Does the Stock Market Evaluate Intangible Assets? An Empirical Analysis Using Data of Listed Firms in Japan

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Paper Prepared for the IARIW 33rd General Conference

Rotterdam, the Netherlands, August 24-30, 2014

Session 4A

Time: Tuesday, August 26, Afternoon

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-An Empirical Analysis Using Data of Listed Firms in Japan-*

This version: July, 2014

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*This research was conducted as a part of the Research Institute of Economy, Trade and Industry (RIETI) research project (Study on Intangible Assets in Japan). We thank Kazumi Asako (Hitotsubashi University), Ryokichi Chida (MeijiUniversity), Takashi Dejima (Sophia University), Kyoji Fukao (Hitotsubashi University), Masahisa Fujita (President, RIETI), Masayuki Morikawa (Vice President, RIETI), Keiichiro Oda (RIETI), Kazuo Ogawa (Osaka University), Kazuyuki Suzuki (Meiji University), Yohei Yamamoto (Hitotsubashi University), and participants of workshops at Gakushuin University, Hitotsubashi University, Meiji University, The 9th APEA Conference at Osaka University, and RIETI for excellent comments and suggestions. This study is partly supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology (No.22223004). Miho Takizawa also acknowledges the support from Grant-in-Aid for Young Scientists (B) (No.24730252). The views expressed in this paper are those of authors and should not be attributed to any organization.

Abstract

Following Corrado et al. (2009), we measure intangible assets at the listed firm level in Japan. Compared to the conventional Tobin's Q, the revised Q including intangibles is almost 1 on average, as suggested by Hall (2000 and 2001). The standard deviation of the revised Q is smaller than that of the conventional Q. Estimation results based on Bond and Cummins (2000) show that greater intangible assets increase firm value. In particular, in the ICT industries, on average Tobin's Q is higher than that in the non-ICT industries, and the stock market reflects the value of intangibles in the ICT industries. These results suggest that the government should adopt policies that promote investment, including intangibles in the ICT industries, and change in industry structure in Japan.

Keywords: Tobin's Q, intangible asset, IT industries, price cost margin, external finance dependence

JEL classifications: E22, G31, G32, L25, O30

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1. Introduction

In the 1990s, new types of firms such as Amazon and Google were founded and grew rapidly under the ICT revolution. There are several characteristics of these firms. As Brynjolfsson (2004) pointed out, they developed new software, invested in human capital, and formed organizational structures that enabled faster decision-making. Due to the success of these firms, economists have paid attention to the role of intangible assets on firm performance and firm value. Corrado et al. (2009) measured comprehensive intangible investment including software investment, investment in human capital, and reform in organizational structure, and showed the significant contribution of intangible assets to US economic growth. Following Corrado et al. (2009), the positive effects of intangible assets on economic growth were found in the advanced countries. [1]

At the firm level, there have been several studies on the effects of R&D investment, which is a part of intangible investment on firm performances and firm value.[2] However, Hall (2000 and 2001) pointed out that after the ICT revolution, the stock market may be evaluating not only R&D stocks but also other types of intangible assets positively. To examine the determinants of firm value after the ICT revolution, we need to measure a broader concept of intangible assets beyond R&D assets like Corrado et al. (2009).

Thus, in our paper, we measure comprehensive intangible assets following Corrado, et al. (2009) by using data of Japanese listed firms. Based on our measurement, we examine the relationship between firm value and intangible assets, and estimate Tobin's Q using not only intangible but also tangible assets. From the above studies, we find that the mean value of

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[1] Intangible investment was measured at the aggregate level by Marrano, Haskel, and Wallis (2009) for the UK, Fukao et, al. (2009) for Japan, Delbeque and Bounfour for France and Germany, Hao, Manole, and Van Ark (2008) and Piekkola (2011) for the EU countries, Burns and McClure (2009) for Australia, and Pyo, Chen, and Rhee (2010) for Korea. At the sectoral Level, Miyagawa and Hisa (2013) measured intangible investment asnd showed posITive effect on productivITy growth.

[2] Griliches (1981) started to examine the relationship between and R&D and market valuation. In a similar framework to ours which we explain below, Hall (1993) and Hall and Oriani (2006) considered not only R&D and but also other intangibles, they focused on the effect of R&D on the market valuation.

Tobin's average Q becomes close to 1 and its variance becomes small when we consider intangible assets, as Hall (2000 and 2001) expected. We also find that intangible assets are positively correlated with firm value. The estimation results show that the accumulation of intangible assets significantly increases firm value. The effect is particularly pronounced and significant in the ICT related industries.

Our paper consists of six sections. In the next section, we review the existing literature on the measurement of intangible assets and how intangible assets are evaluated in the stock market. In the third section, we explain how we measure intangible assets at the firm level. In the fourth section, we examine several features of Tobin's Q that take intangible assets into account. In the fifth section, we examine the effects of intangible assets on firm value by estimating a standard average Tobin's Q. In the last section, we summarize our findings.

2. Intangible Assets and Firm Value: A Literature Review

Hall (2000 and 2001) pointed out that the Tobin's Q in the US stock market consistently exceeded 1. He subsequently argued that as these adjustment costs of tangible assets are accumulated as intangible assets within a firm, the gap between Tobin's Q and 1 is accounted for intangible assets.[3] To examine Hall's proposition, Brynjolfsson, Hitt and Yang (2002) estimated firm value using non-ICT capital and ICT capital, and found that the coefficients of ICT capital, were much greater than those of non-ICT capital. Then, they argued that these large coefficients were affected by intangible assets, complementary to ICT capital. Cummins (2005) and Miyagawa and Kim (2008) estimated firm value using not only non-ICT capital and ICT capital but also with R&D capital and advertisement capital. Although Cummins (2005) did not find a higher than normal rate of return for intangible assets, Miyagawa and Kim (2008) obtained the opposite results to Cummings (2005).

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

While Cummins (2005) and Miyagawa and Kim (2008) focused on R&D capital and advertisement capital, Lev and Radhakrishnan (2005) recognized a portion of sales, general and administrative expenditures as organizational capital. By estimating the difference between market value and book value using organizational capital, they found that organizational capital significantly contributed to market value. Hulten and Hao (2008) estimated firm value of pharmaceutical companies by R&D capital, and organizational capital measured from sales, general and administrative expenditures, and showed that both of these types of intangible assets contributed to increasing firm value.

Abowd et al. (2005) constructed their own measure with respect to quality of human capital from employer-employee datasets. They estimated firm value by obtaining Compustat data using the measure of quality of human capital, and found that their measure was positively correlated with the value of the firm. Bloom and Van Reenen (2007) also constructed their own management score taking organizational management and human resource management into account, using their interview surveys. They showed that this management score was positively correlated with Tobin's Q.

A couple of papers focused on rate of return taking account of intangible assets. Li and Liu (2010) examined the relation between firm stock return and R&D investment using investment based asset pricing theory developed by Cochrane (1996) and Liu, Whited and Zhang (2009). They showed that high R&D intensive firms earn high stock returns than low intensive firms. Görzig and Görnig (2012) measured intangible assets by estimating the share of labor costs of ICT, R&D, and management and marketing employees and examined distributions of rate of return on capital taking account of intangibles. Once they considered intangible assets, they found that the dispersion of rate of return on capital was reduced dramatically.

