Center for China and Asian Studies

Working
Paper
Series
CCAS No.007

"Measuring Organization Capital in Japan -An Empirical Assessment Using Firm-Level Data-"

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April 2008

College of Economics, Nihon University

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-An Empirical Assessment Using Firm-Level Data-

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Abstract

Globalization and the ICT revolution of the 1990s have forced many firms to reorganize in order to survive in a more competitive market. There are several approaches that can be used to assess the measurement of organization capital since it is unobservable. Using an optimizing firm model and assuming that a firm holds multiple assets as suggested by Yang and Brynjolfsson (2001) and Cummins (2005), we examined whether organization capital is accumulated with investment in several types of assets. In contrast to Cummins's (2005) results, we found that the accumulation of organization capital is associated with investment in R&D assets and marketing assets. Using these results and following Basu, Fernald, Oulton, and Srinivasan (2003), we measured the contribution of organization capital to the conventional TFP growth. The estimation results implied that the growth of organization capital did not have significant effects on productivity growth.

Keywords: adjustment cost of investment, intangible asset, organizational capital, Tobin's q, total factor productivity
JEL classifications: L21, L23, L25

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Acknowledgement

The original paper was written when Miyagawa stayed at the Center for Economic Performance in London School of Economics in 2006-07 as a visitor. This study was inspired by Professors Van Reenen, Shankerman, and other members in Program on Productivity, Innovation and Intellectual Property in the CEP. We thank Professors van Ark, Timmer, and Los for their valuable comments at the seminar of the University of Groningen. We also thank Professor Joe-Hyang Lee (Seoul National University) and Dr. Byungwoo Kim (Science and Technology Policy Institute) for insightful comments at the 15th Seoul Journal of Economics International Symposium in Seoul National University.

The Japanese version of this paper was presented at the Research Institute of Economy, Trade, and Industry (RIETI), Gakushuin University, and the 2006 Spring Meeting of the Japanese Economic Association. We would like to thank Dr. Masaru Yoshitomi (RIETI), Professors Kyoji Fukao (Hitotsubashi University), Kaoru Hosono (Gakushuin University), Mototsugu Shintani (Vanderbilt University), Kazuyuki Suzuki (Meiji University), and Toshiaki Watanabe (Hitotsubashi University) and anonymous referees for their valuable comments. All remaining errors are our responsibility.

1. The Role of Intangible Assets and Organization Capital

The information and communication technology (hereafter referred to as ICT) revolution of the 1990s generated a large amount of research that considered the effect of the ICT revolution on productivity growth. Based on these studies, the following two questions have been proposed. The first question is why the stock value rose more than the accumulation of tangible assets, including ICT equipment, in the U.S. The rise in the stock value indicates that the accumulation of ICT capital was not the sole factor for U.S. productivity growth during the 1990s. The second question is why large European countries, such as the U.K., Germany, and France, could not enjoy similar productivity growth even though ICT capital was accumulated in these countries.

In responding to these questions, economists began to pay attention to the role of intangible assets. In answer to the first question, economists think that intangible assets contributed to the increase of stock value because the assets induced productivity growth.[1] As for the second question, economic researchers determined that the slower productivity growth in large European countries was caused by a lack of intangible assets, which support ICT capital.

Van Ark (2004) categorized knowledge capital, including intangible assets, as shown in Table 1. According to his paper, the newly categorized assets contribute to productivity growth. Among these assets, we have focused on the role of "organization capital".

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[1] McGrattan, E., and E. Prescott (2005) and Corrado, C., C. Hulten, and D. Sichel (2006) argued that the rapid increase in intangible assets can explain the high total factor productivity (hereafter referred to as TFP) growth rate in the U.S. during the 1990s.

Table 1 Classification of Capital Components in the Knowledge Economy

(a) ICT capital
  (a1) Hardware
  (a2) Telecommunication infrastructure
  (a3) Software
(b) Human capital
  (b1) Formal education
  (b2) Company training
  (b3) Experience
(c) Knowledge capital
  (c1) Research & development and patents
  (c2) Licenses, brands, copyrights
  (c3) Other technological innovations
  (c4) Mineral exploration
(d) Organizational capital
  (d1) Engineering design
  (d2) Organization design
  (d3) Construction and use of databases
  (d4) Remuneration of innovative ideas
(e) Marketing of new products ("customer capital")
(f) Social capital

Source: van Ark (2004)

