The Macroeconomic Effects of Fintech

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Abstract

This paper first explains the extremely low level of fintech-related investments in Japan compared with the levels in other countries and the possibility of expansion of investments in new, uniquely Japanese businesses, such as the Furusato (hometown) Investment Fund. Next, the paper makes clear distinctions by prefecture in terms of the necessity of financial and economic education and the current status of such education based on the results of a questionnaire survey conducted by the Central Council for Financial Services Information. Finally, by conducting a theoretical analysis of the impact of fintech on various economic agents, the paper shows that fintech has both positive and negative macroeconomic effects and explains the channels whereby the effects spread.

Keywords: Furusato Investment Fund, financial and economic education, financial literacy map drawn by the Central Council for Financial Services Information, economic analysis of fintech
JEL: E02, E21, R22, E44

I. Introduction

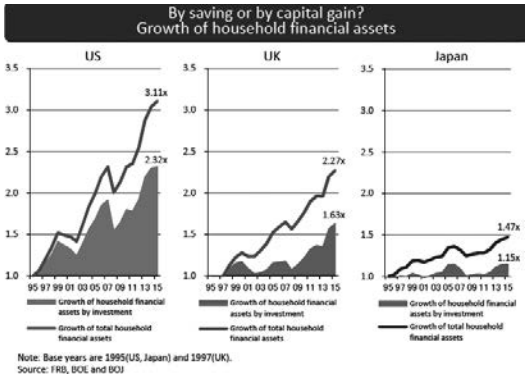
In this paper we discuss the effects of fintech on the Japanese economy, focusing on their macroeconomic aspects. We first discuss the status quo of fintech in Japan, from both its supply and demand sides. Next, we turn our eyes to the effects of fintech on each macroeconomic agent, using a theoretical analysis. We also touch upon its implications for macroeconomic stability.

II. Japanese Asset Management and Fintech-related Investments

Figure 1 shows the growth in financial asset values in the USA, the UK and Japan during the 20 years since 1995. The value of financial assets has become 3.11 times as large in the USA, 2.27 times as large in the UK, during this period. In contrast, the value is only 1.47 times as large in Japan.

In light of the fact that Japan is rapidly ageing, this is a very serious problem. Unless

Figure 1. Asset Management in the USA, the UK and Japan



Source: FSA homepage, 3rd February 2017, Kakei Kinyu Shisan no Genjo Bunseki (current status of household financial assets)

Japanese assets are invested in vehicles that earn higher returns, life after retirement will be very difficult for many. And returns are not the only concern. Risk diversification through regional diversification is also important. Table 1 shows the high growth rates in the Asian region. Investment out of Japan and into this region should be increased.

Figure 2 shows the relative GDP sizes of the different regions of the world, as a percentage of global GDP. Already in 2016, the GDP of Asian economies took up approximately 32% of world GDP, more than the GDPs of north America and Europe.

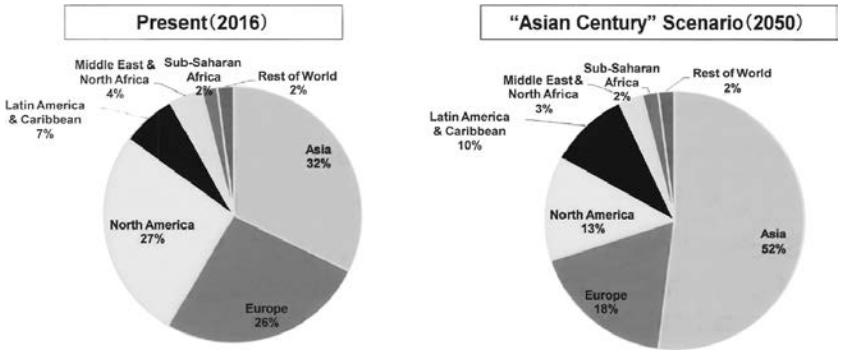
If the ADB's 'Asian Century' scenario turns out to be correct, by 2050, Asian GDP is expected to compose more than half of world GDP. If Japanese investors and financial insti-

Table 1. Asian Economic Growth Rates

	2017	2018 (forecast)	2019 (forecast)
Developing Asia	6.1	6.0	5.9
(excluding NIES)	6.6	6.5	6.4
People's Rep. of China	6.9	6.6	6.4
India	6.6	7.3	7.6
Indonesia	5.1	5.3	5.3
Pakistan	5.3	5.6	5.1
Bangladesh	7.3	7.0	7.2
Philippines	6.7	6.8	6.9
Viet Nam	6.8	7.1	6.8
Thailand	3.9	4.0	4.1
Myanmar	6.8	6.8	7.2
Republic of Korea	3.1	3.0	2.9