3. Measurement of Intangible Assets in Japanese Listed Firms

Although previous studies have shown the contribution of intangible assets to firm value, they did not capture comprehensive intangible assets like Corrado et al. (2009). Therefore, among intangible assets classified by Corrado et, al. (2009), we measure five types of intangibles; software, R&D, brand equity, firm specific human capital, and organizational change. This concept of intangibles is broader than that of previous studies.[4]

Corrado et al. (2009) classified intangible assets into three categories: computerized information, innovative property, and economic competencies. Software investment is a part of investment in computerized information consists of three types of software; custom software investment, packaged software investment, and own account software investment. R&D investment is included in investment in innovative property.[5] Investment in economic competencies consists of brand equity, firm specific human capital, and organizational change. We measure these three components depending on the data in Development Bank of Japan (DBJ) Corporate Financial Databank which covers financial statements of all Japanese listed firms except banking and insurance firms. The detailed methods we use to measure the five Items mentioned above for each firm are as follows:

1) Software: First, the ratio of workers engaged in information processing to the total number of employee is multiplied by the total cash earnings in order to measure the value of software investment. Then, we add the cost of information processing to this number to find total software investment. All the information is obtained from *Basic Survey of Business Activities of Enterprises* (BSBAE) surveyed by Ministry of Economy, Trade, and Industry. We deflate this number by the deflator for software investment in the Japan Industrial Productivity

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4 The measurement of tangible assets evaluated at replacement cost is also explained in Appendix 1.

5 Although innovative property accounts for various items possibly including science and engineering R&D, mineral exploitation, copyright and license costs, and other product development, design, and research expenses, we measure only R&D expenditures, due to the lack of reliable data for intangibles except R&D in innovative property.

(JIP) database.[6][7]

2) Research and Development (R&D): We subtract the cost of acquiring fixed assets for research from the cost of R&D (i.e., in-house R&D and contract R&D) to estimate the value of investment into R&D. All the information is obtained from BSBAE. The output deflator for research (private) in the JIP database is used to deflate this R&D investment.

3) Brand equity: Brand equity is measured based on expenditures on advertising. The data of advertising expenses are obtained from the DBJ Corporate Financial Databank. We use the output deflator for advertising in the JIP database as the deflator for advertising investments.

4) Firm specific human capital: First, we estimate each firm's investment on firm-specific skills by multiplying (i) the total labor cost in the DBJ Corporate Financial Databank with (ii) the industry-average ratio of total employee training cost to the total labor cost for each firm from the General Survey of Working Conditions and (iii) the ratio of the on-the-job and off-the-job training costs for firm-specific skills to the total education cost (0.37).[8] In order to further consider the opportunity cost of the off-the-job training cost for skill improvement, we multiply the number computed in the abovementioned procedure to 2.51.[9]

5) Organizational change: Following Robinson and Shimizu (2006), who conducted a survey of the time-use of Japanese CEOs, we assume that 9% of board members' compensation -- which we can obtain from the DBJ Corporate Financial Databank -- accounts for investment in organizational change. This is deflated by the output deflator for education (private and

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[6] In this procedure, we were not able to measure purchased software investment, which is included in the capital expenditure in the balance sheets of each firm. We ignore this part due to data limitations on capitalized software in our data.

[7] The JIP database is constructed for the productivity measurement at the industry level. The website of the database is http://www.rieti.go.jp/en/database/JIP2011/index.html. Fukao et al. (2007) explain how this database was constructed.

[8] For the ratio of the job training costs for firm-specific skill to overall employee training costs, we use the results in Ooki (2003).

[9] Ooki (2003) estimates the ratio of the average opportunity cost of off-the-job training to the total employee training cost paid by firm (all industry) in 1998 as 1.51. Ooki (2003) uses the micro-data obtained from "The Japan Institute for Labor Policy and Training's Survey on Personnel Restructuring and Vocational Education/Training Investment in the Age of Performance-based Wage Systems" (Gyoseki-shugi Jidai no Jinji SeirITo Kyoiku/Kunren Toshi ni Kansuru Chosa).

non-profit) in the JIP database.

For all five investment category data detailed above, we employ the Perpetual Inventory (PI) method, in which we use FY1995 as the base year, to construct a data series of intangible assets from FY2000. All depreciation rates used for this computation follow that of Corrado et al. (2012).[10]

4. Tobin's Q with Intangibles

The conventional Tobin's Q (Q_{it}^{C}) at the firm level is measured as the ratio of firm value (V_{it}) to the replacement value of tangible assets $((1-\delta_K)K_{it-1})$ at the initial period of *t*.[11]

(1) $$Q_{it}^{C} = \frac{V_{it}}{(1-\delta_{Kt})K_{it}}$$

where δ_K is the depreciation rate of tangible assets. We measure the conventional Tobin's Q as follows:

The conventional Tobin's Q = (Stock value + Book values of commercial paper, corporate bond, and long-term debt)/(1- δ_K)*(Replacement values of tangible assets + Inventory-Short-term debt).

As shown by Lindenberg and Ross (1981), and Hall (2000 and 2001) for the US and Tanaka and Miyagawa (2011) for Japan, the standard Q expressed by (1) has persistently exceeded 1. The mean value of the conventional Tobin's Q shown in Table 1-1 is also 1.40.

Lindenberg and Ross (1981) explained the gap between the measured conventional Q and 1 as being due to monopoly rents, although they knew that unmeasured intangibles affected this gap. When we measure the Tobin's Q considering intangible assets (N_{it-1}) as measured in

[10] The depreciation rates of software, R&D, advertising, human capital and organizational change are 31.5%, 15%, 55%, 40% and 40%, respectively.
[11] As for the derivation of the conventional Q, we follow Bond and Cummins (2000).

Section 3, the revised Tobin's Q (Q_{it}^{R}) is expressed as follows:

$$(2)\qquad Q_{it}^{R} = \frac{V_{it}}{(1-\delta_K)K_{it} + (1-\delta_N)N_{it}}$$

where δ_N is the depreciation rate in intangible assets.

We show a revised Tobin's Q including intangible assets in Table 1-2. The mean value of the revised Tobin's Q is 0.99 which is almost equal to 1. The difference between the two mean values is significant. The standard deviation of the revised Q is smaller than that of the conventional Q, which is consistent with the results of Görzig and Görnig (2012), who showed that the dispersion of profit rates when including intangible assets is smaller than that wIThout intangibles. The distributions of two types of Tobin's Q are shown in Figure 1. We find that the revised Tobin's Q is distributed around 1 compared to the conventional one. The Kolmogorov-Smirnov test rejected the hypothesis that the two distributions are the same.

(Place Tables 1-1, 1-2 and Figure 1 around here)

We divide all samples into two sectors: ICT sectors and non-ICT sectors.[12] The mean value of Tobin's Q in ICT sectors is higher than that in non-ICT sectors in both cases. However, the mean value of the revised Q in the ICT sectors is 1.13, which is much closer to 1 than the mean value of the conventional Q in the ICT sectors. Also, the standard deviation of the revised Q in the ICT sectors is reduced compared to that of conventional Q in the ICT sectors.

