest rate of 2% per year. If no further deposits or withdrawals are made, how much would be in the account after 1 year, once the interest payment is made? Disregard tax deductions. Answer with a whole number.
Knowledge/Basics of Eco & Finance	Q19	Compound interest: Then, how much would be in the account after 5 years? Disregard tax deductions. Choose only one answer.
		1 More than 1.1 million yen
		2 Just 1.1 million yen
		3 Less than 1.1 million yen
		4 Impossible to tell from the information given
		5 Do not know

*continued on next page*

**Appendix 1** *table continued*

Knowledge/Basics of Eco & Finance	Q20	Inflation: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? Choose only one answer  1 More than today 2 Exactly the same 3 Less than today 4 Do not know
Knowledge/Basics of Eco & Finance	Q21_1	Inflation: High inflation means that the cost of living is increasing rapidly  1 Correct 2 Incorrect 3 Do not know
Knowledge/Loan & Credit	Q21_2	Mortgage: When compared, a 15-year mortgage typically requires higher monthly payments than a 30-year loan, but the total interest paid over the life of the loan will be less  1 Correct 2 Incorrect 3 Do not know
Knowledge/Wealth Building	Q21_3	Risk / Return: An investment with a high return is likely to be high risk  1 Correct 2 Incorrect 3 Do not know
Knowledge/Wealth Building	Q21_4	Diversified financial products: Buying a single company's stock usually provides a safer return than a stock mutual fund  1 Correct 2 Incorrect 3 Do not know
Knowledge/Basics of Eco & Finance	Q22	Bonds: If interest rates rise, what will typically happen to bond prices? Choose only one answer. [Required entry]  1 Go up 2 Go down 3 They do not change 4 There is no relationship between bond prices and interest rates 5 Do not know
Knowledge/Basics of Eco & Finance	Q23	Action and judgment when interest rates change: Which of the following is appropriate as an action to take when investing (making deposits, etc.) or borrowing funds at a time of interest rate rise? Choose only one answer.  1 Investing and borrowing at fixed interest rates 2 Investing at a fixed interest rate and borrowing at a floating interest rate 3 Investing at a floating interest rate and borrowing at a fixed interest rate 4 Investing and borrowing at floating interest rates 5 Do not know

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**Appendix 1** *table continued*

Knowledge/Insurance	Q25	<p>Basis of insurance: Which of the following statements on the basic function of insurance is appropriate? Choose only one answer. [Required entry]</p> <ol style="list-style-type: none"> <li>1 Insurance is effective when a risk occurs with high frequency, causing a large risk</li> <li>2 Insurance is effective when a risk occurs with low frequency, causing a large risk</li> <li>3 Insurance is effective when a risk occurs with high frequency, causing a small risk</li> <li>4 Insurance is effective when a risk occurs with low frequency, causing a small risk</li> <li>5 Do not know</li> </ol>
Knowledge/Insurance	Q26	<p>Review of insurance according to changes in family structure: When a 50-year-old man reviews his life insurance policy (whole life insurance) after his children have become financially independent, which of the following statements is appropriate? Suppose that other circumstances have not changed. Choose only one answer.</p> <ol style="list-style-type: none"> <li>1 He should consider increasing the death benefit</li> <li>2 He should consider decreasing the death benefit</li> <li>3 There is no need to review the policy in particular</li> <li>4 Don't know</li> </ol>
Knowledge/Insurance	Q28	<p>Which of the following statements on insurance is inappropriate? Choose only one answer. [Required entry]</p> <ol style="list-style-type: none"> <li>1 You need to pay national pension contributions if you are aged 20 or over, even if you are a student</li> <li>2 The damage caused by an automobile accident will be fully covered by the automobile liability insurance</li> <li>3 You should review the necessity of life insurance and the amount of coverage of insurance according to changes in circumstances of family members and yourself</li> <li>4 Health insurance may not cover pre-existing medical conditions that you had before purchasing the insurance policy</li> <li>5 Do not know</li> </ol>
Knowledge/Loan & Credit	Q30	<p>Housing loan: Which of the following statements on mortgages is appropriate? Choose only one answer</p> <ol style="list-style-type: none"> <li>1 It is far less costly to continue living in a rented house for your whole life than buying a house with a loan</li> <li>2 Mortgages can be repaid by either the equal payment method or the equal principal payment method, but the total repayment is the same for both methods</li> <li>3 Mortgages are offered with either a floating interest rate or a fixed interest rate, and those with a fixed interest rate are always more advantageous than those with a floating interest rate</li> <li>4 In order to decrease the total mortgage repayment, it is effective to prepare as much down payment as possible and make advanced repayments to the extent possible</li> <li>5 Do not know</li> </ol>