Source: Compiled from the ADB Asian Development Outlook

Figure 2. Composition Ratio of GDPs



Source: Compiled from the ADB Asian Development Outlook

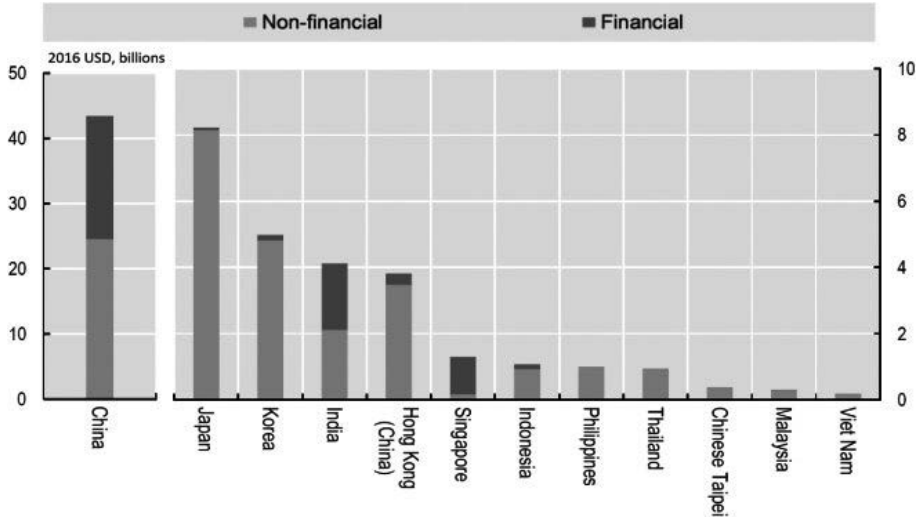
tutions successfully invest in other countries in Asia rather than in Japan, they can expect higher returns. The caveat is that higher returns come with higher risks, and investment abroad involves exchange rate fluctuations. If the investors do not need yen funds in the short run, they can continue to hold the funds in foreign currencies if the yen is stronger at the time of maturity, changing the sum back into yen later when the yen is weaker. Needless to say, gathering and analysis of relevant information is crucial in order to obtain high returns on investments. Relevant information includes political developments, macroeconomic conditions, production levels for each industry, microeconomic aspects of firm activities etc. And the analysis must be detailed scenario analysis of each country's economic future, employing the macroeconomic and microeconomic information. If this can be done, investing abroad should not be much different from investing inside Japan.

The rapid expansion of fintech since the Lehman crisis is having a huge effect on financial institutions. Japan can expect further ageing and the consequent decline in domestic demand, corporate investment and housing investment. To sustain this kind of economy and society, high-yielding investment is crucial. And for that, human resources that engaged in traditional deposit-taking and lending must be retrained so that they become regional specialists capable of analyzing political, macroeconomic and microeconomic information from all over the world.

Japan is behind the rest of the world in terms of fintech investment as well. This is shown in Figure 3, which compares IPOs (initial public offerings) of financial and non-financial firms in 2016. The value for China is so high, five times as high as in Japan, that the scale is set differently from the other countries. Another characteristic of Japanese IPOs is that the majority is in the non-financial sector. In contrast, in China, India and Singapore, IPOs in the financial sector are numerous, reflecting the vivacity of fintech-related investment in these countries.

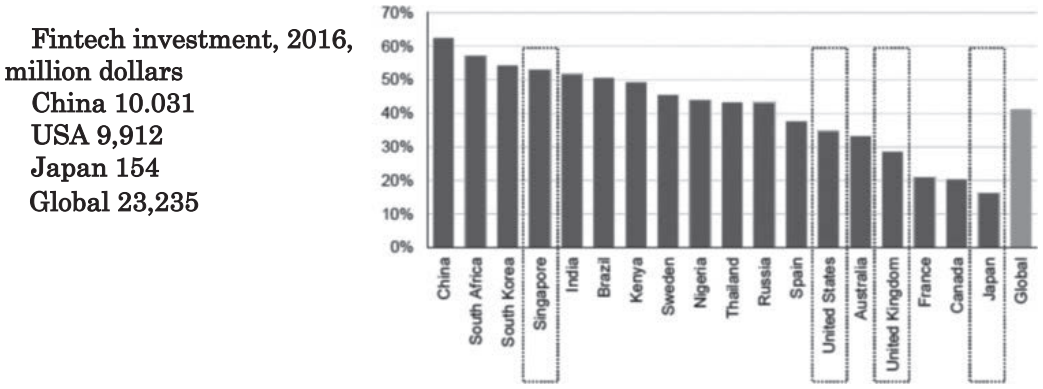
Figure 4 tells us that fintech investment in Japan is only one-sixtieth of those in the USA and China. China is also number one in the use of mobile banking while Japan is at the bottom of this graph, far lower than the global average.

Figure 3. Comparison of IPOs Involving Asian Firms



Source: OECD Equity Markets Review dataset, see methodology for details.

Figure 4. Fintech Investment and Ratio of Mobile Banking Use (2016)



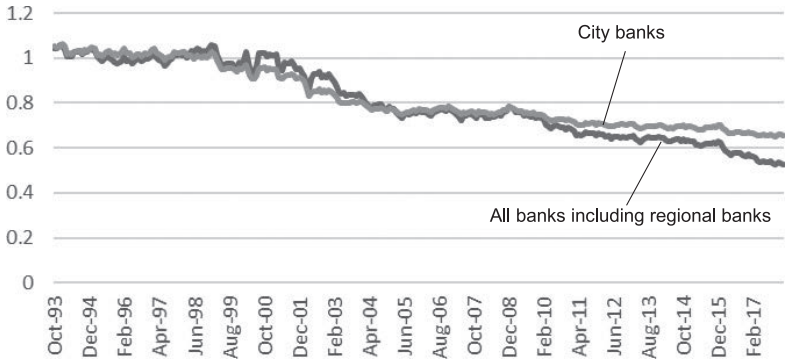
Source: Reference data on industry, finance and IT (Fintech), METI Economic and Industrial Policy Bureau, Industrial Finance Division, April 2016

III. Ageing and the 'Furusato Investment Fund'

Figure 5 shows the decline in borrowing from banks (in particular all banks including regional banks) in Japan. Compared to city banks, all banks including regional banks have seen larger decreases. Cashless payments are not yet widely used in Japan[1]. But the government is encouraging the use of credit cards and mobile payments, while mobile transaction

[1] METI (2018) reports a figure of 18.4% for the ratio cashless payments in all payments in Japan in 2015. The same ratio was 89.1% in South Korea, 60% in China.

Figure 5. Change in Lending-to-Deposit Ratio of Japanese Banks



Source: Yoshino and Yamagami (2019), including both mega banks and regional banks

technologies are mainly dominated by fintech firms rather than traditional banks. The ageing of our population will lead to lower bank loans since elderly people purchase fewer houses and other big-ticket items compared to the young. Growth of fintech firms that provide cashless means of transaction will reduce the profit margins of traditional banks.

One way for banks to survive and prosper in this environment is to work together with Furusato (hometown) Investment Funds[2]. There are two types of such funds, a 'purchasing type' and an 'investment type', and both contribute to regional demand expansion.