(Place Tables 1-3, 1-4, 1-5, and 1-6 around here)

[12] The classification of ICT industries and non-ICT industries is shown in Appendix 2.

Arato and Yamada (2012) measured aggregate intangible assets based on DBJ data. Their estimated ratio of intangible assets to tangible assets is 0.47 in the 1980s. As shown in Table 2, the corresponding rate of our estimates is 0.45, which is similar to that of Arato and Yamada (2012). The result shows that the ratio of intangible assets to tangible assets has not changed in Japan.

(Place Table 2 around here)

5. Do Intangible Assets Explain the Overvaluation of Tobin's Q?

5-1 The Relationship of the Conventional Tobin's Q with Intangibles

Although the revised Q is almost equal to 1 on average, the Tobin's Q in each firm deviates from 1. Thus, we econometrically check the effects of intangible assets on the variation of Tobin's Q. As we introduced in Section 2, Brynjolfsson, Hitt and Yang (2002), Cummins (2005) and Miyagawa and Kim (2008) estimated the effects of intangible assets on firm value. However, these studies focused on fewer components of intangibles than those classified by Corrado et al. (2009). Therefore, we examine the effect of intangibles following the classification by Corrado et al. (2009) on firm value.

Following Bond and Cummins (2000), the profit function (π) depends on tangible and intangible capital. Dividends at firm *i* (D_i) are expressed as follows:

(3) $$D_{it} = \pi(K_{it}, N_{it}) - I_{it} - O_{it} - G(I_{it}, K_{it}) - H(O_{it}, N_{it})$$

where I is investment in tangible assets, O is investment in intangible assets, and G and H are adjustment cost functions in tangible investment and intangible investment, respectively.[13]

$$G(I_{it}, K_{it}) = \frac{a}{2}\left(\frac{I_{it}}{K_{it}}\right)^2 K_{it}$$
$$H(O_{it}, N_{it}) = \frac{b}{2}\left(\frac{O_{it}}{N_{it}}\right)^2 N_{it}$$

Capital accumulation in tangible assets and intangible assets is expressed as follows:

$$K_{it} = I_{it} + (1-\delta_K)K_{it-1}$$
$$N_{it} = O_{it} + (1-\delta_N)N_{it-1}$$

We solve the optimization problems of firm *i* with respect to I, and O.

(4-1) $$q_{Kt} = 1 + a\left(\frac{I_{it}}{K_{it}}\right)$$

(4-2) $$q_{Nt} = 1 + b\left(\frac{O_{it}}{N_{it}}\right)$$

where q_K and q_N are Lagrange multipliers.

When the profit function is linear homogeneous, the firm value of firm *i* is expressed as a linear combination of each asset (Wildasin (1984) and Hayashi and Inoue (1991)).

(5) $$V_{it} = q_{Kt}(1-\delta_K)K_{it} + q_{Nt}(1-\delta_N)N_{it}$$

[13] There are two types of adjustment cost functions. The first type of adjustment cost implies additional costs associated with gross investment. The second type of adjustment cost implies that gross investment includes adjustment costs associated with accumulation of capital. In our study, we use the first type of adjustment cost function.

From (5),

$$(6) \quad q_{Kt} = \frac{V_{it}}{(1-\delta_K)K_{it}} - q_{Nt}\frac{(1-\delta_N)}{(1-\delta_K)}\frac{N_{it}}{K_{it}}$$

Substituting (4-1) and (4-2) into (6), we obtain:

$$(7) \quad \begin{aligned} Q_{it}^C - 1 &= a(\frac{I_{it}}{K_{it}}) + \{1 + b(\frac{O_{it}}{N_{it}})\}\frac{(1-\delta_N)}{(1-\delta_K)}(\frac{N_{it}}{K_{it}}) \\ &= a(\frac{I_{it}}{K_{it}}) + \frac{(1-\delta_N)}{(1-\delta_K)}(\frac{N_{it}}{K_{it}}) + b\frac{(1-\delta_N)}{(1-\delta_K)}(\frac{O_{it}}{K_{it}}) \end{aligned}$$

where $Q_{it}^C = \frac{V_{it}}{(1-\delta_K)K_{it}}$ is the standard average Q at firm *i*.

Equation (7) implies that the gap between the conventional Q ratio and 1 is explained by the ratio of intangible assets to tangible assets, the gross tangible investment/tangible assets ratio, and the gross intangible assets ratio.

5.2 Estimation results

Based on Equation (7), we estimate the following equation:

$$(8) \quad Q_{it}^C - 1 = const. + \alpha_1(\frac{N_{it}}{K_{it}}) + \alpha_2(\frac{I_{it}}{K_{it}}) + \alpha_3(\frac{O_{it}}{K_{it}}) + \sum_{j=1}^{n}\beta_j X_{ijt} + \varepsilon_{it}$$

In Equation (8), X_{ij} is a control variable. Lindenberg and Ross (1981) pointed out that monopoly rents explained the overvaluation of firm value. In addition, financial constraints may affect the gap between a standard Q and 1. Then, we also estimate Equation (8) with a price cost margin or external finance dependence as defined by Rajan and Zingales (1998). We expect that the coefficient of external finance dependence will be negative because a greater dependence on external finance reduces firm value. The basic statistics of the variables used in our estimation are summarized in Table 3.

(Place Table 3 around here)

First, we estimate Equation (8) by OLS. To avoid endogeneity, we take a one-year lag for all explanatory variables. The estimation results are shown in Table 4. In Column (1), we focus on the effect of intangible assets on the overvaluation of the conventional Q. In this estimation, the ratio of intangible to tangible assets significantly explains the overvaluation of the Q ratio. In Column (2), we regress firm value on three variables included in Equation (7). The estimation results show that all variables are positive and the ratio of intangible to tangible assets, and the tangible investment/tangible assets ratio are significant. Due to the strong correlation between intangible assets/tangible assets and intangible investment/tangible assets ratio, the coefficient of intangible investment/tangible assets ratio may be not significant.

In Columns (3) and (4), we estimate Equation (8) including control variables. In Column (3), all three variables in Equation (7) are positive and significant. In addition, the coefficient of external finance dependence is negative and insignificant, as we expected. In Column (4), the ratio of intangible assets to tangible assets and the price cost margin are positive and significant, while intangible and tangible investments are not significant.

(Place Table 4 around here)

Next, we estimate Equation (8) utilizing the instrumental variable method. Instruments are the ratio of white-collar to total workers, and external finance dependence. The results in Table 5 indicate that the ratio of intangible assets to tangible assets is positive and significant in all estimations. However, the intangible investment/tangible assets ratio is negative in Columns (2) and (3). It is possible that negative coefficients of intangible investment/tangible assets are caused by the multicollinearity between intangible assets and intangible investment.

(Place Table 5 around here)

We also conduct panel estimations. As the Hausman test suggests that the random effect estimation is better than fixed effect estimation, we show the results of random effect estimations in Table 6. Table 6 shows that the ratio of intangible assets to tangible assets is positive and significant in all estimations. As the coefficient of price cost margin is also positive and significant, monopoly rents also contribute to the valuation of firm, as Lindenberg and Ross (1981) suggested.