The concept of organization capital has a long history. Seventy years ago, Coase (1937) emphasized the role of a firm as an organization that mitigates failures of the market mechanism. Twenty years later, Penrose (1959) argued that reorganization costs are incurred when a firm grows. More recently, Lucas (1978) and Prescott and Visscher (1980) emphasized the role of managers in constructing organization capital. In their paper, Prescott and Visscher recognized that organization capital is a kind of managerial resource and that it contributes to the production process like other production factors do, such as tangible assets, labor inputs, and intermediate inputs. In particular, Prescott and Visscher introduced the term "organization capital" for the first time in their academic paper. However, all of this early literature focused primarily on the concept or theoretical understanding of organization capital. In contrast to these previous studies, more recent studies have focused on the measurement of organization capital and its effect on productivity.

There are two approaches for the measurement of organization capital. The first approach is to measure organization capital based on the market value of a firm. According to the standard investment theory with adjustment cost of investment, the part that exceeds 1 in Tobin's q is interpreted as the degree of adjustment cost. Hall (2000), (2001) argued that these adjustment costs are accumulated as organization capital within a firm and the market value reflects this organization capital.[2] Yang and Brynjolfsson (2001) and Cummins (2005) estimated adjustment costs in each investment good from the market values of firms. The result in Yang and Brynjolfsson (2001) showed that large adjustment costs of computer investment were observed. However, Cummins argued that the OLS estimation by Yang and Brynjolfsson was biased because the estimated coefficients were affected by the omitted variables concerning organization capital.

The second approach is to measure organization capital based on the estimation of production function. Lev and Radhakrishnan (2005) recognized organization capital as residual which means that it is unable to be captured by the contributions of capital, labor, and intermediate inputs. While organization capital is not a production factor in Lev and Radhakrishnan's model, Basu, Fernald, Oulton, and Srinivasan (2003) assumed a production function where organization capital is a complementary factor of ICT capital. By using the production function, they estimated the effect of organization capital on productivity growth.

In Japan, few empirical studies about organization capital have been carried out. In the White Paper on Trade and Industry, published in 2004 by the Ministry of Economy, Trade, and Industry, the author measured organization capital following Lev and

[2] Hall uses the term 'e-capital' instead of organization capital.

Radhakrishnan (2005). The author's estimation results implied that the organization capital in Japan was less accumulated than that of firms in the U.S. In addition, Kanamori and Motohashi (2006) and Kurokawa and Minetaki (2006) estimated a production function that included qualitative variables that expressed the organizational structure of firms. However, these studies were not without flaws. For example, the studies assumed that organization capital was a part of Solow residuals and that firms did not decide the accumulation of organization capital. This assumption does not reflect essential features of organization capital as a production factor.

Therefore, our purpose in this paper is to measure organization capital and examine its role in Japanese productivity growth based on the optimized behavior of the firm in the previous studies on organization capital. Recently, many Japanese economists have acknowledged that, like major EU countries, the performance of Japanese firms has not improved even though the firms have accumulated ICT assets. In addition, the gap in the performance of firms has widened since the recovery of the Japanese economy began in the early 2000s. Our study, which examines the effect of organization capital, is expected to help better understand the topics discussed above.

In the next section, we will introduce our approach for the measurement of organization capital. Based on the two approaches mentioned above, we will present a model that integrates both approaches for measuring organization capital. In Section 3, using the firm value, we will measure the value of organization capital. In contrast to the results in Cummins (2005), our results show that organization capital is accumulated with the accumulation of R&D assets and marketing assets. In Section 4, using the results from Section 3, we will estimate the contribution of organization capital to productivity growth following Basu et al. (2003). Our estimation implies that the contribution of organization capital to firm-level TFP growth is not significant. In the final section, we will summarize our results and remark on our future research agenda.

2. A Model for the Measurement of Organization Capital

In this section, we propose a model for the measurement of organization capital. Our model is based on the firm value approach. However, the previous firm value approaches, such as proposed by Yang and Brynjolfsson (2001) and Cummins (2005), have not considered organization capital as a production factor explicitly. Following Basu et al. (2003), we include organization capital as a production factor in the following production function:

$$\begin{aligned} Y_{it} &= F(B(K^{I}{}_{it}, O_{it,}), K^{T}_{it}, L_{it}, M_{it}, H_{it}; \Theta_{it}) \\ &= G(B(K^{I}_{it}, O_{it}), K^{T}_{it}, L_{it}, M_{it}, \Theta_{it}) - \{H_{it} + \phi(H_{it}, O_{it})\} \end{aligned} \quad (1)$$

where Y_{is} is a gross output of firm i. In this equation, we assume two kinds of capital goods: one is complementary to organization capital ($K_{it}{}^{I}$) and the other is not ($K_{it}{}^{T}$). O_{is} is organization capital, L_{it} is labor input, M_{it} is intermediate input, and Θ_{it} shows the technology level of firm i. H_{is} represents investment in organization capital and $\phi(H_{jit}, O_{jit})$ is an adjustment cost function of investment in organization capital.[3]

