Can Intangible Investments Ease Declining Rates of Return on Capital in Japan?

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Abstract

Japan's economic growth has slowed since the collapse of the bubble economy in the 1990s due to low capital accumulation. We focus on the low rate of return on capital, which led to this slow capital accumulation, finding that it was caused by an increase in the capital-output ratio and low capital share. Not only has the rate of return on capital declined, but its variance across industries has increased, as has the number of industries with negative rates of return. We estimate a profit function in which the profit rate is explained not only by the real wage but also by intangibles. The estimation results show that investment in human resources increases the profit rate and that intangibles contribute to this increase through productivity improvement, especially in the IT industry. Our study implies that governments should implement a comprehensive innovation policy that stimulates investments not only in R&D, but also in IT and human resources.

Many advanced countries have suffered slow growth rates since the start of the global financial crisis. In his 2015 IMF lecture, Professor Lawrence Summers warned that the United States and advanced countries in Europe might follow the Japanese economy and suffer from a long-term stagnation similar to what Japan has suffered since the collapse of the bubble economy in the 1990s (Summers (2015a, 2015b). He and his followers have emphasized that the

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Table 1: Sources of Economic Growth in Japan, the United States, Korea, and Republic of China, Taiwan (average annual % rate of change)

	Japan			United States		
	1980-90	1990-2000	2000-2010	1980-90	1990-2000	2000-2010
GDP	4.4	0.9	0.7	3.1	3.3	1.5
Labour input	1.1	0.0	0.0	1.0	0.9	-0.3
Capital input	1.9	1.0	0.3	1.2	1.3	1.0
TFP	1.5	-0.1	0.5	0.9	1.1	0.6
	Korea			**Republic of China, Taiwan**		
	1980-90	1990-2000	2000-2010	1980-90	1990-2000	2000-2010
GDP	9.1	6.1	4.2	7.9	6.5	3.4
Labour input	1.6	0.6	-0.1	1.1	0.6	0.5
Capital input	4.4	3.9	2.1	3.8	3.9	1.5
TFP	3.1	1.6	2.1	2.9	1.9	1.4

Source: JIP database, APO productivity databook

slow growth rate in advanced countries is caused by a decline in capital formation and real interest rates.[2]

This slow capital accumulation has led to stagnation in Japan. The gap in economic growth between Japan, the United States, and East Asian countries in the 2000s is not due to the gap in the contributions of labour input but to the gap in contributions of capital input, as shown in Table 1.

Before Summers pointed out the issues concerning the falling real interest rates and corporate profit rates, Japanese economists had discussed that it was the inefficiency of capital that had led to the low real interest and profit rates. Ando, Christelis, and Miyagawa (2003) and Hayashi (2006) argued that corporate savings in Japan were misallocated. As Japanese managers usually pay fixed dividends, the remaining corporate savings are excessively allocated to fixed capital formation, which induced low corporate profits. Based on these views, Saito (2007) argued that over-investment crowds out consumption and generates welfare loss. Fukao *et al.* (2016) confirmed that the over-investment in the 1980s and 1990s led to a high capital-output ratio and a low rate of return on capital. Miyagawa (2004, 2005) suggested that the low corporate profit rate in the 1990s was caused by a high labour share and low TFP growth.

Since the global financial crisis, Japan's real capital stock has fallen despite its historically low interest rate and expansionary monetary policy. Murase and Ando (2014) demonstrated the possibility of a steady state whereby economic agents hold money instead of tangible capital under weak governance, allowing for a low capital accumulation under a zero interest rate. Benigno and Fornaro (2015) also show an equilibrium representing a secular stagnation by combining a standard short-run Keynesian model with an endogenous growth model. In this equilibrium, underemployment and low potential growth coexist under zero interest rates and pessimistic expectations of future growth.

These studies imply that the capital-output ratio, factor shares, and productivity growth play crucial roles in the decline of real rates of interest and corporate profit rates, which leads to low capital accumulation. We examine long-

2 Solow (2014) also discussed the secular stagnation induced by low capital accumulation.

Table 2: Real Gross Rate of Return on Capital in Japan

	1980-1989	1990-1999	2000-2012
Marginal rate of return on capital (%)	13.6	12.9	10.4
Average rate of return on capital (%)	18.0	15.8	14.4

Source: Authors' calculations based on JIP2015 database.

term movements in the rate of return on capital using the Japan Industrial Productivity (JIP) database[3] and determine whether wage rates and innovative factors which improve productivity affect the rate of return on capital by estimating a profit function.[4]

Movements in the marginal rate of return on capital are broken down into the capital-output ratio and capital share. We find that the capital-output ratio follows an upward trend, as Fukao *et al.* (2016) found, and is particularly high in non-IT industries. On the other hand, the capital share in non-IT industries has followed a downward trend over the past 30 years. In addition, the relative variance across industries asset types of the average rate of return on capital was very large in 2012, and the number of industries showing a negative rate of return has increased.