(Place Table 6 around here)

Brynjolfsson, Hitt and Yang (2002), Basu et al. (2003), and Cummins (2005) emphasized that intangible assets are complementary to ICT assets. Miyagawa and Hisa (2013) found that intangible investment in the ICT sectors improve TFP growth. In Section 4, we found that the

Tobin's Q in ICT sectors is higher than that in non-ICT sectors. Then, we divide all samples into those in the ICT sectors and non-ICT sectors and estimate Equation (8) by the instrumental variable method in each sector. Table 7 shows that estimation results in ICT sectors are similar to those in Table 5. The ratio of intangible to tangible assets is positive and significant in all estimations when the coefficients of intangible and tangible investments are not significant. However, in the non-ICT sectors, the coefficients of the ratio of intangible to tangible assets are not necessarily significant, while the signs of the coefficients are positive in all estimations. The estimation results in Table 7 imply that only intangible assets in the ICT industries contribute significantly to the evaluation of firm value.[14] In addition, the price cost margin is positive and significant in the ICT and non-ICT sectors, as can be seen in Tables 5 and 6.

(Place Table 7 around here)

As explained in Section 3, we measure five types of intangible assets; software, R&D, brand equity, firm specific human capital, and organizational change. We examine what kind of assets the stock market assesses favorably. Estimation results in Table 8 show that the stock market assesses assets in software and firm specific human capital favorably, while the assessments of R&D, brand equity, and organizational change are inconclusive. These results imply that the stock market does not necessarily consider all components of intangibles as positive.

(Place Table 8 around here)

[14] We also conduct OLS estimations in each sector. The estimation results are similar to Table 6. Although the ratio of intangible to tangible assets in the ICT industries is positive and significant, the signs of this variable are inconclusive in the non-ICT industries.

Figure 1 shows that the sample deviation from the mean value is not symmetric. In this case, quantile regression -- that estimates parameters based on the error measured as a deviation from the median value in each quantile -- is useful for robustness check of our results. We separate the distribution of a conventional Tobin's Q into four quantiles and conduct quantile regression. Table 9 shows the estimation results of quantile regression that correspond to the OLS estimations in Table 4. As in Table 4, the firm value reflects intangible values in all estimations. In addition, intangible investment also contributes positively and significantly to the increase in firm value (Column (2)), while the coefficient of this variable is not significant in Table 4. As a result, the above two alternative estimations confirm the positive and significant contributions of intangible assets to firm value.

(Place Table 9 around here)

6. Concluding Remarks

The ICT revolution has changed the growth strategy of firms. Software investment has become as important as tangible investment. Firms have focused on accumulation in human capital and restructured their organizations to be compatible with the new technology. Many economists such as E. Brynjolfsson, C. Corrado, R. Hall, C. Hulten, B. Lev, and L. Nakamura summarized these new types of expenditures as intangible investment and examined its effects on firm value. However, many studies have focused on the effects of specific components of intangible assets on firm value, because it is difficult to measure intangibles at the firm level.

Based on the classification of intangibles by Corrado et al. (2009), we measure a broader concept of intangibles than those in the previous studies using the listed firm-level data in Japan.

The mean value of Tobin's Q including intangible assets is almost equal to 1, while the mean value of conventional Tobin's Q exceeds 1, as Hall (2000 and 2001) suggested. The standard deviation of the revised Q is smaller than that of the conventional Q, which is consistent with the results of Görzig and Görnig (2012). These results imply that stock prices reflect the value of intangibles.

Although the results also imply that the market concludes that there are no growth opportunities of Japanese listed firms on average in the 2000s, there are still differences in Tobin's Q. The Tobin's Q in the ICT industries is consistently higher than that in the non-ICT industries. This difference in market value suggests that firms in the ICT industries should expand their businesses, and firms in the non-ICT industries should restructure their businesses. The result is consistent with Miyagawa and Hisa (2013), who argued that intangible investment improves productivity in the ICT industries. The Japanese government should take growth strategies such as to promote investment including intangibles in the ICT industries and to assist firms in the non-ICT industries transform themselves to a business in a growth industry.

Using our measures, we examined the effects of intangibles on firm value. Estimation results following Bond and Cummins (2000) showed that greater intangible assets increase firm value. As these results are robust in the ICT industries in particular, they support our policy implications. However, not all intangible assets are valued in the stock market. The values of innovative property and economic competencies are inconclusive. One possible reason for the long-term slump of the Japanese stock market is that investors are not valuing high level R&D investment and human resources in Japanese firms. The upcoming reform in accounting standards that will evaluate intangible assets will contribute to the revitalization of the Japanese stock market.

Appendix 1. Measurement of tangible capital stock

Capital stock

In reference to Hayashi and Inoue (1991), we create the dataset of tangible capital stock by assets. Tangible assets are classified into (1) non-residential building, (2) construction, (3) machinery, (4) ship/vehicle/transportation equipment, (5) tool appliance equipment, and (6) other tangible assets.

We employ the Permanent Inventory (PI) method for each asset as follows:

$$K_{it}^{m} = (1 - \delta_m)K_{it-1}^{m} + I_{it}^{m}$$

where K_{it}^{m} is the capital stock of asset *m* for firm *i* at time *t*, I_{it}^{m} is real investment, and δ_m is the depreciation rate. After calculating the capital stock of each asset, we estimate the total tangible capital stock, K_{it} by adding them together as follows.

$$K_{it} = \sum_{m} K_{it}^{m}$$

In the following, we introduce the measurement of each part used in calculating the real tangible capital stock.

Nominal investments

The nominal investment of each asset is defined as the amount of each acquisition credited against the retirement and decrease in the tangible asset by the sale of another one. While Hayashi and Inoue (1991) used the retirement and decrease valued by replacement price, we use the book value.

Capital price by the type of capital goods

In order to deflate nominal investments, we use the following price indices in "Corporate goods Price Index (CGPI)" by Bank of Japan.

"Construction material price index" for (1) non-residential building and (2) construction

"Transportation equipment price index" for (4) ship/vehicle/transportation equipment

"Manufacturing product price index" for (6) other tangible assets

For (3) machinery and (5) tool appliance equipment, we use the relevant price indices in the CGPI. At first we calculate the industry level weight for each machinery or tool using the "Fixed Capital Formation Matrix" by the Ministry of Internal Affairs, Government of Japan. We calculate the weighted average price indices using the weights and the relevant price indices in CGPI for (3) machinery and (5) tool appliance equipment.

Starting year for the Perpetual Inventory method

As our study focuses on the relationship between firm value and intangibles in the 2000s, we are able to start Perpetual Inventory method before 1999. For (1) non-house building and (2) construction, a starting year of PI method is FY1980 and for (3) machinery, (4) ship/vehicle/transportation equipment, (5) tool appliance equipment, and (6) other tangible assets a starting year of PI method is FY1990.