The net cash flow of firm i is described as follows:

$$V_{it} = E_t\left[\sum_{s=t}^{\infty} \beta^{t}_{s}\left[F(B(K^{I}{}_{is}, O_{it})K^{T}_{is}, L_{is}, M_{is}; \Theta_{is}) - w_{is}L_{is} - p^{M}_{is}M_{is} - \sum_{j=1}^{2} p^{j}_{is}I^{j}_{is} - \{H_{is} + \phi(H_{is}, O_{is})\}\right]\right]$$
$$where \ \ j = I, T. \quad (2)$$

where w_{is} is a wage rate, P^{M}_{is} is a price of intermediate input, p^{j}_{is} is an investment price

[3] Basu et al. (2003) did not assume adjustment cost of investment in organization capital.

of asset j, and I_{is}^{j} is investment in asset j.

The accumulations of asset j and organization capital in firm i are expressed in the following way:

$$K_{jit} = (1-\delta_j)K_{jit-1} + I_{jt} \tag{3}$$

$$O_{it} = (1-\delta_o)O_{it} + H_{it} \tag{4}$$

Assuming linear homogeneities of the production function and adjustment cost function like in Wildasin (1984) and Hayashi and Inoue (1991), the maximization problem of Equation (2) subject to Equations (3) and (4) leads to the result that the total market value of firm i is expressed as a weighted sum of the value of asset j.

$$V_{it} = \sum_{j=1}^{2} \lambda_{it}^{j}(1-\delta_j)K_{it-1}^{j} + \mu_{it}(1-\delta_O)O_{it-1} \tag{5}$$

where λ_{it}^{j}, a shadow price of asset j, is equal to p_{is}^{j}. μ_{it} is expressed as follows:

$$\mu_{it} = 1 + \frac{\partial\phi(H_{it}, O_{it})}{\partial H_{it}}. \tag{6}$$

Following Basu et al. (2003), we assume that $B(K^{I}{}_{it}, O_{it})$ is the CES function.

$$B(K_{it}^{I}, O_{it}) = \left[\alpha_i K_i^{I\,\frac{\sigma-1}{\sigma}} + (1-\alpha_i)O^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{7}$$

From Equation (7), we have

$$O_{it} = \left(\frac{1-\alpha_i}{\alpha_i} \frac{\lambda_{it}}{\mu_{it}} \right)^{\sigma} K_{it}^I \equiv \eta_{it} K_{it}^I . \tag{8}$$

Substituting Equation (8) into (5) and assuming $\delta_{K^I} \approx \delta_O$, we get

$$\begin{aligned} V_{it} &= p_{it}^T (1-\delta_{K^T}) K_{it-1}^T + p_{it}^I (1-\delta_{K^I}) K_{it-1}^I + \mu_{it} (1-\delta_O) O_{t-1} \\ &= p_{it}^T (1-\delta_{K^T}) K_{it-1}^T + \left\{ p_{it}^I (1-\delta_{K_i^I}) + \mu_{it} (1-\delta_O) \eta_{it} \right\} K_{it-1}^I \\ &= p_{it}^T (1-\delta_{K^T}) K_{it-1}^T + (p_{it}^I + \mu_{it} \eta_{it})(1-\delta_{K_i^I}) K_{it-1}^I \end{aligned} \tag{9}$$

If we regress the firm value on two types of capital goods excluding unobservable organization capital, we have

$$V_t = \hat{q}_{it}^T p_{it}^T (1-\delta_{K^T}) K_{t-1}{}^T + \hat{q}_{it}^I P_{it}^I (1-\delta_{K^I}) K_{t-1}^I . \tag{10}$$

From Equations (5) and (10), we get

$$\begin{aligned} \hat{q}_{it}^T &= 1 \\ \hat{q}_{it}^I &= 1 + \frac{\mu_{it} \eta_{it}}{p_{it}^I} > 1 \end{aligned} . \tag{11}$$

Estimating Equation (10) and checking whether estimated coefficients is equal to 1 or not, we can find the effect of organization capital on firm value indirectly. From Equations (8) and (11), organization capital is expressed as follows:

$$O_{it-1} = \frac{P_{it}^I(\hat{q}_{it}^I - 1)}{\mu_{it}} K_{it-1}^I \qquad (12)$$

Assuming that adjustment cost of investment in organization capital is too small, we can measure organization capital by using the estimation results of Equation (10).