We estimate a profit function based on a simple production function that uses industry-level data and examine the factors affecting the rate of return on capital. The estimation results show, first, that an increase in wage rates has a negative impact on the rate of return on capital, as we expected. Second, greater investment in intangibles leads to higher rates of return on capital through productivity growth. Third, we find complementary effects among intangibles, especially in the IT industry. These results suggest that governments should implement a comprehensive innovation policy that stimulates investments in not only R&D but in IT and human resources as well.

In the first section, we examine movements in the rate of return on capital, the capital-output ratio, and capital share using the JIP Database. In the second section, we estimate a profit function to examine the determinants of the profit rate. In the third and final section, we summarize our results and discuss their policy implications.

Why Has The Rate Of Return On Capital Declined?

We show two types of real gross rate of return on capital in the market sector in Table 2. The first measure is the marginal rate of return on capital (marginal product of capital = MPK). Assuming a Cobb-Douglas function ($Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$), where Y is value added, L is labour input, K is capital input, and A is a technological factor, we obtain the following MPK:

$$MPK = \frac{\delta Y}{\delta K} = \alpha \times \frac{Y}{K} \qquad (1)$$

where α represents capital share. Then, we measure the marginal rate of return on capital

3 The Japan Industrial Productivity (JIP) Database is a KLEMS-type database that provides data on outputs, intermediate inputs, labour, and capital from 1970 to 2012. It contains 108 industries, categorized following the two-digit industry classification of the Japan Standard Industrial Classification (JSIC). The database is available on the website of the Research Institute of Industry, Trade, and Industry (RIETI). Fukao *et al.*(2007) show how the JIP database is constructed.

4 Many studies on investment behavior in Japan suggest that the profit rate (or the Tobin's Q indicating future profitability) is the most important determinant of capital formation (e.g. Tanaka and Miyagawa, 2011).

Table 3: Decomposition of Rate of Return on Capital in Japan

		1980-1989	1990-1999	2000-2012
Capital-output ratio	Market economy	2.53	2.67	3.12
	IT industries	1.72	1.91	2.11
	Non-IT industries	3.48	3.71	4.90
Capital share (%)	Market economy	34.3	34.1	32.2
	IT industries	31.4	33.6	32.9
	Non-IT industries	38.1	34.8	31.0

Source: Authors' calculations based on JIP2015 database.

by dividing the capital share by the capital-output (value added) ratio.[5] We measure real value added by dividing nominal value added by the output deflator in the JIP database.[6] We also measure capital share by dividing the sum of the operating surplus and consumption of fixed capital by the nominal value added in the JIP database.

The second measure is the average real rate of return on capital. We obtain this measure by dividing the sum of the operating surplus and consumption of fixed capital by the real capital stock in the JIP database.[7]

Table 2 shows that both rates of return on capital were lower in the 2000s than those in the 1980s and 1990s. The average rate of return declined drastically in the 1990s. On the other hand, we find a significant decrease in the marginal rate of return in the 2000s. Hence, the gap between the average and marginal rates of return slightly widened in the 2000s. This increase implies that Japanese firms have concentrated on businesses that earn high profits by restructuring after the financial crisis in Japan, while the rate of return on new investment has declined.

Following Equation (1), we break down the marginal rate of return into the capital-output ratio and the capital share. We show these variables not only in the market sector but also in the IT-using and non-IT using sectors (Table 3). The IT-using industry is comprised of firms with a ratio of IT assets to total assets that exceeds the 2005 median value. IT assets consist of computers and peripheral equipment, communication equipment, and software.[8]

As Fukao *et al.* (2016) pointed out, the capital-output ratio in the market economy has been on an upward trend. The capital-output ratio in the non-IT sector has increased rapidly and seems to dominate the capital-output ratio movement in the market sector. The rising capital-output

5 All KLEMS-type databases like the JIP database assume that the marginal rate of return on capital in each asset can be captured as the capital service of this asset. This assumption implies that each type of capital is utilized efficiently. However, as Basu and Fernald (2001) and Miyagawa, Sakuragawa, and Takizawa (2006) showed, the capital utilization rate fluctuates in the short run. In addition, Jorgenson *et al.* (2007) and Fukao *et al.*(2012) showed that there can be a gap between the rate of return on capital at the aggregate level and the rate at the industry level due to a misallocation of capital input.

6 In the JIP database, real value added in some industries becomes negative when we measure it by subtracting real intermediate inputs from real output. Therefore, we obtain real value added by dividing nominal value added by an output deflator.

7 Operating surplus and consumption of fixed capital are deflated by the investment deflator by industry.

8 The sum of IT-using industries and non-IT using industries covers the total market economy. Hereafter, we call IT-using industries 'IT industries' and non-IT using industries 'non-IT industries'.