The 'purchasing type' advertises products made by start-up companies. Consumers order the products produced by start-up companies over the internet using their computer or mobile phone. If the products are reliable and of high quality, many consumers repeatedly order the products. Good start-ups can keep on expanding their sales. The Furusato funds provide risk money, advice and consulting to entrepreneurs. By using the internet, products exclusive to remote regions can be sold all over Japan and the world. Products made by entrepreneurial farmers, such as vegetables, rice, meat and others that can only be purchased in that town can be advertised in Japanese, Chinese, Thai and other languages. Customers can pay online electronically. This way, Japanese regions with declining populations can still revitalize their economies. This is the 'purchase-type' hometown investment fund, made possible by cashless electronic payments. Once the start-ups get on the path of stable growth, their source of funds can be switched to bank lending. Banks can provide good advice to the start-ups for further expansion of their business.

The other hometown investment fund is the 'investment-type' fund, which is also known as 'crowdfunding'. Investors can provide small sums to entrepreneurs and start-ups and send words of moral support electronically. Borrowers with no record of borrowing or collateral often find it difficult to borrow from banks whom they contact for the first time. But the Furusato fund can lend to get the entrepreneurs on the right path, as more are beginning to do

[2] Details are in Yoshino and Kaji eds. (2013).

in Japan.

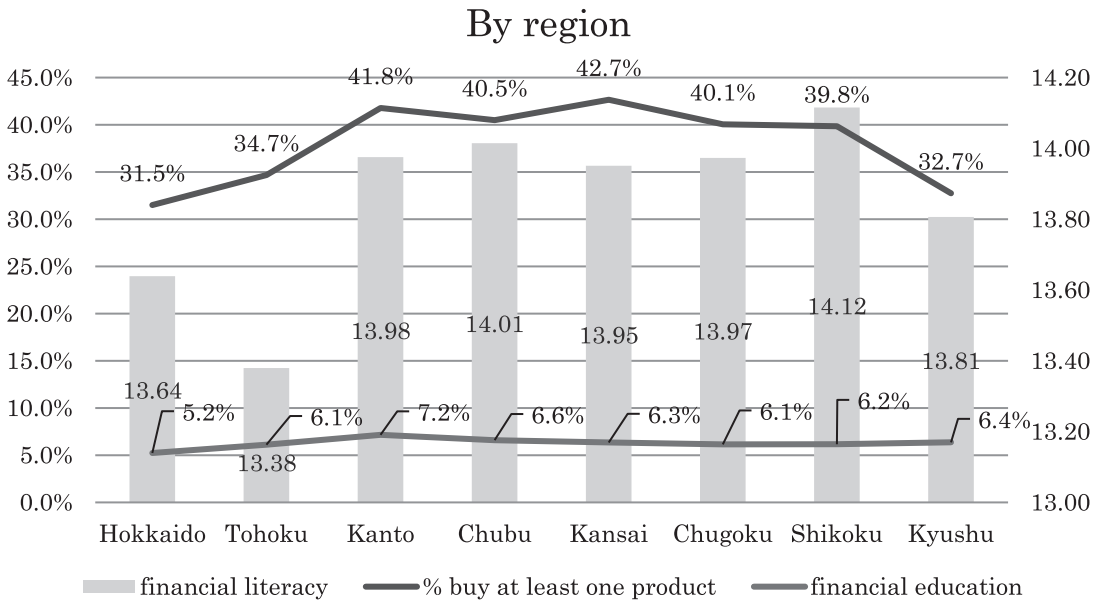
Even if businesses fail, each investor's amount of contribution is not so large. Many individuals would like to assist start-ups and help them grow their business. Each start-up individual explains his/her vision in order to attract individual contributors. The crowdfunding companies can assist these start-ups by providing sales channels by over the internet. Banks whose finance come from deposits cannot provide loans to these yet unknown start-ups. Crowdfunding is the way to provide finance to such risky start-up businesses. Many Asian countries do not have deep capital markets. Venture capital firms have difficulty raising money. Community-based hometown crowdfunding will be one of the ways to encourage micro business and start-ups. Hometown crowdfunding started about 20 years ago, and has now been expanded to Peru, Cambodia, Vietnam etc.

IV. Fintech and Economic and Financial Education

In the previous section, we discussed the supply side of financing to start-ups and micro SMEs. In this section, we explain why we need financial education in the age of development of financial technology. This section is taken from Yoshino, Morgan and Long (2017) which explains detailed analysis by use of BOJ survey data. Today, many people have access to not just a bank account but also various financial products via the internet. One can access overseas financial products easily by use of technology.

Without solid knowledge of risks and returns from various financial products, one can easily purchase risky financial products and lose money. Households can access consumer

Figure 6. Financial Literacy Score by Various Regions of Japan



Source: Yoshino, Morgan and Long (2017)

loans by use of their credit card, mobile phones etc. Households' debt overhang becomes a serious problem in, for example, Thailand and several other Asian countries. Malaysia, Thailand, Vietnam, and Cambodia have started financial education initiatives at school. Yet much more emphasis has to be put on financial education at many levels of education.

Figure 5 shows (i) the score of financial literacy (survey conducted by Bank of Japan, Central Council for Financial Services Information), (ii) the purchase of sophisticated financial products (such as stocks, trusts and foreign currency products), and (iii) the amount of financial education. There is a wide disparity in the regions. Urban regions show higher share of purchasing sophisticated financial products, as shown by the % share that bought at least one product among stocks, trusts and foreign currency products. Tohoku region in Japan shows very low score of financial literacy.

IV-1. The Financial Literacy Survey of Japan

The Central Council for Financial Services Information (CCFSA) conducted a nationwide survey of 25,000 individuals with ages ranging from 18 to 79. The survey was taken from all over Japan (47 prefectures) by balanced sampling. 18 questions in the survey are about financial knowledge and 7 questions are about asset allocation.