3. Estimation of Organization Capital

Following our formulation explained in Section 2, we will estimate Equation (10) by using firm-level data. While Yang and Brynjolfsson (2001) estimated Equation (10) by OLS, Cummins (2005) argued that coefficients estimated by OLS were biased for the following three reasons: firstly, observed firm value includes noise; secondly, the gap between observed firm value and true firm value affects investment policy of the firm; finally, technological shock is likely to correlate with investment policy of the firm. Therefore, we will estimate Equation (10) not only by the OLS and fixed effect estimation but also by the system GMM method.

We attained account information of the firms from a database provided by the Development Bank of Japan (hereafter referred to as DBJ). This database contains firms listed on all stock exchanges in Japan. In addition, we used a database provided by Toyokeizaishinposha (a Japanese publishing company) to access the stock price information and R&D investment of the firms.

Because Yang and Brynjolfsson (2001) and Cummins (2005) assumed that firms hold multiple assets, we constructed tangible assets, R&D assets, and marketing assets from our dataset.[4] The tangible assets were not evaluated by the book value, but by the replacement

[4] As the Japanese accounting system does not require firms to disclose information about their IT investment, we are unable to construct IT capital stock at firm-level.

value. The R&D assets and marketing assets were constructed by using the perpetual inventory method. A detailed description of the construction of the assets data is found in the Appendix. Because few firms carry out R&D investment in the non-manufacturing sector, we focused on the measurement of organization capital in the manufacturing sector. From these datasets, we attained 5995 observations from 1990 to 2003. Table 2 shows the statistical features of our data.[5]

Table 2 Summary Statistics of the Estimation of Organization Capital

Variable	Obs	Mean	Std Dev	Min	Median	Max
Market value	5995	3.04E+08	8.95E+08	432600	6.95E+07	2.06E+10
K_K	5995	9.42E+07	2.49E+08	438296.4	2.36E+07	3.74E+09
$K_{R\&D}$	5995	5.54E+07	2.10E+08	0.0039063	4027503	2.72E+09
K_{AD}	5995	7207800	1.70E+07	27.875	1106811	2.28E+08

As a result, the equation for the estimation is described as follows:

$$V_{it} = q_{Kit}(1-\delta_K)p^{K}_{it-1}K_{Kit-1} + q_{R\&Dit}(1-\delta_{R\&D})p^{R\&D}_{it-1}K_{R\&Dit-1} + q_{ADit}(1-\delta_{AD})p^{AD}_{it-1}K_{ADit-1} + \varepsilon_{it} \tag{13}$$

where p^{j}_{it-1} is a price in asset j. In our framework discussed in the previous section, q of an asset that is not complementary to organization capital should be 1. Hence, the case where q_{jit} exceeds 1 implies that some adjustment costs are generated that are associated with capital accumulation and that are used for the arrangement of the new organizational structure of a firm.

[5] Before the estimation, we checked outliers in Tobin's q which includes firm value and capital stock. We regarded as outliers those whose value of Tobin's q is greater than 97.5 percentile or smaller than 2.5 percentile of the industry distribution of Tobin's q. As for R&D, we omitted firms which did not conduct R&D activities.

The results of the estimation in Equation (13) are described in Table 3. In Table 3, q_K is 1.05 in the OLS estimation and 1.03 in the system GMM estimation, respectively. As these coefficients are not significantly different from 1, we do not find any evidence of the formation of organization capital.