Table 4: Variances and Relative Standard Deviations in the Rate of Return on Capital in Japan

		1980	1990	2000	2012
Marginal rate of return	Variances	1785.6	1026.3	909.3	290.9
	Relative SD	1.5	1.2	1.4	1.5
Average rate of return	Variances	3256.9	1179.8	652.3	453.2
	Relative SD	2.0	1.3	1.4	1.7

Source: Authors' calculations based on JIP2015 database.

ratio in non-IT industries is caused by a steep decline in real value added, because this sector includes many stagnant industries.

Table 3 also shows movements in the capital share. The capital share in the market economy was greater than 30 per cent for the past 30 years. Since the 1990s it has been on a slight downward trend. Capital shares in the IT and non-IT sectors show movements different from that in the market sector. The capital share in the IT sector increased in the 1990s, while the capital share in the non-IT sectors has shown a downward trend. In Japan, the downward trend in the capital share in non-IT sectors has been more influential than has the movement in the IT sector.

The findings shown in Table 3 indicate variances in rates of return on capital among industries.[9] Table 4 shows the variances and relative standard deviations (= standard deviation/mean) in the rates of return on capital. Variances in the rates of return have decreased as the rates of return have fallen. However, the relative standard deviations have not declined to the same extent. Since 1990 the relative standard deviation in the rate of return has increased despite the decrease in the rate of return. These findings suggest that specific factors at the industry level as well as aggregate factors may affect movements in rates of return on capital. Below, we examine some of the factors affecting rates of return on capital using industry-level data.

Estimating the Profit Function

In this section, we empirically examine how the rates of return fluctuate. Taking the log in Equation (1), we obtain the following equation:

$$ln\, r_t = ln\,\alpha + ln\left(\frac{Y_t}{K_t}\right) \qquad (2)$$

where r is the rate of return on capital. Assuming a Cobb-Douglas function, Equation (2) leads to

$$ln\, r_t = ln\,\alpha + ln\, A_t + (1-\alpha)\, ln\left(\frac{L_t}{K_t}\right) \qquad (3)$$

When firms minimize their costs, (L/K) is negatively correlated with the relative factor price (w/r). Arranging Equation (3) with respect to ln r, we obtain

$$ln\, r_t = const + \alpha w_t + bA_t \qquad (4)$$

where w is the real wage. The real wage rate at the industry level is calculated as follows:

9 Nomura (2004) also found large variances in rates of return on capital across industries. As we use the JIP database, the rate of return on capital is measured on an activity basis. Firms combine some of the activities listed in the JIP database.

Real wage rate = (real value added * labour share)/total man-hours.[10]

We also assume that the technological factor is positively correlated with intangibles such as IT and R&D. Griliches and Mairesse (1990) and Hall (1993) assumed that R&D investment enhances technological progress. We extend this concept to the broader category of intangibles.[11] Our basic empirical equation is thus

$$\begin{aligned} ln r_t &= const + \alpha_1 ln w_{jt} \\ &+ \alpha_2 ln\left(\frac{K_{jt}^{IT}}{K_{jt}^{T}}\right) + \alpha_3 ln\left(\frac{K_{jt}^{RD}}{K_{jt}^{T}}\right) \\ &+ \alpha_4 ln\left(\frac{K_{jt}^{HR}}{K_{jt}^{T}}\right) + \alpha_5 ln Y_{jt} \\ &+ u_j + n_t + \varepsilon_{jt} \end{aligned} \qquad (5)$$

In this expression, K^{IT}, K^{RD}, K^{HR}, and K^T account for the capital stock in information technology, R&D, human resources (HR), and tangible assets, respectively.[12] Y is the value added by industry as a control variable. Subscripts j and t denote industry and time, while u_j and n_t denote industry and year fixed effects.[13]

Given the presumption that an increase in labour's share (decline in capital share) would reduce the rate of return on capital, we predict the sign of the coefficient will be $\alpha_1 < 0$. Thus, $\alpha_2 > 0$, $\alpha_3 > 0$, $\alpha_4 > 0$ can also be predicted because an increase in intangible investments is expected to enhance the Hicks-neutral technology. Thus, intangibles have positive effects on the rate of return on tangible capital.