Table 2 compares the literacy scores based of the different prefectures. Nara and Kagawa prefectures have the highest scores in Japan followed by Kyoto Okayama and Kagoshima prefectures. The Western part of Japan shows relatively higher scores compared to the Northern part of Japan. On the other hand, Yamanashi and Okinawa prefectures show the

Table 2. Literacy Score of Various Prefectures

		Objective assessment			
	Prefecture	% Correct answers given to questions	National average=100	Self-assessment (national average=100)	Gap (actual score - self-assessment)
Highest	Nara	60.5	108.8	102	6.8
2nd highest	Kagawa	59.4	106.8	106.7	0.1
3rd highest	Kyoto	58.2	104.7	99.8	4.9
4th highest	Okayama	58	104.3	101	3.3
5th highest	Kagoshima	57.9	104.1	99.8	4.3
National average		55.6	100	100	0
5th lowest	Nagasaki	52.5	94.4	96.5	-2.1
5th lowest	Tottori	52.5	94.4	104	-9.6
4th lowest	Aomori	51.7	93	103	-10
3rd lowest	Yamagata	51.6	92.8	Ob	-10.2
2nd lowest	Okinawa	51.3	92.3	92.5	-0.2
Lowest	Yamanashi	48.7	87.6	94	-6.4

Source: Yoshino, Morgan and Long (2017)

lowest scores followed by Yamagata, Aomori, Tottori and Nagasaki prefectures. By region, the Shikoku region shows the highest score and Hokkaido has the lowest score.

The Nichi-nichi newspaper in Yamanashi prefecture where the literacy score was the lowest wrote that "the survey's result that our prefecture shows the lowest score among 47 prefectures in Japan is quite shocking to the residents in Yamanashi prefecture. There must be cultural reasons. People in the region appreciate mutual assistance, and group oriented traditional financing was popular which made people in the prefecture not aware so much about financial education."

Table 3 shows the result of a cluster analysis that grouped prefectures similar in financial literacy. Five groups have been classified by use of prefectural data. The first group consists of Yamagata, Yamanashi, Tottori, and Ishikawa prefectures, etc. The second group is Wakayama, Miyagi, and Kochi prefectures. The third group is Nakano, Okayama, and Tokushima prefectures, etc. The fourth group consists of Hyogo, Saitama, Osaka, Fukuoka, Tokyo etc. which are highly populated prefectures in Japan. The fifth group is Okinawa. Densely populated prefectures show a similar characteristic and regional prefectures are grouped in another similar characteristic.

Table 4 compares the scores of males and females (1), and the US and Japan (2). The accuracy ratio for males is higher than that for females. The males in their 50s, 60s and 70s show relatively higher score than other ages. A comparison between Japan and US can also be seen in Table 4. The US score is 21.0 which is much higher than the score of Japan which scores 6.6.

Table 3. Clustering of Prefectures Based on Literacy Score

Group 1	Group 2	Group 3	Group 4	Group 5
Yamagata	Wakayama	Nagano	Hyogo	Okinawa
Yamanashi	Miyazaki	Okayama	Saitama	
Tottori	Kochi	Tokushima	Osaka	
Ishikawa	Akita	Nara	Fukuoka	
Nagasaki	Yamaguchi	Kumamoto	Miyagi	
Tochigi	Shimane	Gifu	Chiba	
Toyama		Kagawa	Aichi	
Ibaraki		Kagoshima	Shiga	
Hokkaido		Shizuoka	Kanagawa	
Gumma		Fukui	Tokyo	
Fukushima		Oita		
Niigata		Kyoto		
Ehime				
Mie				
Saga				
Aomori				
Hiroshima				
Iwate				

Source: Yoshino, Morgan and Long (2017)

Table 4. (1) Age Group and Gender Group Scores, (2) Japan-US Comparison

Table 4 (1) Age group and gender group scores

	All	Male	Female
All	20.90%	26.50%	15.50%
Age<30	10.10%	12.90%	7.20%
Age>=30 & Age<40	16.60%	22.70%	10.30%
Age>=40 & Age<50	20.70%	26.60%	14.80%
Age>=50 & Age<60	25.80%	30.80%	20.90%
Age>=60 & Age<70	28.10%	35.10%	21.90%
Age>=70	23.90%	31.80%	16.80%

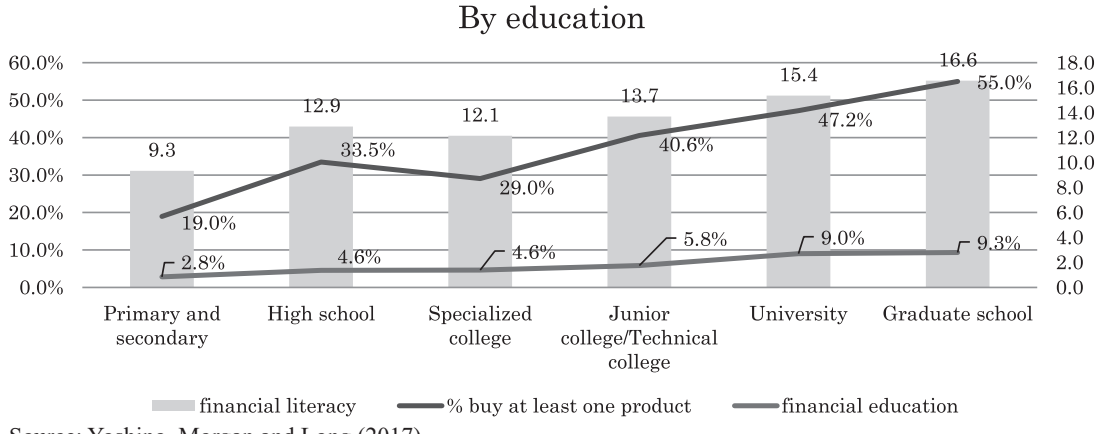
Table 4 (2) Japan-US comparison

	% with financial education
Japan	6.60%
Age 18-29	10.70%
Student (Age 18-24)	14.40%
Age 30-59	6.00%
Age 60-79	5.50%
USA	21.00%

Source: Yoshino, Morgan and Long (2017)

The score of financial literacy relates to the level of education, as can be seen in Figure 7. Those who had studied up to graduate school show the highest score followed by the group with undergraduate degrees. And financial literacy scores also positively correlate with income. The higher the income level, the higher the score (Figure 8).