Depreciation rate

We use the depreciation rate that Hayashi and Inoue (1991) created using Hulten and Wykoff (1979, 1981). Specifically, the rates are the following: (1) non-house building, 4.7% (2)

construct, 5.64% (3) machinery, 9.489% (4) ship/vehicle/transportation equipment, 14.7% (5) tool appliance equipment and (6) other tangible assets are both 8.838%.

Appendix 2. Classification of ICT sectors

JIP code	ICT-using manufacturing sector
20	Printing, plate making for printing and bookbinding
23	Chemical fertilizers
24	Basic inorganic chemicals
29	Pharmaceutical products
34	Pottery
38	Smelting and refining of non-ferrous metals
42	General industry machinery
45	Office and service industry machines
46	Electrical generating, transmission, distribution and industrial apparatus
53	Miscellaneous electrical machinery equipment
56	Other transportation equipment
59	Miscellaneous manufacturing industries

JIP code	ICT-using non-manufacturing sector
63	Gas, heat supply
67	Wholesale
68	Retail
69	Finance
70	Insurance
79	Mail
85	Advertising
86	Rental of Office equipment and goods
88	Other services for businesses
92	Publishers

JIP code	ICT-producing manufacturing sector
47	Household electric appliances
48	Electronic data processing machines, digital and analog computer, equipment and accessories
49	Communication equipment
50	Electronic equipment and electric measuring instruments
51	Semiconductor devices and integrated circuits
52	Electronic parts
57	Precision machinery & equipment

Appendix 2. (Cont'd.)

JIP code	ICT-producing non-manufacturing sector
78	Telegraph and telephone
90	Broadcasting
91	Information services and internet based services

JIP code	Non-ICT intensive manufacturing sector
8	Livestock products
9	Seafood products
10	Flour and grain mill products
11	Miscellaneous foods and related products
12	Prepared animal foods and organic fertilizers
13	Beverages
14	Tobacco
15	Textile products
16	Lumber and wood products
17	Furniture and fixtures
18	Pulp, paper, and coated and glazed paper
19	Paper worked products
21	Leather and leather products
22	Rubber products
25	Basic organic chemicals
26	Organic chemicals
27	Chemical fibers
28	Miscellaneous chemical products
30	Petroleum products
31	Coal products
32	Glass and its products
33	Cement and its products
35	Miscellaneous ceramic, stone and clay products
36	Pig iron and crude steel
37	Miscellaneous iron and steel
39	Non-ferrous metal products
40	Fabricated constructional and architectural metal products
41	Miscellaneous fabricated metal products
43	Special industry machinery
44	Miscellaneous machinery
54	Motor vehicles
55	Motor vehicles parts and accessories
58	Plastic products

Appendix 2. (Cont'd.)

JIP code	Non-ICT intensive non-manufacturing sector
62	Electricity
64	Waterworks
65	Water supply for industrial use
66	Waste disposal
71	Real estate
73	Railway
74	Road transportation
75	Water transportation
76	Air transportation
77	Other transportation and packing
81	Research(private)
87	Automobile maintenance services
89	Entertainment
93	Video picture, sound information, character information production and distribution
94	Eating and drinking places
95	Accommodations
96	Laundry, beauty and bath services
97	Other services for individuals

JIP code	Other Industries
1	Rice, wheat production
2	Miscellaneous crop farming
3	Livestock and sericulture farming
4	Agricultural Services
5	Forestry
6	Fisheries
7	Mining
60	Construction
61	Civil engineering

References

Abowd, J. M., Haltiwanger, J., Jarmin, R., Lane, J., Lengermann, P., McCue, K., McKinney, K., Sandusky, K. 2005. The relation among human capital, productivity, and market value. In: Corrado, C., Haltiwanger, J., Sichel D. (eds), Measuring Capital in the New Economy, The University of Chicago Press, Chicago, IL. USA. 153-203.

Arato H., Yamada, K. 2012. Japan's intangible capital and valuation of corporations in a neoclassical framework. Review of Economic Dynamics 15, 293-312.

Barnes, P., McClure, A. 2009. Investments in intangible assets and Australia's productivity growth. Productivity Commission Staff Working Paper, Productivity Commission, Melbourne.

Basu, S., Fernald, J. G., Oulton, N., Srinivasan, S. 2003. The case of the missing productivity growth: or, does information technology explain why productivity accelerated in the United States but not the United Kingdom? In: Gertler, M., Rogoff K. (eds), NBER Macroeconomics Annual, 2003, MIT Press, Cambridge, MA, USA. 9-63.

Bloom, N., Van Reenen, J. 2007. Measuring and explaining management practices across firms and countries. Quarterly Journal of Economics 122, 1351-1408.

Bond, S., Cummins, J. 2000. The stock market and investment in the new economy: Some tangible facts and intangible fictions. Brookings Papers on Economic Activity 1, 61-124.

Brynjolfsson, E. 2004. Intangible Assets, translated to Japanese by Diamond Inc., Tokyo.

Brynjolfsson, E., Hitt, L., Yang, S. 2002. Intangible assets: Computers and organization capital. Brookings Papers on Economic Activity 1, pp. 137-181.

Cochrane, J. 1996. A cross-sectional test of and investment- based asset pricing model. Journal of Political Economy 104, 572-621.

Corrado, C., Haskel, J., Jona-Lasinio, C., Iommi, M. 2012. Intangible capital and growth in advanced economies: measurement and comparative results. Presented at the 2nd World KLEMS Conference at Harvard University.

Corrado, C., Hulten, C., Sichel D. 2009. Intangible capital and U.S. economic growth. Review of Income and Wealth 55, 658-660.

Cummins, J. G. 2005. A new approach to the valuation of intangible capital. In: Corrado, C., Haltiwanger, J., Sichel D. (eds), Measuring Capital in the New Economy, The University of Chicago Press, Chicago, IL. USA. 47-72.

Delbecque, V., Bounfour A. 2011. Intangible investment: Contribution to growth and innovation policy issues. The European Chair on Intellectual Capital Management Working Paper Series, No. 2011-1A.

Fukao, K., Hamagata, S., Inui, T. Ito, K., Kwon, H. , Makino, T., Miyagawa, T., Nakanishi, Y., Tokui, J. 2007. Estimation procedure and TFP analysis of the JIP database 2006 (revised), RIETI Discussion Paper Series 07-E-003, the Research Institute of Economy, Trade and Industry, Tokyo.

Fukao, K., Miyagawa, T., Mukai, K. Shinoda, Y., Tonogi, K. 2009. Intangible investment in Japan: Measurement and contribution to economic growth. Review of Income and Wealth 55. 717-736.

Görzig, B. Görnig, M. 2012. The dispersion in profits rates in Germany: A result of imperfect competition? presented at the 32nd General Conference of International Association for Research in Income and Wealth at Boston, USA.

Griliches, Z. 1981. Market value, R&D, and patents. Economic Letters, 7. 83-187.

Hall, B.H. 1993. The stock market's valuation of R&D investment during the 1980's. American Economic Review 83, 259-264.

Hall, B. H., Oriani, R. 2006. Does the market value R&D investment by European firms? Evidence from a panel of manufacturing firms in France, Germany, and Italy. International Journal of Industrial Organization 24, 971-993.