In addition to Equation (5), we also estimate the following equation to check for complementary effects between intangibles:

$$\begin{aligned} ln r_t &= const + \alpha_1 ln w_{jt} \\ &+ \alpha_2 ln\left(\frac{K_{jt}^{IT}}{K_{jt}^{T}}\right) + \alpha_3 ln\left(\frac{K_{jt}^{RD}}{K_{jt}^{T}}\right) \\ &+ \alpha_4 ln\left(\frac{K_{jt}^{HR}}{K_{jt}^{T}}\right) + \alpha_5 ln Y_{jt} \\ &+ b_1 n\left(\frac{K_{jt}^{IT}}{K_{jt}^{T}}\right) \times ln\left(\frac{K_{jt}^{RD}}{K_{jt}^{T}}\right) \\ &+ b_2 ln\left(\frac{K_{jt}^{IT}}{K_{jt}^{T}}\right) \times ln\left(\frac{K_{jt}^{HR}}{K_{jt}^{T}}\right) \\ &+ u_j + n_t + \varepsilon_{jt} \end{aligned} \qquad (6)$$

When $b_1 > 0$, $b_2 > 0$ in Equation (6), we find positive complementary effects among intangibles on productivity growth.

10 According to the Monthly Labour Survey compiled by the Japanese Ministry of Health, Labour and Welfare, real wages have been declining since 2000. Contrary to this widely used statistic, the data series for real wages used in this study, obtained from the JIP database, shows an increasing trend over this period. The discrepancy between these data series is due partly to the inclusion of income from self-employment in the JIP database.

11 If we include intangibles in a production function, following Corrado *et al.* (2009), we have to adjust the value added accounting intangible investment. However, as the value added in the JIP2015 database does not fully consider the fact that intangibles are investment and have externality and network effects, we assume that intangibles affect Hicks-neutral technological progress.

12 Note that the "capital stock in information technology" used in the estimations do not account for investment in hardware associated with IT but only for investment in software.

13 To focus on the rate of return on tangible capital, we subtract the contribution of custom software from the rate of return on capital, which initially included the contribution of intangibles.

Table 5 Summary Statistics: Market Economy, 1985-2012

Variables	Definitions	Mean	Std. Dev	Min	Max	Obs
r_marginal	Marginal rate of return on capital	22.674	26.287	0.022	237.888	1,762
r_average	Average rate pf return on capital	22.431	30.083	0.027	385.338	1,762
w	Wage	3.438	3.194	0.456	34.304	1,762
K_{IT}/K_T	IT capital stock over tangible capital stock	0.012	0.014	0.000	0.104	1,762
K_{RD}/K_T	R&D capital stock over tangible capital stock	0.046	0.091	0.000	0.829	1,762
K_{HR}/K_T	Human Resources capital stock over tangible capital stock	0.003	0.003	0.000	0.031	1,762
Y	Value added	3781351	5651996	47902.62	3.87E+07	1,762
ln r_marginal	Log of marginal rate of return on capital	-1.899	0.954	-8.422	0.867	1,762
ln r_average	Log of average rate pf return on capital	-1.921	0.947	-8.208	1.349	1,762
ln w	Log of wage	1.044	0.547	-0.785	3.535	1,762
ln K_{IT}/K_T	Log of IT capital stock over tangible capital stock	-4.968	1.077	-9.099	-2.261	1,762
ln K_{RD}/K_T	Log of R&D capital stock over tangible capital stock	-4.749	2.577	-16.357	-0.188	1,762
ln K_{HR}/K_T	Log of Human Resources capital stock over tangible capital stock	-6.470	1.141	-10.102	-3.462	1,762
ln Y	Log of value added	14.455	1.164	10.777	17.472	1,762

Notes: All variables are converted into values in constant prices for 2000.
Source: Authors' calculations based on the JIP2015 database.

As mentioned, our data are obtained from the JIP2015 database. Our analysis focuses on the market economy from 1985 to 2012, consisting of 92 industries. Appendix 1 provides a description of our dataset, and Appendix 2 shows the industrial classification. Table 5 presents summary statistics for the variables used in our analysis. We find that the percentage of R&D capital in tangible capital is about 5 per cent on average. The IT capital share is lower than that of R&D capital, and the HR capital share is the lowest (about 0.3 per cent on average and 3 per cent at maximum).

We use both the marginal and average rates of return for the rate of return on capital employed for our dependent variables. Panel A in Table 6 shows the results of the industry-level fixed-effect estimation for the market economy. We also conduct a GMM estimation to test for endogeneity among our explanatory variables, using the marginal rate of return on capital.[14] First, the coefficient on wages is negative and significant in all estimations. Second, the coefficient on IT capital stock is positive and significant in the estimations of Equation (6). Third, the coefficient on R&D capital stock is negative and significant in almost all equations, suggesting that R&D investments do have negative impacts on the rate of return on capital, which is highly counterintuitive. However, the coefficient on HR capital stock is positive and significant, suggesting that greater investment in HR leads to higher rates of return on capital. In addition, the coefficient in the cross term between IT and HR is positive and significant, implying that investment in HR has a positive impact on productivity improvement not only through its own effect but also via a complementary effect with IT.