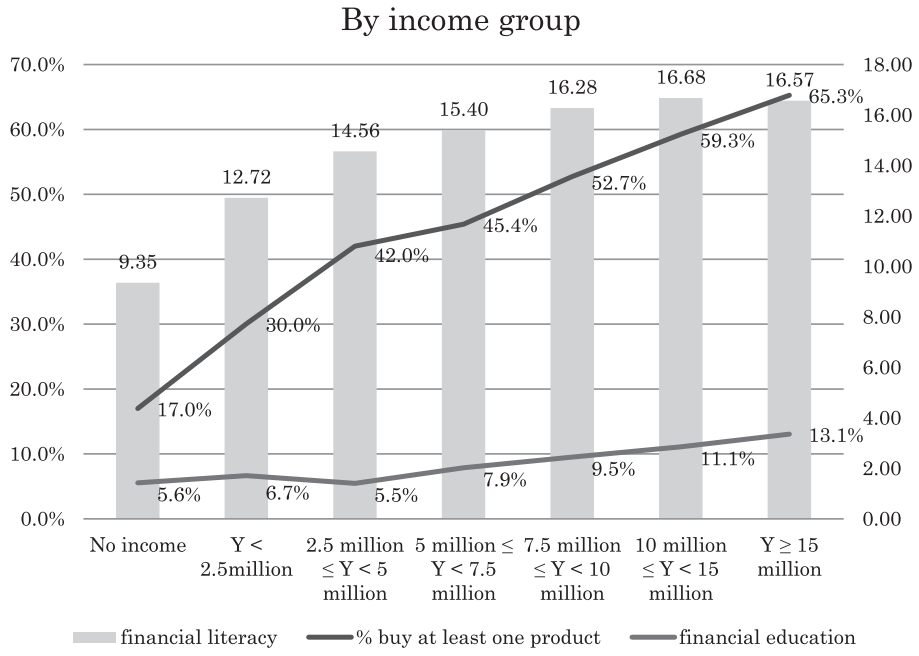
Figure 7. Financial Scores Based on Education Level



Source: Yoshino, Morgan and Long (2017)

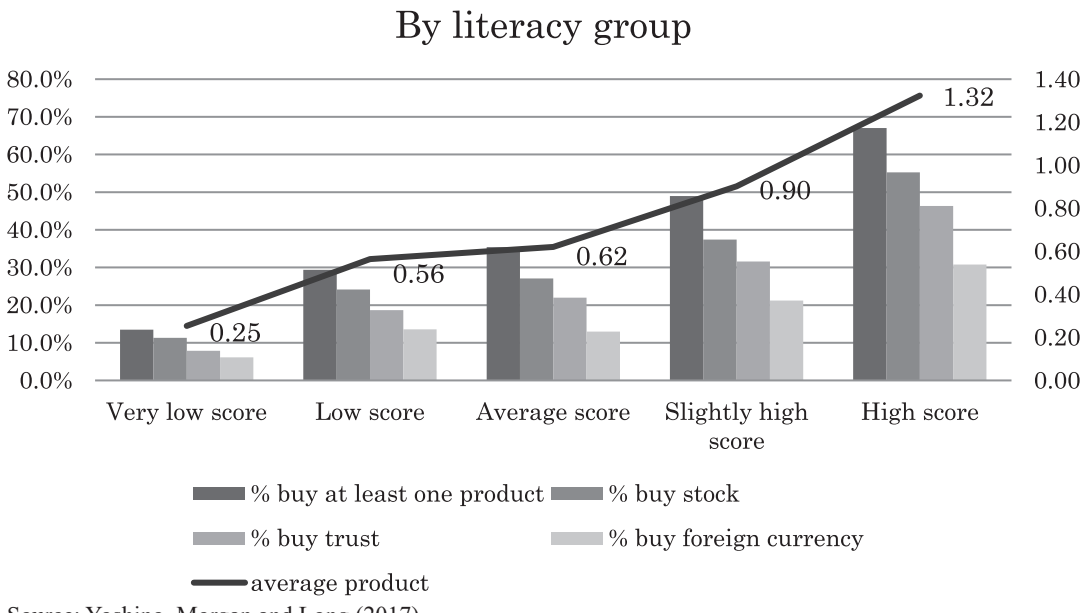
Finally, Figure 9 shows the relationship between financial literacy score and asset allocation. The survey asks whether each individual owns (i) stocks, (ii) investment trusts, (iii)

Figure 8. Financial Literacy and Annual Income



Source: Yoshino, Morgan and Long (2017)

Figure 9. Financial Literacy Score and its Relation to Asset Diversification



Source: Yoshino, Morgan and Long (2017)

foreign-currency-denominated assets. The figure shows a lower score to the left and a higher score to the right. The higher the score of financial literacy, higher the asset allocation.

By using the following equations, we applied the two-stage least-squares analysis to the data. The first level examined how the financial literacy score can be explained. In the second stage, financial asset allocation was explained by literacy score and other explanatory variables. The results can be summarized as follows:

(1) Those who score high in financial literacy tend to diversify their financial assets.
(2) Higher the financial education, higher the diversification of financial assets rises.
(3) Higher the level of education, higher the diversification of financial assets rises.
(4) Higher the income, higher the diversification of financial assets increases.
(5) Males tend to invest more into various financial assets compared to females in Japan.

