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Valuing Japanese Corporations: A New Perspective on Japan's Stock Market "Bubble" of the 1980s*

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Abstract

Employing a new accounting data set we apply the framework of McGrattan and Prescott (2005) to the Japanese economy in order to assess if Japanese stocks were priced correctly in the period after 1980. We find that the stock market tended to undervalue the fundamental value of installed capital. We also provide a new interpretation of Japanese stock market phenomena during the "bubble period" and suggest that from a theoretical perspective, stock prices during the "bubble period" were correctly valued. Changes in the reproducible cost of intangible capital play an important role in our new interpretation.

keywords: Intangible capital, Stock price bubbles, Book information

JEL classification: E01, E22

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1 Introduction

Japanese stock prices rose rapidly and subsequently fell precipitously during the so-called ”bubble period” (December 1986 – February 1991). This commonly applied label is based largely on casual observations; yet, there are few formal analyses that have assessed whether stocks were priced correctly or not. This paper provides a new interpretation of Japanese stock market developments after 1980 by applying the framework of McGrattan and Prescott (2005) which considers the role of intangible capital. To do so, we employ a new accounting data set, together with a national aggregate data set. We find that the reproducible cost of intangible capital in Japan is very large when compared with the United States and Britain. We also find that Japanese stock markets tended to undervalue the total fundamental value of installed capital, probably because of limited information on intangible capital. While these findings suggest a malfunctioning of Japanese stock markets, a more interesting and non-intuitive finding is that, from a theoretical perspective, stock prices during the “bubble period” were correctly valued.

There are a number of studies that have sought to analyze Japanese stock prices by estimating the ratio of actual corporate market value to the theoretically-predicted fundamental value, that is, Tobin’s average q. Using micro data sets, Hoshi and Kashyap (1990) and Hayashi and Inoue (1991) estimated Tobin’s average q and found this to be greater than one in investment models with adjustment costs, suggesting that the Japanese stock market functioned well in 1974-88 and in 1977-86, respectively. An interesting point is that this finding applies to the dawn of the “bubble era” as well. Using aggregate data from the Quarterly Report of Financial Statements of Incorporated Business, Ogawa and Kitasaka (1999) found that after 1986, the discrepancy between Tobin’s average q and marginal q became large. They argue that this may represent evidence of a stock price bubble during this period. Thus, overall, it appears that preceding studies do not provide a clear consensus on whether stock prices during the so-called “bubble period” were overvalued or in fact correctly valued.

A theoretical flaw of these studies is that they did not consider the value of intangible capital in estimating their measures of Tobin's average q. In particular, a series of papers by McGrattan and Prescott (2000, 2004, 2005) shows that intangible capital plays a crucial role in explaining secular movements of stock prices in the United States and Britain.

In this paper, we estimate the value of intangible capital by applying the elaborate dynamic general equilibrium model proposed by McGrattan and Prescott (2005) (henceforth MP) to the Japanese economy. Similar to Hoshi and Kashyap (1990) and Hayashi and Inoue (1991), we employ a micro data set and assess the pricing of Japanese stocks. However, our approach differs from these studies in that we consider intangible capital and employ a new accounting data set. Our estimates of the ratio of corporate market value to the predicted fundamental value taking the value of intangible capital into account are on average smaller than one during the 1980s and during the mid-1990s. This finding of undervaluation is in sharp contrast with those of the previous studies by Hoshi and Kashyap (1990) and Hayashi and Inoue (1991).

A more interesting finding of this paper is the following. When we focus our attention on the period from 1987 to 1989, our estimates of the ratio of corporate market value to the predicted fundamental value are greater than, or fairly close to, one. Hence, our findings using the new framework and new data set, like Hoshi and Kashyap (1990) and Hayashi and Inoue (1991), suggest that from a theoretical point of view, the "bubble economy" was actually not a bubble.

However, despite arriving at the same conclusion regarding the stock market "bubble," the way in which this result is derived here differs from that of the previous studies. Previous studies found that the stock price surge during the "bubble period" was accompanied by a simultaneous increase in the price and value of land capital. Their measures of Tobin's average q remained at reasonable levels even during the "bubble era" since the price surge in corporate market values was cancelled out by the increase in the fundamental value of corporations.[1] On the other hand, in our frame-

[1]It remains an open question whether there was a bubble in the land market. This is a

work, seemingly irrational exuberance in the land market is not the sole reason to reach the conclusion that there was no bubble in stock markets.

Our conclusion that there was no bubble is based on a novel finding in this paper, which is that the fundamental value of intangible capital declined considerably during the "bubble era" when compared with the level in the early 1980s. This reduction in intangible capital and accompanying changes in capital composition in the "bubble era" mitigated information problems regarding the valuation of installed capital. This allowed market traders to value a greater proportion of the total fundamental value of installed capital, resulting in the seemingly counter-intuitive conclusion that stock pricing was correct during the so-called "bubble period."