Table 3 Estimation of Organization Capital

	OLS		**Fixed Effect**		**System GMM**	
	Coef.		Coef.		Coef.	
K_K	1.0505	***	-0.4445	***	1.0365	***
	(7.58)		(-4.32)		(3.96)	
$K_{R\&D}$	2.0979	***	1.9701	***	1.9855	***
	(12.88)		(27.77)		(6.71)	
K_{AD}	9.8872	***	6.161	***	12.7836	***
	(5.25)		(4.57)		(3.14)	
Constant	2.72E+07		2.70E+08	***	9.85E+06	
	(0.74)		(12.05)		(0.2)	
Year Dummy	Yes		Yes		Yes	
Industry Dummy	Yes				Yes	
Sample Size	5995		5995		5995	

1. Dependent variable is firm's market value in manufacturing industry.
2. *, **, and *** mean p<0.1, p<0.5, and p<0.01 respectively.
3. Dependent and independent variables are in nominal term.
4. The figures in parenthesis are *t*-values.

However, $q_{R\&D}$ and q_{AD} are significantly different from 1. This implies that the formation of organization capital is associated with the accumulation of R&D investment and advertising investment. In contrast to Cummins (2005), the result is robust even in the system GMM estimation. Thus we conclude that, in Japan, organization capital is accumulated in association with R&D expenditures and advertisement expenditures.

We also estimated Equation (13) in the machine industries. The results shown in Table 4 are similar to those in Table 3. q_K is not significantly different from 1, but $q_{R\&D}$

and q_{AD} exceed 1 significantly. Therefore, we confirm that R&D expenditures and advertisement expenditures induce the reorganization of Japanese firms.

Table 4 Estimation of Organization Capital for Machine Industry

	OLS		Fixed Effect		System GMM	
	Coef.		Coef.		Coef.	
K_K	1.0806	***	-0.5625	***	1.1124	***
	(6.46)		(-3.39)		5.54	
$K_{R\&D}$	1.7016	***	1.8203	***	1.6364	***
	(8.25)		(17.82)		4.13	
K_{AD}	15.9427	***	8.9885	***	17.1424	**
	(3.24)		(4.28)		2.3	
Constant	1.30E+08	***	3.76E+08	***	1.93E+08	***
	(4.61)		(8.63)		5.31	
Year Dummy	Yes		Yes		Yes	
Industry Dummy	Yes				Yes	
Sample Size	1132		1132		1132	

1. Dependent variable is firm's market value in Machinery Industry.
2. *, **, and *** mean p<0.1, p<0.5, and p<0.01 respectively.
3. Dependent and independent variables are in nominal term.
4. The figures in parenthesis are t-values.

4. Contribution of Organization Capital to Productivity Growth

Using the results from the previous section, we will estimate the contribution of organization capital to firm-level TFP. We can estimate the volume of organization capital by using the results from Table 3 and Table 4. Following Equation (12) and assuming that adjustment cost of investment in organization capital is very small, we measure the organization capital at firm-level as follows:

$$O_{it} \approx \{(\hat{q}_{R\&Di}-1)p_{it}^{RD}K_{R\&Dit}+(\hat{q}_{ADi}-1)p_{it}^{AD}K_{ADit}\}. \quad (14)$$

Following Equation (14) and using the estimation parameter of the R&D asset ($\hat{q}_{R\&D}$) and market asset ($\hat{q}_{AD}$) in the system GMM estimation, we construct organization capital.[6] We assume that the depreciation rate of organization capital (δ_O) is 35%, because this value is the same depreciation rate as software stock in Japan.[7]

Following Basu et al. (2003), the conventional TFP growth rate ($\Delta\tau_i$) is expressed as follows:

$$\Delta\tau_{it} \approx \frac{F_o{}'O_{it}}{Y_{it}}\Delta o - \frac{H_{it}}{Y_{it}}\Delta h + s_G\Delta\theta_{it} \quad (15)$$

In Equation (15), s_G is an elasticity of technological term to output. Equation (15) shows that the conventional TFP growth does not reflect purified technological progress ($\Delta\theta_{it}$) because the conventional TFP growth includes the positive contribution of the increase in organization capital and the negative contribution in internal adjustment cost.[8] Hence, Equation (15) implies that the conventional TFP growth rate decreases when investment in organization capital increases rapidly. After organization capital is sufficiently accumulated,

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[6] Since q_K is not significantly different from 1 in the estimation results of the previous section, we do not include the tangible assets in the measurement of organization capital.

[7] Corrado, Hulten, and Sichel (2006) assumed that the depreciation rate in firm-specific resources is 40%. Our assumption of the depreciation rate of organization capital is no different from their assumption.