Though the negative coefficient on R&D capital stock is puzzling, the coefficients on IT and HR capital stock are positive and significant, implying that these two intangible assets contribute to higher rates of return on tangible capital.

Panel B in Table 6 shows the fixed-effect and GMM estimation results for the market economy. We use the average rate of return on capital

14 The second lags of the dependent variable and the first difference of all the exogenous variables were used as instruments.

Table 6: Estimation Results Using the Marginal and Average Rate of Return on Capital In the Market Economy

Panel A: Dependent Variable: Marginal Rate of Return on Capital

Market economy

Dependent variable: Marginal rate of return on capital

	(1)			(2)			(3)			(4)		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
ln w	-0.642	0.058	***	-0.613	0.059	***	-0.750	0.071	***	-0.883	0.069	***
$\ln K_{IT}/K_T$	0.031	0.026		0.476	0.095	***	-0.066	0.036	*	0.555	0.128	***
$\ln K_{RD}/K_T$	-0.068	0.020	***	-0.116	0.046	**	-0.088	0.035	**	0.078	0.069	
$\ln K_{HR}/K_T$	0.148	0.039	***	0.433	0.071	***	0.063	0.046		0.510	0.093	***
ln Y	1.413	0.049	***	1.429	0.048	***	1.585	0.059	***	1.643	0.059	***
$\ln K_{IT}/K_T * \ln K_{HR}/K_T$				0.068	0.014	***				0.075	0.018	***
$\ln K_{IT}/K_T * \ln K_{RD}/K_T$				-0.010	0.007					0.037	0.012	***
Constant	-20.962	0.741	***	-19.433	0.801	***	-23.745	0.901	***	-21.234	1.027	***
	Fixed-effects model			Fixed-effects model			GMM			GMM		
Number of obs	1,762			1,762			1,732			1,732		
Number of groups	70			70			70			70		

Panel B: Dependent Variable: Average Rate of Return on Capital

Market economy

Dependent variable: Average rate of return on capital

	(1)			(2)			(3)			(4)		
	Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err		Coef.	Std. Err	
ln w	-1.180	0.061	***	-1.156	0.061	***	-0.978	0.075	***	-1.122	0.071	***
$\ln K_{IT}/K_T$	0.075	0.027	***	0.492	0.099	***	0.021	0.038		0.905	0.124	***
$\ln K_{RD}/K_T$	-0.059	0.020	***	-0.076	0.047		-0.077	0.037	**	0.132	0.072	*
$\ln K_{HR}/K_T$	0.167	0.040	***	0.413	0.073	***	0.165	0.046	***	0.656	0.091	***
ln Y	1.326	0.050	***	1.342	0.050	***	1.434	0.061	***	1.528	0.060	***
$\ln K_{IT}/K_T * \ln K_{HR}/K_T$				0.060	0.014	***				0.105	0.018	***
$\ln K_{IT}/K_T * \ln K_{RD}/K_T$				-0.004	0.007					0.046	0.012	***
Constant	-18.608	0.768	***	-17.176	0.832	***	-20.229	0.914	***	-17.481	0.980	***
	Fixed-effects model			Fixed-effects model			GMM			GMM		
Number of obs	1,762			1,762			1,732			1,732		
Number of groups	70			70			70			70		

Source: Authors' calculations based on JIP2015 database.

as the dependent variable. First, we find negative coefficients of the real wage rate in all estimations, similar to the results shown in Panel A in Table 6. Second, contrary to those results, the coefficients on IT stock are positive in all estimations. Third, the coefficients on R&D stock show positive and significant impacts on the profit rate in the estimation in Column (4), although it shows the opposite effect in the other three estimations. Fourth, the results for HR are qualitatively the same as those shown in Panel A in Table 6.

Given these baseline results, we conduct an additional subsample analysis by dividing our sample into IT industry and non-IT industry groups. Panel A in Table 7 shows the results for the IT industry using the marginal rate of return.[15] IT stock has a positive and significant impact on the profit rate in all estimations. Contrary to the results shown in Panel A Table 6, R&D stock shows a positive and significant sign in Column (4). The cross term between IT and R&D also shows positive and significant complementary effects on productivity. The results for the other variables are almost the same as those shown in Panel A in Table 6. Overall, we find that intangibles play a crucial role in raising

15 We also estimate Equations (5) and (6), where the dependent variables are the average rate of return in the IT and non-IT industries. These estimation results are similar to those shown in Tables 8 and 9.