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**Appendix 1** *table continued*

Knowledge/Loan & Credit	Q31	Compound interest: Suppose you owe 100,000 yen on a loan and the interest rate you are charged is 20% per year compounded annually. If you didn't pay anything off, at this interest rate, how many years would it take for the amount you owe to double? Choose only one answer.
	1	Less than 2 years
	2	At least 2 years but less than 5 years
	3	At least 5 years but less than 10 years
	4	At least 10 years
	5	Do not know
Knowledge/Wealth Building	Q33	Deposit insurance system: Which of the following statements on the types of deposits protected up to 10 million yen under Japan's deposit insurance system is appropriate? Choose only one answer
	1	Only ordinary deposits are protected
	2	Ordinary deposits and time deposits are protected
	3	All types of deposits including ordinary deposits, time deposits, and foreign currency deposits are protected
Use of Outside Expertise (1)	Q36	Workarounds for financial trouble: Which of the following is inappropriate as a behavior or attitude when determining whether to purchase an unfamiliar financial product? Choose only one answer.
	1	Collecting information to make sure that the product is not frequently causing trouble and no warning has been issued by a public institution
	2	Collecting information from the internet, books, and several sellers and comparing the product with other products
	3	Consulting with an institution, agency, etc., that provides information from a neutral standpoint and receiving advice
	4	Purchasing the product if the seller tells you that you can expect a high return
	5	Do not know
Use of Outside Expertise (2)	Q37	Behavior and judgment: Which of the following is appropriate as an action to take when considering purchase of a financial product with a complicated structure? Choose only one answer.
	1	Purchasing the product if it is selling well, even if you do not understand its structure clearly
	2	Purchasing the product if you can trust the financial institution providing the product, even if you do not understand its structure clearly
	3	Purchasing the product if you can expect a high return, even if you do not understand its structure clearly
	4	Purchasing the product if you understand its structure and find no problem
	5	Do not know
Use of Outside Expertise (3)	Q38	Which of the following is inappropriate in a consultant office or a system to be used when trouble occurs in relation to a contract for a financial product? Choose only one answer. [Required entry]
	1	Consumer center
	2	Financial alternative dispute resolution (ADR) system
	3	Rating company
	4	Attorney at law

Source: CCFSI (2019).