Hall, R. 2000. E-capital: The link between the stock market and the labor market in the 1990s. Brookings Papers on Economic Activity 1, 73-118.

Hall, R. 2001. The stock market and capital accumulation. American Economic Review 91. 1185-1202.

Hao, J., Manole, V., van Ark, B. 2008. Intangible assets in Europe: Measurement and international comparability. Presented at the final conference of EUKLEMS Project held on June 10, 2008.

Hayashi, F., Inoue, T. 1991. The relation between firm growth and *Q* with multiple capital goods: Theory and evidence from panel data on Japanese firms, Econometrica, 731-753.

Hulten, C. R., Wykoff, F. C. 1979. Economic depreciation of the U.S. capital stock. Report submitted to the U.S. Treasury Department Office of Tax Analysis, Washington, D.C.

Hulten, C. R., Wykoff, F. C. 1981. The measurement of economics depreciation. In: Hulten. C. (ed), Depreciation, Inflation and the Taxation of Income from Capital,, Urban Institute Press, Washington, D.C. 81-125.

Hulten C. R., Hao, X. 2008. What is a company really worth? Intangible capital and the ‘market to book value’ puzzle. NBER Working Paper No. 14548.

Lev, B., Radhakrishnan, S. 2005. The valuation of organization capital. In: Corrado, C., Haltiwanger, J., Sichel D. (eds), Measuring Capital in the New Economy, The University of Chicago Press, Chicago, IL. USA. 73-99.

Li, E., Liu, L. 2010. Intangible assets and cross-sectional stock returns: Evidence from structural estimation, http://webuser.bus.umich.edu/xuenanli/R&D_Aug2010.pdf.

Lindenberg, E. Ross, S. A. 1981. Tobin's Q ratio and industrial organization. Journal of Business, 54. 1-32.

Liu, L., Whited, T., Zhang, L. 2009. Investment-based expected stock returns, Journal of Political Economy 117, 1105-1139.

Marrano, M, Haskel, J. Wallis, G. 2009. What happened to the knowledge economy? IT, intangible investment, and Britain's productivity revisited. Review of Income and Wealth 55. 661-716.

Miyagawa, T. Hisa, S. 2013. Estimates of intangible investment by industry and productivity growth in Japan. The Japanese Economic Review 64, 42-72.

Miyagawa, T. Kim, Y. 2008 Measuring organizational capital in Japan: An empirical assessment using firm-level data. Seoul Journal of Economics 21. 171-193.

Ooki E. 2003. Performance-based wage systems and vocational education/training investment, (Gyoseki-shugito Kyoiku Kunren Toshi). (in Japanese). In: Imano K. (ed), Implications of Performance-based Wage Systems for Individuals and Organizations (Ko to Soshiki no Seikashugi), Chuo Keizai Sha, Tokyo, Japan.

Piekkola, H. 2011. Intangible capital in EU 27 – Drivers of growth and location in the EU. Proceedings of the University of Vaasa. Reports 166.

Pyo, H., Chun, H,. Rhee, K. 2010. The productivity performance in Korean industries (1990-2008): Estimates from KIP database. Presented at RIETI/COE Hi-Stat International Workshop on Establishing Industrial Productivity Database for China (CIP), India (IIP), Japan (JIP), and Korea (KIP) held on October 22, 2010.

Rajan, R.G. Zingales, L. 1998. Financial dependence and growth. American Economic Review 88. 559-586.

Robinson, P., Shimizu, N. 2006. Japanese corporate restructuring: CEO priorities as a window on environmental and organizational change. The Academy of Management Perspectives 20. 44-75.

Tanaka, K. Miyagawa, T. 2011. Oogatatousi ha kigyo pafo-mansu wo koujou saseruka? (Does large investment improve firm performance? In: Asako, K., Watanabe, T. (eds.), Econometric Analyses of Finance and Business Cycles 191-235 (in Japanese).

Wildasin, D. E. 1984. The *q* theory of investment with many capital goods, American Economic Review 74. 203-210.

Table 1-1

Conventional Tobin's Q (All Sectors)	
Periods: FY2000-FY2009	
Mean	1.404
Median	1.056
Minimum	0.207
Maximum	6.933
Standard Deviation	1.146
Observations	2939

Table 1-2

Revised Tobin's Q (All Sectors)	
Periods: FY2000-FY2009	
Mean	0.990
Median	0.774
Minimum	0.142
Maximum	6.238
Standard Deviation	0.742
Observations	2939

Notes: 1) We drop the top and bottom 4% tails of the Conventional Tobin's Q.

2) Conventional Tobin's Q is calculated as follows:

Conventional Tobin's Q=(Stock value + Book value of Commercial paper and Corporate bond and Long-term debt) / ((1- δ_K)*Replacement value of tangible assets＋Inventory-Short-term debt)

3) Revised Tobin's Q is calculated as follows:

Revised Tobin's Q=(Aggregate market value + Book value of Commercial paper and Corporate bond and Long-term debt) / ((1- δ_K)*Replacement value of tangible assets+(1- δ_N)*Replacement value of intangible asset＋Inventory-Short-term debt))

Figure 1. Density of Tobin's Q

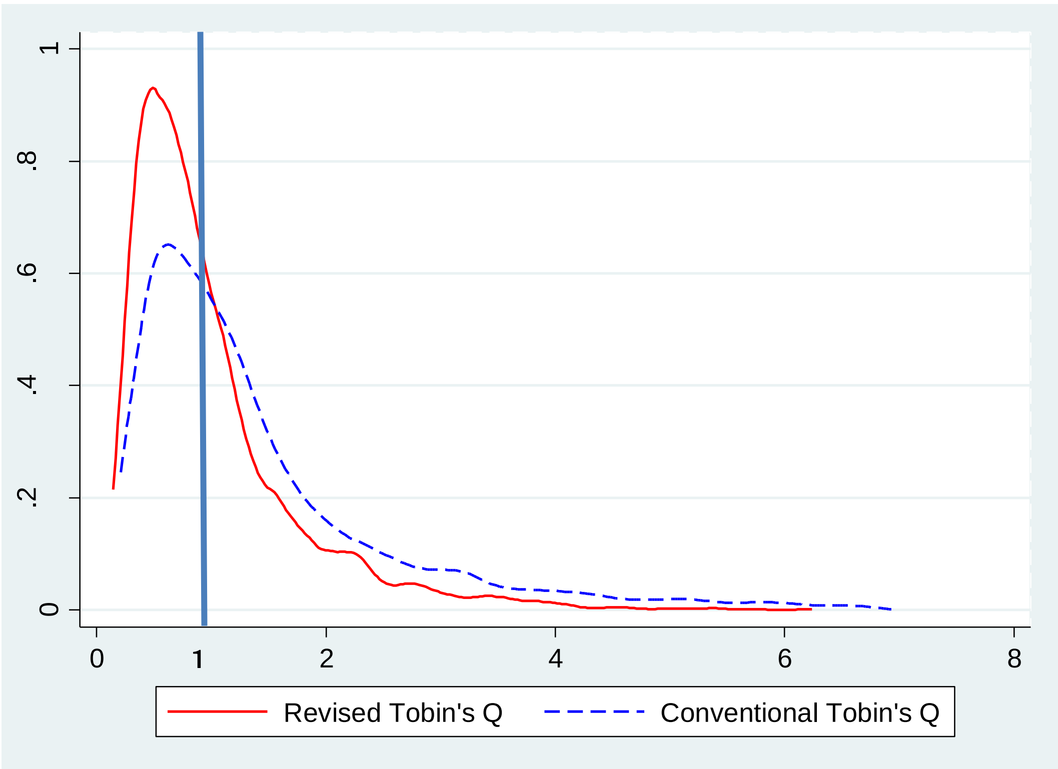

Table 1-3

Table 1-3 Conventional Tobin's Q (ICT Sectors)	
Periods: FY2000-FY2009	
Mean	1.710
Median	1.262
Minimum	0.207
Maximum	6.625
Standard Deviation	1.304
Observations	1089