Table 7: Estimation Results Using the Marginal Rate of Return on Capital for IT and Non-IT Industries

Panel A: IT Industries

IT industries

Dependent variable: Marginal rate of return on capital

	(1)		(2)		(3)		(4)	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
ln w	-0.588	0.085 ***	-0.617	0.089 ***	-0.805	0.096 ***	-1.032	0.097 ***
ln K_{IT}/K_T	0.138	0.043 ***	0.739	0.155 ***	0.124	0.047 ***	0.938	0.159 ***
ln K_{RD}/K_T	-0.070	0.030 **	0.108	0.070	0.014	0.040	0.441	0.083 ***
ln K_{HR}/K_T	0.091	0.055 *	0.296	0.103 ***	0.209	0.059 ***	0.444	0.105 ***
ln Y	1.443	0.068 ***	1.479	0.069 ***	1.578	0.085 ***	1.730	0.086 ***
ln K_{IT}/K_T*ln K_{HR}/K_T			0.066	0.021 ***			0.061	0.023 ***
ln K_{IT}/K_T*ln K_{RD}/K_T			0.040	0.014 ***			0.103	0.016 ***
Constant	-21.487	1.061 ***	-19.988	1.181 ***	-21.291	1.251 ***	-20.146	1.342 ***
	Fixed-effects model		Fixed-effects model		GMM		GMM	
Number of obs	1,040		1,040		1,018		1,018	
Number of groups	41		41		41		41	

Panel B: Non-IT industries

Non-IT industries

Dependent variable: Marginal rate of return on capital

	(1)		(2)		(3)		(4)	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
ln w	-0.664	0.079 ***	-0.722	0.078 ***	-0.629	0.062 ***	-0.658	0.062 ***
ln K_{IT}/K_T	-0.053	0.030 *	0.315	0.159 **	-0.061	0.029 **	-0.065	0.152
ln K_{RD}/K_T	-0.041	0.025	-0.384	0.076 ***	0.007	0.033	-0.176	0.078 **
ln K_{HR}/K_T	0.177	0.059 ***	0.617	0.128 ***	0.078	0.038 **	0.266	0.114 **
ln Y	1.433	0.067 ***	1.511	0.068 ***	1.432	0.058 ***	1.458	0.058 ***
ln K_{IT}/K_T*ln K_{HR}/K_T			0.094	0.023 ***			0.026	0.019
ln K_{IT}/K_T*ln K_{RD}/K_T			-0.053	0.011 ***			-0.030	0.012 **
Constant	-21.256	1.026 ***	-21.084	1.235 ***	-20.991	0.907 ***	-21.285	1.184 ***
	Fixed-effects model		Fixed-effects model		GMM		GMM	
Number of obs	722		722		714		714	
Number of groups	29		29		29		29	

Source: Authors' calculations based on JIP2015 database.

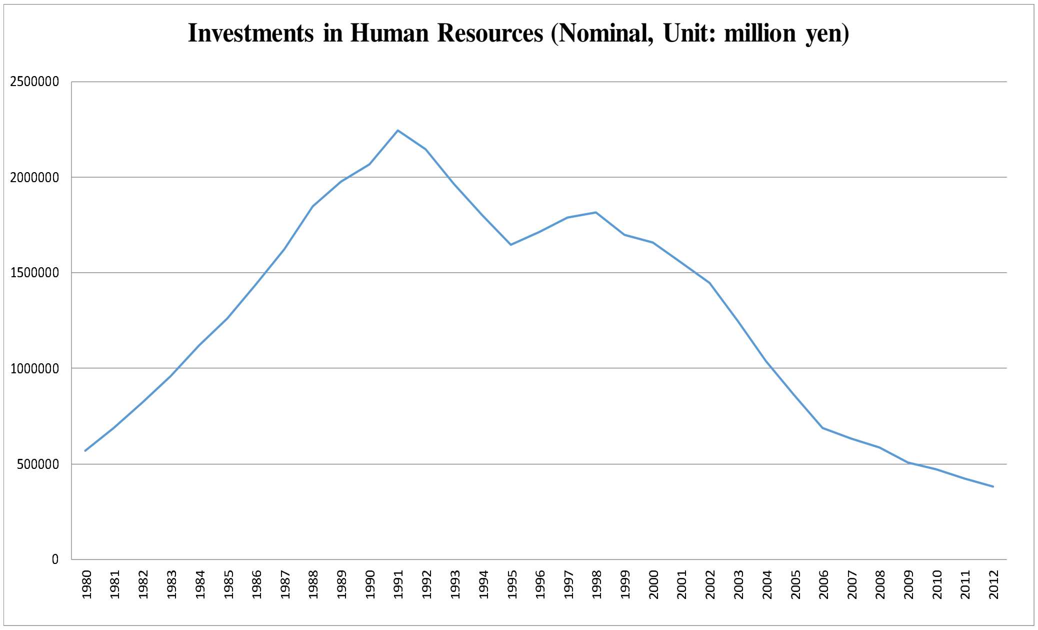
profit rates through productivity improvement in the IT industry.