[8] Again, we assume that the adjustment cost of investment in organization capital is very small. From our data, we calculate the conventional TFP growth as follows:

$$\Delta\tau_{it} = \Delta y_{it} - \sum_{k}^{5} c_{ik}\Delta n_{ikt}$$

where c_{ik} is the cost share of factor input *k* and *N* represents the amount of factor input *k* (*n* represents *logN*).

it starts to contribute to conventional TFP growth. The model presented by Basu et al. (2003) coincides not only with the Solow Paradox, which showed that productivity in the late 1980s did not increase even though computer investment increased, but also with the slow productivity growth seen in large European countries where ICT investment increased in the late 1990s.

Because the conventional TFP growth at firm-level is very volatile, we measured TFP growth not only for one year, but also for three years and five years. Statistical features of the variables used in the estimation of Equation (15) are described in Table 5.

Table 5 Summary Statistics of the Contribution of Organization Capital to Productivity Growth

Variable		Obs	Mean	Std Dev	Min	Max
$\Delta TFP(1\ year)$		4,932	0.00863	0.06027	-1.21491	0.53021
$\Delta TFP(3\ year)$		3,081	0.03358	0.09788	-1.76178	0.55247
$\Delta TFP(5\ year)$		1,454	0.04987	0.13267	-1.87409	0.44756
with no lag						
1 year growth rate	Δo	4,932	0.01014	0.11858	-0.34419	5.49212
	Δh	4,932	-0.00348	0.22853	-1.44228	7.19704
3 year growth rate	Δo	3,081	0.02391	0.27483	-0.99867	5.96346
	Δh	3,081	0.01693	0.33080	-1.69664	6.73330
5 year growth rate	Δo	1,454	0.03899	0.38984	-1.50961	5.66782
	Δh	1,454	0.02808	0.39974	-1.60815	6.02943
with 1 year lagged variables						
1 year growth rate	Δo	4,415	0.01032	0.12142	-0.35260	5.49212
	Δh	4,415	-0.00332	0.23152	-1.44228	7.19704
3 year growth rate	Δo	2,662	0.02211	0.25803	-0.90950	5.88804
	Δh	2,662	0.01329	0.31224	-1.69664	6.51241
5 year growth rate	Δo	1,075	0.03502	0.36617	-1.43641	5.54093
	Δh	1,075	0.01894	0.37188	-1.58178	5.62820

The estimation results of Equation (15) are shown in Table 6 and Table 7.[9] In Table

[9] Tables 6 and 7 describe estimation results in the manufacturing sector.

7, we take a one-year lag for explanatory variables to avoid a simultaneous bias. Estimation methods are the OLS, the fixed effect estimation and the system GMM. In Table 6, the estimation parameters using a one year growth rate show opposite signs, which we had expected. However, the results using a 3 year growth rate and a 5 year growth rate show that estimated parameters indicate expected signs and are significant in OLS and the fixed effect estimations. In the system GMM estimation, only the result using a 5 year growth rate supports our hypothesis.

Table 6 Contribution of Organization Capital to Productivity Growth

	OLS		Fixed Effect		System GMM	
$\Delta\tau$	Coef.		Coef.		Coef.	
1 year growth rate						
Δo	-0.075	***	-0.128	***	-0.101	***
	(-4.49)		(-8.66)		(-2.77)	
Δh	0.057	***	0.068	***	0.062	***
	(4.86)		(10.38)		(2.71)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	4932		4932		4932	
3 year growth rate						
Δo	0.131	***	0.144	***	-0.084	
	(2.95)		(3.98)		(-0.93)	
Δh	-0.103	***	-0.128	***	0.056	
	(-2.85)		(-5.04)		(0.83)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	3081		3081		3081	
5 year growth rate						
Δo	0.169	***	0.108	***	0.177	***
	(3.55)		(2.77)		(3.05)	
Δh	-0.139	***	-0.116	***	-0.174	***
	(-3.89)		(-3.36)		(-3.14)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	1454		1454		1454	

1. Dependent variable is firm's change rate of TFP in Manufacturing Industry.

2. *, **, and *** mean $p<0.1$, $p<0.5$, and $p<0.01$ respectively.