Table 1-4

Table 1-4 Revised Tobin's Q (ICT Sectors)	
Periods: FY2000-FY2009	
Mean	1.129
Median	0.880
Minimum	0.162
Maximum	5.424
Standard Deviation	0.802
Observations	1089

Table 1-5

Conventional Tobin's Q (Non-CIT Sectors)	
Periods: FY2000-FY2009	
Mean	1.224
Median	0.944
Minimum	0.208
Maximum	6.933
Standard Deviation	1.000
Observations	1850

Table 1-6

Revised Tobin's Q (Non-ICT Sectors)	
Periods: FY2000-FY2009	
Mean	0.908
Median	0.711
Minimum	0.142
Maximum	6.238
Standard Deviation	0.692
Observations	1850

Table 2. Statistics of the ratio of intangible assets to tangible assets (N/K)

Periods: FY2000-FY2009	
Mean	0.442
Median	0.305
Minimum	0.013
Maximum	3.999
Standard Deviation	0.438
Observations	2939

Table 3. Statistics of the sample

Periods: FY2000-FY2009	Q-1	N/K	I/K	O/K	CC	PCM
Mean	0.404	0.442	0.103	0.129	0.130	0.036
Median	0.056	0.305	0.086	0.088	0.099	0.031
Minimum	-0.793	0.013	-0.019	0.004	-4.830	-0.469
Maximum	5.933	3.999	0.845	1.065	2.721	0.334
Standard Deviation	1.146	0.438	0.075	0.125	0.274	0.063
Observations	2939	2939	2939	2939	2026	2939

Notes:

N/K indicates the ratio of intangible to tangible assets.

I/K indicates the ratio of tangible to tangible assets.

O/K indicates the ratio of intangible to tangible assets.

CC indicates the measure of credIit constraint.

We calculate this measure following Rajan and Zingales (1998) as follows:

(Capital expenditures (tangible + intangible) - Cash flow from operations)/Tangible capital stock.

PCM indicates the price cost margin. The price cost margin is calculated as follows:

(Operating surplus - Interest expense)/Sales.

Table 4. OLS estimates of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)		(4)	
	All Sectors		All Sectors		All Sectors		All Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.619	0.053 ***	0.598	0.126 ***	0.390	0.143 ***	0.724	0.121 ***
I/K			0.571	0.236 **	1.036	0.292 ***	0.043	0.227
O/K			0.103	0.428	1.329	0.478 ***	-0.288	0.408
CC					-0.337	0.084 ***		
PCM							4.983	0.293 ***
Const.	-0.478	0.922	-0.575	0.922	-0.495	0.883	-0.723	0.878
Industry dummy	Yes		Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes		Yes	
Number of obs	2882		2882		2047		2882	
F	19.62		19.15		15.61		25.07	
Prob > F	0		0		0		0	
R-squared	0.312		0.313		0.3315		0.377	
Adj R-squared	0.296		0.297		0.3103		0.362	
Root MSE	0.918		0.917		0.87606		0.874	

Notes:

*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Dependent variable: Standard Tobin's Q-1

Explanatory variables: Nt/Kt indicates the ratio of intangible assets to tangible assets.

I_t/Kt indicates the ratio of tangible investments to tangible assets.

Ot/Kt indicates the ratio of intangible investments to tangible assets.

CC indicates the measure of credit constraint.

We calculate this measure following Rajan and Zingales (1998) as follows: (Capital expenditures (tangible + intangible) - Cash flow from operations)/Tangible capital stocks.

PCM indicates the price cost margin. Price cost margin is calculated as follows: (Operating surplus - Interest expense)/Sales.

Table 5. Instrumental variable (IV) estimates of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.518	0.212 **	3.413	0.763 ***	1.788	0.623 ***
I/K			0.924	0.315 ***	0.193	0.269
O/K			-9.934	2.768 ***	-4.146	2.261 *
PCM					6.005	0.356 ***
Const.	-0.759	0.171 ***	0.161	0.445	-0.670	0.371 *
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	52.06		12.27		20.75	
Prob > F	0		0		0	
R-squared	0.3196		0.1438		0.3767	
Adj R-squared	0.387		0.2286		0.4384	
Root MSE	0.8708		0.9769		0.8335	
Sargan statistic	9.624		0.488		0.409	
Chi-sq(1) P-val	0.0019		0.4847		0.5225	

Notes: See the notes in Table 4.
Skilled labor ratio indicates the ratio of white-color to total workers.

Table 6. Panel estimate (Random Effect) of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.613	0.082 ***	0.451	0.129 ***	0.595	0.125 ***
I/K			0.242	0.172	0.010	0.167
O/K			0.711	0.391 *	0.286	0.380
PCM					4.014	0.286 ***
Const.	-1.203	0.986	-0.558	0.987	-0.707	0.943
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.772		0.772		0.730	
sigma_e	0.600		0.599		0.581	
rho	0.623		0.624		0.612	
Number of obs	2882		2882		2882	
Number of groups	332		332		332	

	(1)		(2)		(3)	
	ICT Sectors		ICT Sectors		ICT Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.666	0.110 ***	0.370	0.176 **	0.523	0.171 ***
I/K			0.563	0.344	0.155	0.337
O/K			1.108	0.481 **	0.666	0.469
PCM					4.860	0.565 ***
Const.	0.804	1.097	0.809	1.104	0.759	1.063
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.772		0.779		0.741	
sigma_e	0.738		0.733		0.712	
rho	0.523		0.530		0.520	
Number of obs	1211		1211		1211	
Number of groups	135		135		135	

Table 6. (Cont'd.)

	(1)		(2)		(3)	
	Non-CIT Sectors		Non-ICT Sectors		Non-ICT Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
Nt/Kt	0.567	0.109 ***	0.319	0.155 **	0.453	0.149 ***
It/Kt			0.106	0.182	-0.082	0.176
Ot/Kt			1.148	0.498 **	0.714	0.481
PCM					3.961	0.318 ***
Const.	-0.721	0.752	-0.666	0.736	-0.799	0.682
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
sigma_u	0.669		0.649		0.593	
sigma_e	0.544		0.544		0.524	
rho	0.602		0.587		0.562	
Number of obs	1845		1845		1845	
Number of groups	202		202		202	

Notes: See the notes in Table 4.