The allocation of assets and financial and economic literacy

$$FPi = \beta_0 + \beta_1 FLi + \beta_2 Xi + \eta i$$

FPi = whether they own stocks, trusts and foreign currency products
FLi = score of financial literacy
Xi = explanatory variables (1) age (2) gender (3) level of education (4) annual income (5) profession (6) whether they read articles related to economics (7) region
ηi t = he residual term

Explanatory factors of financial and economic literacy

$$FLi = \alpha 0 + Xi' \alpha 1 + \varepsilon i$$

FLi = degree of financial and economic literacy
Xi = explanatory variables (1) age (2) gender (3) level of education (4) annual income (5) profession (6) whether they read articles related to economics (7) region
εi = the residual term

IV-2. The reasons why Japanese financial education lagged behind

What are the reasons why Japan's financial education lagged behind compared to that in the US? The Security dealers' association conducted a survey of secondary schools and high schools in Japan. The results tell us the following. (1) not much time is allocated to financial education at school, (2) there are many other subjects which students have to learn, (3) teachers do not have enough knowledge to teach financial education at school, (4) there are not so many statements related to finance in the text books used at school. Several schools do teach financial education, but teachers face many difficulties. (1) Only technical terms are presented for memorization without explanation on the significance in terms of finance, (2) many expressions in the textbooks such as "rate of return" and "risks associated with financial investment" have nothing to do with students' daily life and difficult to understand. Based on these difficulties, the Central Council for Financial Services Information (CCFSA)

not only provides detailed description of teaching materials but also supplies free textbooks online and visits various schools to conduct actual teaching to students. Online lectures began so as to fit the daily living of students' life style.

V. Effects of Fintech on Macroeconomic Agents

This section analyzes the impact of fintech on consumer behavior, banking behavior and corporate behavior by use of a simple microeconomic model. The impact of fintech on the macroeconomy will be addressed at the end of the section.

V-1. Households' utility maximization and the impact of fintech on household behavior

Households' utility depends on three factors, namely consumption (C), labor supply (N) and deposit holdings (D). C and D have positive impacts on the level of utility, the labor supply has negative impact on utility.

Coefficients β and γ are the respective weights on labor supply and deposits. If one feels that the holding of deposits have high value, the coefficient of γ will be large.

$$U\ (Ct, Nt, Dt) = \log C_t - \beta \log N_t + \gamma \log D_t$$

Households receive wages (W_tN_t) and interest income holding deposits together with their principal $(1 + r^D_t)D_t$. These incomes are divided into consumption (P_tC_t) and savings (S_t). The two-period model has two budget constraints of period t and t+1 to maximize the utility of the household.

$$\left(\begin{array}{l} P_tC_t + S_t = W_tN_t + (1 + r^Dt)D_t \\ P_{t+1}C_{t+1} + S_{t+1} = W_{t+1}N_{t+1} + (1 + r^D_{t+1})\ D_t + S_t) \end{array} \right)$$

The amount of deposit at the end of t+1 (D_{t+1}) is the total amount of deposit at the end of period t (D_t) and the amount of savings in period t (S_t).

$$D_{t+1} = D_t + S_t$$

Utility maximization of households can be solved by use of the Lagrange multiplier as follows.

$$\begin{aligned} L\ (C, N, A) = (&\log C_t - \beta \log N_t + \gamma \log D_t) + \theta\ (\log C_{t+1} - \beta \log N_{t+1} + \gamma \log D_{t+1}) \\ &- \lambda_1 \{P_tC_t + S_t - W_tN_t - (1 + r^D_t)\ D_t\} \\ &- \lambda_2 \{P_{t+1}C_{t+1} + S_{t+1} - W_{t+1}N_{t+1} - (1 + r^D_{t+1})(D_t + S_t)\} \end{aligned}$$

The optimal amount of consumption (C_t), labor supply (N_t) and deposit (D_t) at period t are obtained as follows:

$$\frac{\partial L}{\partial C_t} = \frac{1}{C_t} - \lambda_1 P_t = 0$$

$$\frac{\partial L}{\partial N_t} = -\beta \frac{1}{N_t} - \lambda_1 W_t = 0$$

$$\frac{\partial L}{\partial D_t} = \gamma \frac{1}{D_t} + \lambda_1 (1 + r_t^D) = 0$$

The optimal amount of consumption becomes,

$$C_t = \frac{1}{\lambda_1 P_t}$$

The amount of optimal labor supply becomes,

$$\beta \frac{1}{N_t} = \lambda_1 W_t \Rightarrow N_t = \frac{\beta}{\lambda_1 W_t}$$

The optimal amount of deposit will become as follows.

$$\gamma \frac{1}{D_t} - \lambda_1 (1 + r_t) \Rightarrow D_t = -\frac{\gamma}{\lambda_1 (1 + r_t)}$$

The development of fintech will increase efficiency of banking businesses which will increase interest rates on deposits. Increase in the deposit rates of interest will lead to an increase of deposits by households as follows.

$$\frac{\partial \mathrm{U}}{\partial r_t} = \frac{\partial \mathrm{U}}{\partial D_t} \frac{\partial D_t}{\partial r_t^D} > 0$$

Households' consumption in period t+1 (C_{t+1}), labor supply in t+1 (N_{t+1}) and deposit supply in period t+1 (D_{t+1}) will be as follows.

$$\frac{\partial L}{\partial C_{t+1}} = \frac{\delta}{C_{t+1}} - \lambda_2 P_{t+1} = 0$$

$$\frac{\partial L}{\partial N_{t+1}} = -\beta \frac{\delta}{N_{t+1}} - \lambda_2 W_{t+1} = 0$$

$$\frac{\partial L}{\partial D_{t+1}} = \gamma \frac{\delta}{D_{t+1}} + \lambda_2 (1 + r_{t+1}^D) = 0$$

$$C_{t+1} = \frac{\delta}{\lambda_2 P_{t+1}}$$

$$N_{t+1} = \frac{\beta \delta}{\lambda_2 W_{t+1}}$$

$$D_{t+1} = -\frac{\gamma\delta}{\lambda_2(1+r_{t+1})}$$

Development of fintech will make banks operate more efficiently, which will increase the rate of interest on deposits. Thus, the utility of households will be improved by the development of financial technology.