3. The figures in parenthesis are *t*-values.

Table 7 Contribution of Organization Capital to Productivity Growth with Lagged Explanatory Variables

	OLS		Fixed Effect		System GMM	
$\Delta\tau$	Coef.		Coef.		Coef.	
1 year growth rate						
Δo	-0.025	*	-0.084	***	-0.058	**
	(-1.71)		(-5.61)		(-2.02)	
Δh	-0.003		0.009		0.021	
	(-0.32)		(1.33)		(1.43)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	4,415		4,415		4,415	
3 year growth rate						
Δo	0.167	***	0.112	***	0.133	
	(2.73)		(3.49)		(1.60)	
Δh	-0.142	***	-0.129	***	-0.125	*
	(-3.32)		(-5.19)		(-1.92)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	2,662		2,662		2,662	
5 year growth rate						
Δo	-0.020		-0.105	***	-0.103	**
	(-0.46)		(-2.82)		(-2.16)	
Δh	0.052		0.114	***	0.109	**
	(0.91)		(3.03)		(2.26)	
Year Dummy	Yes		Yes		Yes	
Industry dummy	Yes				Yes	
Sample size	1,075		1,075		1,075	

1. Dependent variable is firm's change rate of TFP in Manufacturing Industry.
2. *, **, and *** mean $p<0.1$, $p<0.5$, and $p<0.01$ respectively.
3. Δo andΔh are 1 year lagged values.
4. The figures in parenthesis are *t*-values.

The results in Table 7 are similar to the results in Table 6. Though the estimated parameters using a 5 year growth rate do not show expected signs in Table 7, the estimation results using a 3 year growth rate in OLS and the fixed effect estimations are the same as those in Table 6. The estimation parameters in system GMM also show right signs. These results suggest that growth in organization capital contributes to productivity growth, though the investment in organization capital decreases the conventional TFP growth in the middle term. If there is a rapid increase in investment in organization capital, the Solow Paradox will emerge in the middle term.

From Equation (15), the coefficient of organization capital shows the share of organization capital to output and the coefficient of investment in organization capital shows the ratio of investment to output. The results in Tables 6 and 7 indicate that the elasticity of organization capital to output (that is, the revenue share of organization capital) is estimated from 0.1 to 0.17. These values are larger than 0.05 estimated by Corrado, Hulten, and Sichel (2006).

The investment in organization capital (including associated costs of investment in organization capital)/output ratio is estimated from 10% to 14%. According to McGratten and Prescott (2005) the estimated ratio of intangible investment to output was from 2% to 8%. Corrado, Hulten, and Sichel (2005), (2006) showed that the estimated ratio of expenses to organization capital to GDP was 6.9%.[10]

One possible reason why our estimated ratios are larger than those in the previous studies is the difference in firm size between our study and the previous studies. While we focused on the measurement of organization capital in large manufacturing firms that have economic competencies in Japan, the previous studies included small-size firms.

Substituting the estimated parameters into Equation (15), we examined how organization capital affects TFP growth rate. Table 8 shows the results. The accumulation of organization capital contributes about 0.1% to TFP growth during 3 or 5 years, though these estimated values are not significantly different from 0. These results imply that the

[10] Corrado, Hulten, and Sichel (2005), (2006) classified expenses to intangible assets into 9 types of expenses. We recognized 3 types of intangible assets (brand equity, firm specific human capital, and organizational structure) among the 9 types as organization capital.

contribution of organization capital to TFP growth is small even in the middle term.

Table 8 Summary Statistics of Estimated TFP Bias

Variable	Obs	Mean	Std Dev	Min	Max
With no lagged variable					
1 year growth rate forecast	4,932	-0.0007	0.0056	-0.0411	0.0759
3 year growth rate forecast	3,081	0.0008	0.0051	-0.0745	0.0410
5 year growth rate forecast	1,454	0.0018	0.0111	-0.0491	0.1024
With 1 year lagged stock variable					
1 year growth rate forecast	4,415	-0.0001	0.0025	-0.1066	0.0101
3 year growth rate forecast	2,662	0.0009	0.0063	-0.0988	0.0559
5 year growth rate forecast	1,075	0.0003	0.0050	-0.0208	0.0768

1. Coefficients from OLS estimation adopted.

Variable	Obs	Mean	Std Dev	Min	Max
With no lagged variable					
1 year growth rate forecast	4,932	-0.0011	0.0069	-0.1889	0.0628
3 year growth rate forecast	3,081	0.0009	0.0080	-0.1280	0.0728
5 year growth rate forecast	1,454	0.0014	0.0097	-0.0577	0.0425
With 1 year lagged stock variable					
1 year growth rate forecast	4,415	-0.0005	0.0051	-0.2340	0.0155
3 year growth rate forecast	2,662	0.0006	0.0094	-0.1365	0.0805
5 year growth rate forecast	1,075	-0.0008	0.0040	-0.0173	0.0236