This paper is organized as follows. The next section presents our framework for assessing the Japanese stock market. It presents the model developed by MP and considers the value of intangible capital as well as tax and regulatory reforms. Section 3 describes our data. Section 4 presents and discusses our results on pricing in the Japanese stock market. We also provide results using national aggregate data of System of National Account (SNA) and compare our results with those of previous studies using the SNA. Section 5 concludes the paper.

2 MP's Model

This section presents, for reference, the model developed by MP to assess stock valuations. MP show that, under a balanced-growth path, the total value of corporate equity (V) satisfies[2]

$$V = (1 - \tau_{dist})[(1 - \tau_x - \tau_\delta)K_m + (1 - \tau_{corp})K_u], \tag{1}$$

where K_m, K_u, τ_{dist}, τ_x and τ_{corp} respectively represent the amount of tangible capital, the amount of intangible capital, the tax rate on distributions,

question that is difficult to answer since data on households' expectations in the late 1980s are not available now. The land price surge may have been the result of households' rational expectations with regard to the future stream of profits from land capital.

[2]See sections 2 and 3 of MP for the derivation.

the investment tax credit, and the tax rate on corporate profits.[3] In addition, τ_δ, which arises because of accelerated depreciation allowances, is given as

$$\tau_\delta = \tau_{corp}[\hat{\delta}_x + (1 - \hat{\delta}_x)(\frac{\hat{\delta}_m}{i + \pi + \hat{\delta}_m})(\frac{(1 - \delta_m)(1 + \pi) - 1 + \hat{\delta}_m}{\gamma + \eta + \pi + \hat{\delta}_m})], \qquad (2)$$

where $\hat{\delta}_x$, $\hat{\delta}_m$, δ_m, γ, i, π, and η respectively denote the allowed rate of immediate expensing of investment, the allowed rate of depreciation on book value capital, the economic rate of depreciation on tangible capital, the growth rate in labor-augmenting technology, the real interest rate, the inflation rate, and the population growth rate.

As can be seen from (1), the price of tangible capital for the stockholders is discounted by $(1 - \tau_{dist})(1 - \tau_x - \tau_\delta)$, while the price of intangible capital is discounted by $(1 - \tau_{dist})(1 - \tau_{corp})$. Distribution tax affects these prices because a dollar reinvested is not taxed, but a dollar distributed is. Subsidies to tangible investment reduce the price of tangible capital because they make investing in tangibles cheaper. The price of intangible capital depends not only on the corporate distribution tax but also on the corporate income tax rate because investments in intangible capital are expensed and reduce taxable corporate income (MP, p.772).

From (1) we obtain the ratio of corporate market value to the predicted fundamental value (RATIO), i.e.:

$$RATIO = \frac{V}{(1 - \tau_{dist})[(1 - \tau_x - \tau_\delta)K_m + (1 - \tau_{corp})K_u]}. \qquad (3)$$

The formula accords with the textbook version of Tobin's average q, if we do not consider the reproducible cost of intangible capital K_u and accelerated depreciation allowances τ_δ. The quantitative implications of considering the tax-discounted value of intangible capital $(1 - \tau_{dist})(1 - \tau_{corp})K_u$ in the denominator are one of the central topics of this paper. We expect that our estimates of RATIO may become less than one, while Hoshi and Kashyap (1990) and Hayashi and Inoue (1991) showed that their estimates

[3]Here we neglect the value of foreign capital because it is negligible for Japanese firms. Following Hayashi and Prescott (2002), we estimated the amount of foreign capital and find that the ratio of estimated foreign capital to tangible capital including land before 1990 was less than 3%.

of Tobin's average q which do not take account of intangible capital were well above one in investment models with adjustment costs.

The estimation formula of the reproducible cost of intangible capital is derived from firms' maximization problem as follows:

$$K_u = [\Pi - \frac{i}{(1-\tau_{corp})(\gamma+\eta+\delta_m)} X_m]/(i-\gamma-\eta), \tag{4}$$

where Π is the profit of corporations and X_m is the gross investment in tangible capital.

3 Data Description

This study mainly employs micro-level accounting data from the Corporate Financial Databank (CFD) provided by the Development Bank of Japan for the construction of macro entries such as the reproducible cost of tangible capital, total profits, total investment, and total actual corporate value. We normalize these aggregates with output measures of GDP from the System of National Accounts (SNA). The data set includes accounting data for all non-financial companies listed on the first or second section of the stock exchanges of Tokyo, Osaka, and Nagoya.[4] How the aggregate variables V, K_m, Π, and X_m are constructed from the CFD, and how the parameters τ_{dist}, τ_x, τ_{corp}, $\hat{\delta}_x$, $\hat{\delta}_m$, δ_m, γ, i, π, and η are calibrated for the period 1980–2003 is described in the Appendix.