$$\frac{\partial \mathrm{U}}{\partial r_{t+1}} = \frac{\partial \mathrm{U}}{\partial D_{t+1}} \frac{\partial D_{t+1}}{\partial r^D_{t+1}} > 0$$

V-2. The impact of fintech on banking behavior

Banking behavior is summarized as accepting deposits and making loans to firms and households. Their profits are interest income from loans ($(1+r_t)\ L_t$) subtracted by default losses ($\rho_t L_t$) and interest payment to depositors ($(1+r_t^D)\ D_t$). Banks' costs are loan evaluation and various costs of accepting deposits as ($C\ (L_t, D_t)$).

$$\Pi^{\beta}_t = (1+r^L_t)L_t - \rho_t L_t - (1+r^D_t)D_t - C(L_t, D_t)$$

The balance sheet of the bank is shown as follows; banks receive deposits (D) and keep a certain amount of capital (A^B_t) in order to match the Basel capital requirement. The asset of banks is bank loans (L_t).

$$L_t = D_t + A^{\beta}_t$$

Substituting the balance sheet of the bank into the profit function, we get the following equation.

$$\Pi^{\beta}_t = (1+r^L_t)L_t - \rho_t L_t - (1+r^D_t)(L_t - A^{\beta}_t) - C(L_t, L_t - A^{\beta}_t)$$

Assuming that the cost function of the bank is quadratic in terms of loans and deposits,

$$C\ (L_t, D_t) = \alpha_1 L^2_t + \alpha_2 L_t + b_1 D_t + b_2 D^2_t$$

Profit maximization with respect to bank loans can be obtained as follows.

$$\frac{\partial \Pi^{\beta}_t}{\partial L_t} = 1 + r^L_t - \rho_t - (1+r^D_t) - 2\alpha,\ L_t = 0$$

The optimal amount of bank loans will be,

$$L_t = \frac{1}{2\alpha_1}\{r^L_t - \rho_t - r^D_t\}$$

The development of fintech will reduce various costs for banks. The coefficient of α_1, α_2, b_1, b_2 will decline when banks' operations are made efficient. Monitoring costs of firm behavior will be reduced by use of data analysis, while traditionally monitoring was only pos-

sible by visiting firms and checking business activities. Cost efficiency created by the development of fintech will be represented by reduction in α_1.

$$\frac{\partial L_t}{\partial \alpha_1} = -\frac{1}{2\alpha_1^2}\{r_t^L - \rho_t - r_t^D\} < 0$$

The reduction in α will increase the amount of loans provided by banks due to improved efficiency by banks. The development of fintech will also reduce the loan rate and increase the deposit rate of interest by reducing costs of banks. Big data analysis by the development of fintech will reduce default risks (ρ) which will benefit both households and firms which benefit from the decline in the loan rate and the increase in deposit interest rate.

V-3. Profit maximizing behavior of Firms

The production function of a representative firm can be represented by a Cobb-Douglas production function as,

$$Y_t = f(N_t, K_t) = N_t^{\theta} K_t^{1-\theta}$$

with labor input (N_t) and capital input (K_t).

The profit of the firm is shown as total sales (P_tY_t) subtracted by wage payment (W_tN_t) and interest payment to banks ($r_t^LK_t$).

$$\Pi_t^F = P_tY_t - W_tN_t - r_t^LK_t$$

The optimal amount of capital and labor inputs will be obtained as follows.

$$\frac{\partial \Pi_t^F}{\partial N_t} = P_t\frac{\partial Y_t}{\partial N_t} - W_t = \theta P_t\frac{Y_t}{N_t} - W_t = 0$$

Optimal labor input depends of amount of sales (P_tY_t) and the wage rate (W_t).

$$N_t = \frac{\theta P_tY_t}{W_t}$$

$$\frac{\partial \Pi_t^F}{\partial K_t} = P_t\frac{\partial Y_t}{\partial K_t} - r_t = (1-\theta)P_t\frac{Y_t}{K_t} - r_t^L = 0$$

Which will be rewritten in terms of optimal capital as follows.

$$K_t = \frac{(1-\theta)P_tY_t}{r_t^L}$$

It depends on sales (P_tY_t) and the interest rate paid to banks (r_t^L). This equation can be seen as a borrowing equation of loans by firms from banks where capital is financed by bank loans.

Supply of bank loans is obtained from section V-2. The lending rate of interest is ex-

pressed by the amount of bank loans, default risk ratio and deposits interest rate as follows.

$$r_t^L = 2\alpha_1 L_t + \rho t + r_t^D$$

The supply interest rate charged by banks can be substituted into demand for bank loans.

$$K_t = \frac{(1-\theta) P_t Y_t}{2\alpha_1 L_t + \rho t + r_t^D}$$

The capital stock which comes from bank loans become larger when the cost of banks (α_1) declines due to the development of fintech. The reduction of cost of banks (α_1) will increase capital stock of firms (K_t).

$$\frac{\partial K_t}{\partial \alpha_1} < 0$$

In increase of capital stock due to the development of the fintech will increase total sales of firms as follows.

$$\frac{\partial Y_t}{\partial \alpha_1} = \frac{\partial Y_t}{\partial K_1} \frac{\partial K_t}{\partial \alpha_1} < 0$$

An increase of sales by firms will increase wages which will lead to higher income for households. The level of household utility will rise.

$$\frac{\partial U}{\partial \alpha_1} = \frac{\partial \mathrm{U}}{\partial C_t} \frac{\partial C_t}{\partial \mathrm{Yt}} \frac{\partial \mathrm{Yt}}{\partial \alpha_1} < 0$$

V-4. Changes in capital inflow and outflow from abroad due to fintech

The development of fintech will make it much easier for firms to raise money. Access to various financial products not only in the domestic market but also from overseas markets will lower costs. The domestic bank loans (L_t) are augmented by capital inflows (CAP_t) from abroad to raise capital (K_t).