1. Coefficients from fixed effect estimation adopted.

5. Concluding Remarks and Implications

Globalization and the ICT revolution of the 1990s have forced firms to rearrange their organizations in order to survive in a more competitive market. At the same time, many economists have begun to examine how the reorganization relates to the firms' performance. However, because organization capital is unobservable, there has not yet been a decisive approach for measuring it. Interpreting several different approaches in a unified way, we measured organization capital as adjustment cost associated with accumulations of several types of assets by using the approach examined by Yang and Brynjolfsson (2001) and Cummins (2005). We then estimated the effects of organization capital on conventional TFP growth by using the production function suggested by Basu et al. (2003). Our study is the first approach to measure organization capital and determine its effects on the productivity growth in Japan.

According to Yang and Brynjolfsson (2001) and Cummins (2005), organization capital is accumulated as adjustment costs associated with investment in several types of assets. Therefore, we regressed the firm value on tangible assets, R&D assets, and marketing assets to check whether adjustment costs generate when these assets accumulate. Despite considering the measurement problems pointed out by Cummins (2005), our estimation results imply that the accumulation of organization capital is associated with R&D expenditures and advertisement expenditures.

Following Basu et al. (2003), the conventional TFP growth is affected by organization capital and its investment. Though organization capital contributes to TFP growth positively, the investment in organization capital decreases TFP growth because of the adjustment costs. Using the previous estimation results, we constructed the organization capital and its investment and examined their effects on TFP growth. As a result, we got expected signs in the middle term. However, the total contribution of organization capital to TFP growth is not significant. In addition, estimation results indicate that the revenue-based share of organization capital is from 10% to 17% and the investment in organization capital/output ratio is from 10% to 14%.

The measurement of organization capital has some practical implications. Recently, the accounting systems in the U.S. and Europe have tried to evaluate the value of both tangible and intangible assets of a firm. These movements in the U.S. and Europe will affect the Japanese accounting system. Therefore, our approach will be helpful for understanding how the intangible assets of a firm are evaluated.

We can extend and revise our approach to the following topics. First, we need to separate ICT equipment from the total tangible assets and construct software stock. Though the Japanese accounting system does not require firms to disclose the book value of ICT equipment, we have tried to construct ICT equipment data at firm level by searching accessible data. As for software, some firms in both the banking and warehouse industries have recently disclosed the book values of software, though the sample is still quite small.

Second, we need to extend our approach to firms in the non-manufacturing industry. As Bloom, Sadun, and Van Reenen (2006) have pointed out, the role of organization capital in productivity growth is more important in the non-manufacturing sector than in the manufacturing sector because the non-manufacturing sector suffers from a lower productivity growth rate than the manufacturing sector does.

Finally, our approach is an indirect measure of organization capital. However, Bloom and Van Reenen (2006) challenged the measurement of a manager's ability by conducting their own interviews with managers. In the future, we will also try to collect more detailed information on the organizational structure within firms by carrying out our own survey, utilizing the information that we collect to attain a more accurate measure of organization capital.

Appendix: Firm Value and the Construction of Assets

1. The definition of firm value

Because we evaluated a firm value as a current value of assets, we define it as follows:

$$V_t = Number\ of\ shares\ issued * Stock\ value + Total\ debt - Liquid\ assets$$

Total debt and liquid assets are evaluated as book value.

2. The construction of tangible and intangible assets

For tangible assets, we constructed the real value of tangible assets by using the perpetual inventory method. We used a depreciation rate by industry provided by the JIP (Japan Industry Productivity) 2006 database. Because we started to accumulate investment series from 1980, the capital stock in the 1980s is underestimated. We then used the capital stock series from 1990 for the estimation. Multiplying the real capital stock by the capital stock deflator provided by JIP 2006, we constructed the nominal capital stock series.

In our paper, we constructed two types of intangible assets: R&D stock and marketing assets. These two assets were also constructed using the perpetual inventory method. The R&D investment data were provided by the DBJ database and a survey conducted by Toyokeizaisimposha. The DBJ database is based on the accounting information. However, the disclosure of R&D expenditures was not enforced before 2000. Therefore, we used the data of R&D expenditures prior to 2000 from the Toyokeizaisimposha survey and used the data for 2000 onwards from the DBJ database. The depreciation rate of R&D assets by industry was provided by the JIP 2006 database. We set the depreciation rate of marketing assets at 30%. This rate is consistent with that found in Corrado, Hulten, and Sichel (2006).

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