Panel B in Table 7 shows the results for non-IT industries using the marginal rate of return. The coefficient on the IT investment ratio is not stable, suggesting that IT investment does not contribute to a higher rate of return on capital in non-IT industries. As in Panel A in Table 6, the coefficient on R&D is negative and significant in Columns (2) and (4). The cross terms between intangibles show mixed results: the cross term between IT and HR is positive and significant, as in the previous results, on the other hand, the cross term between IT and R&D is negative and significant.

The estimation results shown in Table 7 offer hints concerning the puzzling results shown in Table 6 . In the IT industry, the IT capital stock has a positive and significant impact on profit rates. The coefficient on R&D stock has a positive sign, except in Column (1) in Panel A in Table 7. On the other hand, in non-IT industries, IT and R&D show no positive impact on profit rates. These estimation results for both industries suggest that the ambiguous estimation results for IT and R&D are caused by the contrast between the results for non-IT industries and those for the IT industry.

Non-IT industries include many traditional industries in decline. Firms in such industries

Chart 1: Investments in Human Resources in the Market Economy in Japan, 1980-2012



Source: Authors' calculations based on JIP2015 database.

have no incentive to invest in IT; thus, IT facilities do not contribute to the rate of return on capital. Moreover, R&D efficiency may decline in these industries, as Bloom *et al.* (2017) pointed out. Ikeuchi *et al.* (2013) have also shown that Japanese firms in traditional industries have moved their high-productivity factories overseas. We may not have captured the relationship between productivity and R&D due to this hollowing-out effect.

Importantly, the positive and significant sign of the IT industry implies that IT investments improve technology levels in this industry. In other words, IT investments are likely to raise the rate of return on tangible capital for industries with a larger accumulation of IT stock.

Almost all the estimation results indicate that the coefficients on HR capital stock (α_4) are positive and significant, suggesting that growth in HR is crucial to increasing the rate of return on capital. However, Chart 1 shows that investments in HR at current prices have fallen steeply in Japan since 2000, which might have led to the low rate of return on capital.[16]

Finally, we find many positive and significant cross terms between intangibles, implying that complementary effects among intangibles raise the profit rate. Chun *et al.* (2015) examined the correlation between the dynamics of IT assets and R&D or other intangibles (including HR) and found that the dynamics of IT assets were not positively correlated with that of intangibles in Japan during the 2000s. The evidence in Chun *et al.* (2015) and our estimation results on the cross terms between intangibles indicate that the lack of complementary effects among intangibles in Japan has led to the declining profit rate.

16 Chun *et al.* (2015) showed their estimation method and data source for HR in detail. After the collapse of the bubble economy, Japanese firms shifted from regular employment to irregular employment practices. Opportunities for education and training are often fewer for irregular employees than for regular employees, which is one reason why HR investment has decreased since 1990. Investments in HR include off-the-job training costs, which corresponds to 'firm-specific human capital' in Corrado *et al.* (2009).

Conclusion and Policy Implications

The Japanese economy has suffered from long-term stagnation since the collapse of the bubble economy in the 1990s. Advanced economies such as the United States and Europe have been following in Japan's footsteps since the global financial crisis. One of the main symptoms of this long-term stagnation is the low growth rate induced by stagnant capital formation under low interest rates. We focus on movements in the real rate of return on capital in order to understand secular stagnation using the JIP database.

First, we divide the rate of return on capital into the capital-output ratio and capital share. We find that the capital-output ratio shows an upward trend. The ratios in non-IT industries are particularly high, indicating that these industries have accumulated inefficient capital stock. These findings are consistent with the argument in Fukao *et al.* (2016). On the other hand, the capital share has been maintained at over 30 per cent, but has shown a downward trend in non-IT industries over the past 30 years. The downward trend in the rate of return on capital has caused a number of industries to have negative profit rates. In addition, the greater relative standard deviation indicates that industry-level factors affect the dispersion of the rate of return on capital.

Based on these findings, we estimate a profit function based on a simple production function in which the profit rate is affected by factor prices and total factor productivity. We choose intangibles such as IT investment and R&D investment as determinants of productivity. While the level of IT and R&D investments are relatively high in Japan, the rate of return on capital, which could benefit from such high investments, is low. To clarify the mechanism of this phenomenon, we empirically examine the effect of intangibles on the profit rate.

The estimation results show, first, that a higher real wage is associated with a lower rate of return, as expected. This might imply that a policy measure intended to increase wages does not necessarily stimulate capital formation. On the other hand, the positive sign of value added suggests that an increase in aggregate demand is likely to increase capital formation.

Second, in a puzzling result, IT has a positive and significant effect on the rate of return on tangible capital, especially in the IT industry. In non-IT industries, we find no positive or significant effects of IT on the rate of return on capital, implying that non-IT firms might not be fully utilizing the performance of IT facilities. Thus, we suggest that Japanese management should pay more attention to ways of incorporating IT technologies in their firms.