Table 7. Instrumental variable (IV) estimates of determinants of conventional Tobin's Q-1 (ICT or Non-ICT sectors)

	(1)		(2)		(3)	
	ICT Sectors		ICT Sectors		ICT Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.887	0.264 ***	3.233	1.127 ***	2.176	1.042 **
I/K			0.923	0.622	0.040	0.581
O/K			-7.598	3.691 **	-4.498	3.410
PCM					4.913	0.599 ***
Const.	-1.012	0.355 ***	-0.412	0.464	-0.820	0.429 *
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	777		777		777	
F	7.81		9.05		12.22	
Prob > F	0		0		0	
R-squared	0.307		0.2248		0.3432	
Adj R-squared	0.457		0.3927		0.4855	
Root MSE	0.9451		0.9996		0.92	
Sargan statistic	4.013		0.231		0.021	
Chi-sq (1) P-val	0.045		0.631		0.884	

Table 7. (Contd.)

	(1)		(2)		(3)	
	Non-ICT Sectors		Non-ICT Sectors		Non-ICT Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.022	0.267	3.443	0.999 ***	1.369	0.752 *
I/K			0.753	0.370 **	0.304	0.299
O/K			-12.174	4.025 ***	-3.423	3.025
PCM					6.535	0.435 ***
Const.	-0.018	0.265	-0.078	0.307	-0.350	0.247
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	1269		1269		1269	
F	13.84		10.55		21.07	
Prob > F	0		0		0	
R-squared	0.3062		0.0653		0.3996	
Adj R-squared	0.3398		0.1106		0.4287	
Root MSE	0.8257		0.9584		0.7681	
Sargan statistic	3.634		1.081		0.156	
Chi-sq (1) P-val	0.057		0.298		0.693	

Notes: See the notes in Table 4.
Skilled labor ratio indicates the ratio of white-color to total workers.

Table 8. Instrumental variable (IV) estimates of determinants of Conventional Tobin's Q-1 (Software, R&D, Brand equity, Human capital, and Organizational change)

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Software		Software		Software	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	3.676	2.050 *	73.826	35.946 **	47.953	23.001 **
I/K			0.891	0.553	0.089	0.384
O/K			-211.792	106.955 **	-133.847	68.346 *
PCM					7.444	0.854 ***
Const.	-0.890	0.398 **	-1.800	0.755 **	-1.747	0.531 ***
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	13.1		3.67		9.42	
Prob > F	0		0		0	
Centered R2	0.2913		-1.6073		-0.3055	
Uncentered R2	0.3615		-1.349		-0.1762	
Root MSE	0.8887		1.705		1.206	
Sargan statistic	12.95		0.466		1.149	
Chi-sq (1) P-val	0.0003		0.495		0.2838	

Table 8. (Cont'd.)

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	R&D		R&D		R&D	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.908	0.263 ***	2.797	1.334 **	-0.289	1.118
I/K			0.684	0.298 **	-0.016	0.266
O/K			-10.646	6.867	4.824	5.762
PCM					5.711	0.358 ***
Const.	-0.467	0.287	-0.598	0.309 *	-0.666	0.275 **
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	13.52		12.8		20.22	
Prob > F	0		0		0	
Centered R2	0.3062		0.2268		0.3877	
Uncentered R2	0.375		0.3034		0.4483	
Root MSE	0.8793		0.9283		0.8261	
Sargan statistic	4.561		4.747		2.564	
Chi-sq (1) P-val	0.0327		0.0293		0.1094	

Table 8. (Cont’d.)

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Brand equity		Brand equity		Brand equity	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	2.27	1.36 *	375.95	352.43	164.59	139.15
I/K			2.18	1.90	0.47	0.70
O/K			-666.91	626.78	-291.10	247.49
PCM					7.74	1.64 ***
Const.	-1.27	0.60 **	-2.49	1.95	-1.80	0.88 **
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	12.82		0.94		5.02	
Prob > F	0		0.5995		0	
Centered R2	0.2763		-8.8485		-1.3675	
Uncentered R2	0.348		-7.8728		-1.1329	
Root MSE	0.8981		3.313		1.624	
Sargan statistic	13.04		0.005		2.42	
Chi-sq (1) P-val	0.0003		0.9411		0.1198	

Table 8. (Cont'd.)

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Human capital		Human capital		Human capital	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	-2.33	1.29 *	36.74	9.66 ***	27.42	7.28 ***
I/K			1.90	0.49 ***	0.77	0.36 **
O/K			-90.68	24.59 ***	-66.55	18.51 ***
PCM					8.35	0.74 ***
Const.	-0.20	0.33	-0.40	0.37	-0.75	0.30 **
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	11.03		8.49		16.02	
Prob > F	0		0		0	
Centered R2	0.1579		-0.1409		0.2251	
Uncentered R2	0.2413		-0.0278		0.3019	
Root MSE	0.9688		1.128		0.9293	
Sargan statistic	10.326		1.183		3.282	
Chi-sq (1) P-val	0.0013		0.2767		0.07	

Table 8. (Cont'd.)

	(1)		(2)		(3)	
	All Sectors		All Sectors		All Sectors	
	Organizational change		Organizational change		Organizational change	
	Coef.	SE	Coef.	SE	Coef.	SE
N/K	93.29	50.05 *	2419.06	1860.25	22.58	598.39
I/K			1.45	0.85 *	0.04	0.30
O/K			-5773.80	4517.08	44.18	1453.14
PCM					5.96	0.75 ***
Const.	-2.20	1.01 **	-3.28	1.70 *	-1.44	0.61 **
Industry dummy	Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes	
Instrumented	N/K		O/K		O/K	
Instrumental Variables	Skilled labor ratio		Skilled labor ratio		Skilled labor ratio	
	CC		CC		CC	
Number of obs	2040		2040		2040	
F	12.68		3.42		20.17	
Prob > F	0		0		0	
Centered R2	0.2677		-1.8208		0.3918	
Uncentered R2	0.3403		-1.5413		0.452	
Root MSE	0.9034		1.773		0.8234	
Sargan statistic	12.168		2.358		13.272	
Chi-sq (1) P-val	0.0005		0.1246		0.0003	

Notes: See the notes in Table 4.

Skilled labor ratio indicates the ratio of white-color to total workers.

Table 9. Quantile regression of determinants of conventional Tobin's Q-1

	(1)		(2)		(3)		(4)	
	All Sectors		All Sectors		All Sectors		All Sectors	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
N/K	0.709	0.042 ***	0.575	0.086 ***	0.321	0.123 ***	0.553	0.075 ***
I/K			0.764	0.160 ***	1.026	0.247 ***	0.176	0.141
O/K			0.520	0.290 *	1.687	0.408 ***	0.403	0.253
CC					-0.218	0.071 ***		
PCM							4.081	0.181 ***
Const.	-0.309	0.063 ***	-0.441	0.061 ***	-1.885	0.431 ***	-0.468	0.054 ***
Industry dummy	Yes		Yes		Yes		Yes	
Year dummy	Yes		Yes		Yes		Yes	
Number of obs	2882		2882		2047		2882	
Pseudo R2	0.1885		0.1907		0.2067		0.2333	

Note: See the notes in Table 4