## APPENDIX 2: FINANCIAL LITERACY AND ADOPTION OF FINTECH SERVICES: ROBUSTNESS CHECK

	Using Electronic Money (1)	Using Mobile Payment Apps (2)	Using Either Electronic Money or Mobile Payment Apps (3)	Holding Crypto Currency (4)
Financial literacy	0.060*** [0.003]	0.008*** [0.002]	0.064*** [0.003]	-0.019*** [0.002]
Financial education	0.043*** [0.012]	0.032*** [0.008]	0.051*** [0.012]	0.113*** [0.009]
Male	-0.038*** [0.007]	0.034*** [0.004]	-0.029*** [0.008]	0.042*** [0.004]
Age group (Reference group: Age<30)				
>=30& <40	0.036*** [0.011]	-0.010 [0.008]	0.026** [0.012]	-0.010 [0.008]
>=40& <50	0.048*** [0.011]	-0.039*** [0.008]	0.027** [0.011]	-0.034*** [0.007]
>=50& <60	0.061*** [0.012]	-0.066*** [0.008]	0.031*** [0.012]	-0.052*** [0.008]
>=60& <70	0.028** [0.012]	-0.085*** [0.007]	-0.005 [0.012]	-0.067*** [0.007]
>=70	-0.042*** [0.013]	-0.098*** [0.007]	-0.080*** [0.013]	-0.075*** [0.007]
Education (Reference group: Primary and junior high school)				
High school	-0.010 [0.016]	-0.006 [0.009]	-0.005 [0.017]	-0.001 [0.009]
Specialized college	0.009 [0.018]	-0.015 [0.010]	0.011 [0.018]	0.002 [0.010]
Junior college/tech college	0.017 [0.018]	-0.009 [0.010]	0.018 [0.018]	0.012 [0.010]
University	0.039** [0.017]	-0.006 [0.009]	0.036** [0.017]	0.015* [0.009]
Graduate school	0.076*** [0.022]	0.005 [0.014]	0.078*** [0.023]	0.041*** [0.014]
Income (JPY) (Reference group: No income)				
<2.5 million	0.078*** [0.017]	0.031*** [0.009]	0.087*** [0.017]	0.009 [0.011]
>=2.5 million & <5 million	0.085*** [0.017]	0.032*** [0.009]	0.097*** [0.017]	-0.004 [0.011]
>=5 million & <7.5 million	0.099*** [0.018]	0.037*** [0.010]	0.109*** [0.018]	0.010 [0.011]
>=7.5 million & <10 million	0.111*** [0.019]	0.051*** [0.011]	0.126*** [0.019]	0.014 [0.012]
>=10 million & <15 million	0.139*** [0.021]	0.073*** [0.013]	0.150*** [0.021]	0.032** [0.014]
>=15 million	0.165*** [0.028]	0.104*** [0.019]	0.176*** [0.028]	0.063*** [0.020]
Don't report income	0.051*** [0.016]	0.022** [0.009]	0.056*** [0.017]	-0.032*** [0.010]

*continued on next page*

Appendix 2 *table continued*

	Using Electronic Money (1)	Using Mobile Payment Apps (2)	Using Either Electronic Money or Mobile Payment Apps (3)	Holding Crypto Currency (4)
Occupation (Reference group: Unemployed/Don't report)				
Company employee	0.099*** [0.010]	0.047*** [0.005]	0.108*** [0.010]	0.039*** [0.005]
Govt employee	0.100*** [0.020]	0.034*** [0.013]	0.094*** [0.020]	0.039*** [0.013]
Teacher	0.060** [0.029]	0.027 [0.018]	0.067** [0.029]	-0.011 [0.016]
Self-employed	0.036*** [0.013]	0.027*** [0.007]	0.039*** [0.014]	0.024*** [0.007]
Part-timer	0.080*** [0.011]	0.021*** [0.006]	0.086*** [0.011]	0.010* [0.005]
Homemakers	0.033*** [0.011]	0.011** [0.005]	0.036*** [0.011]	0.022*** [0.005]
Students	0.155*** [0.018]	0.025** [0.011]	0.148*** [0.018]	0.003 [0.012]
Frequency of news acquisition (Reference group: Almost every day)				
Once a week	-0.009 [0.009]	-0.006 [0.005]	-0.005 [0.009]	-0.008 [0.005]
Once a month	-0.047*** [0.011]	-0.025*** [0.006]	-0.041*** [0.011]	-0.010 [0.007]
Less often than once a month	-0.064*** [0.009]	-0.038*** [0.005]	-0.066*** [0.009]	-0.051*** [0.005]
Never	-0.087*** [0.009]	-0.052*** [0.005]	-0.093*** [0.009]	-0.076*** [0.005]
Don't answer	-0.082 [0.109]	0.110 [0.092]	-0.035 [0.111]	-0.071*** [0.015]
Prefecture dummies	Yes	Yes	Yes	Yes
Intercept	0.233*** [0.028]	0.060*** [0.015]	0.258*** [0.028]	0.072*** [0.017]
Number of observations	25,000	25,000	25,000	25,000

Note: \*, \*\*, \*\*\* indicate the significance level at 10%, 5%, 1%, respectively. Standard errors are in bracket.

Source: Author estimation.