$$K_t = L_t + CAP_t$$

Whether firms borrow from overseas or not depends on the interest rate charged by domestic banks and the cost of raising money from abroad. When firms borrow from domestic banks, they pay the loan rate of interest (r^L_t). On the other hand, raising money from abroad involves foreign interest rates (r_t^λ), exchange-rate fluctuations ($\Delta e/e$), cost of borrowing from overseas (t_t^e) and other risks associated with raising from money from overseas (σ).

$$CAP_t = f\left\{(r_t^L) - (r_t^\lambda + \frac{\Delta e}{e} - t_t^e + \sigma)\right\}$$

The development of fintech will reduce various costs of raising money from overseas

(t_t^e)which will make it easier for Japanese companies to borrow from overseas. It will contribute to raising output of Japanese firms.

$$\frac{\partial Y_t}{\partial K_t} = \frac{\partial K_t}{\partial CAP_t} \frac{\partial CAP_t}{\partial t_t^e} < 0$$

At the same time, the development of fintech will increase risks of overseas' capital flows due to increases in volatility of capital flows. In turn the volatility of output of Japanese firms will rise.

$$\text{VAR}\ (Y_t) = \delta \text{VAR}\ (CAP_t)$$

The following conclusions are obtained from this simple mathematical analysis.

(i) The development of fintech will make baking business much more efficient, which will increase the deposit rate of interest. Consumers' welfare will be improved.

(ii) An increase of efficiency of banks will reduce their lending rate of interest, and analyzing the big data of borrowers will reduce the default losses of banks. Companies will benefit from lower interest rates for their bank loans and can increase the sales of their company.

(iii) Fintech development will reduce the transaction costs of capital from abroad which will enable Japanese companies to raise money from abroad. Information of Japanese firms can be obtained with less cost by overseas investors due to the development of fintech, which will increase capital flows from abroad.

(iv) However, the volatility of capital flows will become wider which will increase the volatility of output of companies that rely not only on domestic banks but also overseas capital. The volatility of capital flows might increase the volatility of exchange rates which will lead to larger risks associated with exchange rate fluctuations.

If development of financial technology can increase the volatility of the macroeconomy, we need to reconsider how we conduct macroeconomic policy and macroprudential policy. Policy measures to stabilize capital flows among various countries need to be considered with fintech-enabled private sector firms to provide the means of payment and settlement. Even if sovereign currencies are used, fintech allows payment and investment without any involvement of the banking sector. This means regulation and supervision of the banking sector alone is not enough to avoid financial crises, they must cover private sector firms providing the electronic means of payment and investment. If and when such private sector firms are in financial trouble, we need to know which institution will provide capital injection on which legal grounds. We also need to pay attention to the foreign holding of stocks of such private sector firms that provide the means of payment and investment. Some amount of legal protection from foreign takeovers seems to be called for, because stopping the payment application can stop that part of the macroeconomy.

VI. Concluding Remarks

In this paper, we showed how Japan is left far behind in fintech, on its supply and demand sides. Comparing Japanese returns on asset management and fintech-related investment to those of other countries, we can see that Japan is way behind on the supply side. To strengthen the supply side, funds such as the Hometown Investment Funds would play important roles. On the demand side, Japan clearly needs to strengthen its financial and economic education.

As for effects of fintech on the different macroeconomic agents, our theoretical analysis shows that they can be both positive and negative. Fintech also has prudential implications for macroeconomic stability. For instance, a legal framework is necessary for capital injection into a non-financial firm in financial difficulty, if it is engaging in financial intermediation and/or payment settlement. Laws need to be prepared also to punish misuse of electronic payment applications and the collected data[3].

Fintech also heavily affects the national security aspect of macroeconomic stability. Stopping a payment application can stop (at least that part of) the economy. If private firms come to play a dominant role in settlements, they are effectively a part of the money supply and may need to be regulated against foreign takeovers, just like major infrastructure industries[4].

References

Kaji, Sahoko (2018) "Electronic settlements and financial regulation", Paper presented at the 2nd CAG-KGRI Workshop, Tokyo

Kaji, Sahoko (2019) "Electronic settlements and financial regulation", forthcoming in Kikuchi, T. and M. Sakuragawa eds. Financial Cooperation in East Asia, RSIS Monograph, S. Rajaratnam School of International Studies.

METI (2018) *Cashless Vision*, https://www.meti.go.jp/english/press/2018/0411_002.html

McNelis, Paul and Naoyuki Yoshino (2016) "Finding stability in a time of prolonged crisis: Unconventional policy rules for Japan", Journal of Financial Stability, Vol. 27, December.

McNelis, Paul and Naoyuki Yoshino (2018) "Household Income Dynamics in a Lower-Income Small Open Economy: A Comparison of Banking and Crowdfunding Regimes", Singapore Economic Review, Vol. 63, No.1

Yoshino, Naoyuki and Sahoko Kaji eds. (2013) Hometown Investment Trust Funds, A Sta-

[3] In relation to blockchains, Japan's cabinet decided, and FSA submitted to the diet, on 15th March 2019 a bill (Johogijutsu no hatten ni tomonau kinyutorihiki no tayoka ni taiou surutameno shikinkessai ni kansuru houritutou no ichibu wo kaisei suru houarituan) which contained renaming of 'crypto currencies' to 'crypto assets', in the form of a partial revision of the Payment Services Act (Shikin Kessai Ho). Article 18 of the supplementary provisions of this bill makes the same change in the income tax law. https://www.fsa.go.jp/common/diet/198/02/houritsuanriyuu.pdf

[4] This point is discussed in more detail in Kaji (2018, 2019).

ble Way to Supply Risk Capital, Springer.
Yoshino, Naoyuki, Peter J. Morgan and Trinh Q. Long (2017) "Financial Literacy in Japan: Determinants and Impacts", No. 796, December 2017, Asian Development Bank Institute (ADBI) Working Paper Series
Yoshino, Naoyuki and Hidefumi Yamagami (2019) *Kinyuron*, Keio University Publishing