Third, in non-IT industries, R&D investment has a negative and significant impact on the rate of return on capital, possibly due to declining research efficiency and the relocation of high-productivity factories overseas.

Fourth, in a particularly important result, strongly positive HR-related effects on the rate of return on capital appear in the results for the market economy, despite the rapid decline in HR investments in Japan since 2000.[17]

Fifth, complementary effects contribute to the increase in profit rates in the IT industry. Due to the rapid decline in HR investments, however, these effects have little significance in Japan. This result suggests that governments should encourage not only expenditures in HR but also comprehensive investments in intangibles.

17 Fukao and Otaki (1993) provided a model in which conventional capital formation is associated with human capital accumulation. Otaki and Yaginuma (2014) emphasized that skill in human capital is crucial for firm growth.

The argument of Benigno and Fornaro (2015) that we cannot rely on an aggregate demand policy but need an aggressive innovation policy to end the current stagnation is supported by the policy implications of our estimation results. Indeed, an aggregate demand policy implemented through an increase in wages would fail to induce aggressive capital formation. We need a bold innovation policy that includes not only accumulation in HR but also organizational reforms that can vitalize the complementary effects between intangibles.

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Appendix Table 1: Data Definition

Variables	Definitions	Constructions
r_marginal	Marginal rate of return on capital	Capital share × (Value added / Net capital stock)
r_average	Average rate pf return on capital	(Operating surplus +Consumption of fixed capital) / Net capital stock
w	Wage rate	Labor share×value added / Man-hours
IT	Capital formation in Information Technology (IT)	See Chun et al. (2015)
K_{IT}	IT capital stock	See Chun et al. (2015)
RD	Capital formation in R&D over R&D capital stock	See Chun et al. (2015)
K_{RD}	R&D capital stock	See Chun et al. (2015)
HR	Capital formation in Human Resources	See Chun et al. (2015)
K_{HR}	Human Resources capital stock	See Chun et al. (2015)

Notes: All variables are converted into values in constant prices for 2000. We obtain the data from the JIP2015 database.

Appendix Table 2: JIP Database Industrial Classification in the Market Economy

IT industries	Non-IT industries
9 Seafood products	1 Rice, wheat production
10 Flour and grain mill products	2 Miscellaneous crop farming
17 Furniture and fixtures	3 Livestock and sericulture farming
20 Printing, plate making for printing and bookbinding	4 Agricultural services
21 Leather and leather products	5 Forestry
22 Rubber products	6 Fisheries
23 Chemical fertilizers	7 Mining
24 Basic inorganic chemicals	8 Livestock products
25 Basic organic chemicals	11 Miscellaneous foods and related products
27 Chemical fibers	12 Prepared animal foods and organic fertilizers
28 Miscellaneous chemical products	13 Beverages
29 Pharmaceutical products	14 Tobacco
34 Pottery	15 Textile products
38 Smelting and refining of non-ferrous metals	16 Lumber and wood products
40 Fabricated constructional and architectural metal products	18 Pulp, paper, and coated and glazed paper
41 Miscellaneous fabricated metal products	19 Paper products
42 General industry machinery	26 Organic chemicals
43 Special industry machinery	30 Petroleum products
44 Miscellaneous machinery	31 Coal products
45 Office and service industry machines	32 Glass and its products
46 Electrical generating, transmission, distribution and industrial apparatus	33 Cement and its products
47 Household electric appliances	35 Miscellaneous ceramic, stone and clay products
48 Electronic data processing machines, digital and analog computer equipment and accessories	36 Pig iron and crude steel
49 Communication equipment	37 Miscellaneous iron and steel
50 Electronic equipment and electric measuring instruments	39 Non-ferrous metal products
52 Electronic parts	51 Semiconductor devices and integrated circuits
53 Miscellaneous electrical machinery equipment	54 Motor vehicles
56 Other transportation equipment	55 Motor vehicle parts and accessories
57 Precision machinery & equipment	58 Plastic products
59 Miscellaneous manufacturing industries	60 Construction
63 Gas, heat supply	61 Civil engineering
67 Wholesale	62 Electricity
68 Retail	64 Waterworks
69 Finance	65 Water supply for industrial use
70 Insurance	66 Waste disposal
78 Telegraph and telephone	71 Real estate
79 Mail	73 Railway
81 Research (private)	74 Road transportation
85 Advertising	75 Water transportation
86 Rental of office equipment and goods	76 Air transportation
88 Other services for businesses	77 Other transportation and packing
90 Broadcasting	87 Automobile maintenance services
91 Information services and internet-based services	89 Entertainment
92 Publishing	94 Eating and drinking places
93 Video picture, sound information, character information production and distribution	95 Accommodation
96 Laundry, beauty and bath services	97 Other services for individuals