As has been pointed out in previous studies using micro data, the national aggregate data of the SNA published by the Economic and Social Research Institute (ESRI) contain some problems which may impede the reliability of numerical analyses of the sort conducted in this paper. First, it is well known that the corporate stock values of private *non-listed* corporations are severely underestimated in the SNA (see, e.g., Ando 2002; Hayashi 2006). Second, the coverage of the private sector in the SNA includes public enterprises, and the method of distinguishing information

[4]Among previous studies on Japanese stock market employing micro data, Hoshi and Kashyap (1990) and Hayashi and Inoue (1991) used the Nikkei Financial Data Tapes while Hori, Saito, and Ando (2006) relied on the CFD.

on private companies from that on public ones is not open to researchers. Despite these measurement issues, which are expected to be absent in the micro-accounting data set of the CFD, we also provide results from the SNA which take into account intangible capital.

The SNA is useful to gain an overview of the Japanese economy in aggregate, so that we used it for calibrating the parameter values in the model.

4 Analysis of Asset Pricings in the Japanese Economy

The equations presented in Section 2 are applicable to economies on a balanced growth path. In general, assuming homogeneity of degree one in the production function, an economy can be said to be on a balanced growth path if the ratio of capital to output evolves stably over time. Therefore, following Hayashi and Prescott (2002), we calculated the ratio with respect to the entire Japanese economy using SNA data for 1980–2003.[5] Figure 1 shows the result. The figure suggests that the capital output ratio evolved stably during 1981–1989 and 1993-1997, suggesting that we are justified in applying the equations to these periods. Interestingly, the former period includes the so-called "bubble era" (December 1986 – February 1991) when stock prices surged. We therefore divide the period 1981–1989 into two sub-periods, 1981–1986 and 1987–1989, for which we provide additional results.

Figure 2 shows the time series of the aggregate of the corporate value of listed Japanese firms calculated from the CFD data.[6] In the early 1980s, the sum of the corporate stock value and tax adjusted net debt of Japanese firms

[5]In this paper, the SNA entries are based on SNA93, which became available after publication of the paper by Hayashi and Prescott (2002), who used data on an SNA68 basis. SNA93-based entries since 1980 are available on the ESRI website.

[6]Note that we do not control for firm entries and exits so that the time series path of stock values presented here may differ from the movement of the NIKKEI225 stock price index. On the other hand, the path of the TOPIX resembles that of our stock value measure, since the TOPIX represents the total of the corporate values of firms listed on the First Section of the Tokyo Stock Exchange.

was equivalent to about 40 percent of GDP. It subsequently more than doubled, reaching 103 percent of GDP in 1990. Following the "bubble period," it fell back to around 60 percent of GDP in the mid-1990s, which is around 1.5 times the level in the early 1980s.[7] Since the tax adjusted value of net debt moved stably during the period, we can attribute the large movement in total corporate value to the movement in stock prices.

Figure 3 presents the price of tangible capital, $(1-\tau_{dist})(1-\tau_x-\tau_\delta)$, and the price of intangible capital, $(1-\tau_{dist})(1-\tau_{corp})$, during the period. Interestingly, those prices evolved stably, unlike the secular large movements seen in the United States and Britain. MP explained movements in corporate valuation in the United States and Britain using the changes in those prices. It is noteworthy here that in the case of the Japanese economy we cannot attribute the surge of actual corporate values in the late 1980s to changes in capital prices.

4.1 Estimating Intangible Capital from the CFD Data

We begin by explaining how we estimated intangible capital from the CFD data. Given the calibrated parameters in the top panel of Table 1,[8] and the value of investment relative to GDP, we estimate the contributions of tangible and intangible capital to domestic pre-tax profits. The first column of Table 1 shows the estimation results for intangible capital K_u for the period 1981–1989. We find that during the 1980s, about 70% of domestic pre-tax corporate profits are derived from tangible capital. This value is smaller than that in the case of the United States shown in Table 2 of MP. This figure declines to around 57% by the mid-1990s, as shown in the last column of the table. This finding suggests that in the Japanese economy intangible capital has played greater role in the production process than in the U.S. and U.K. economies.

K_u is estimated using equation (4). The bottom row of Table 1 shows the estimated reproducible cost of intangible capital for each period. Thus,

[7] We can find similar patterns using SNA information of total stock values for the private non-financial sector.

[8] See the Appendix on details regarding data construction and calibrations.

the first column indicates that during the 1980s, K_u was 1.57 times the GDP level; this amount is very large compared to the values for the United States and Britain.[9] This particular feature of the Japanese composition of capital stock might result in undervaluation of corporate values in the stock markets. This could be because stock market traders may not take the *true* value of intangible capital into account. When we compare our estimated reproducible cost of intangible capital with the accounting information from the CFD (intangible capital [K1540]), we find that the amount of intangible capital presented in the CFD accounts for less than 1% of our estimated value of reproducible cost of intangible capital. If stock market traders consider merely book value information on intangible capital, this will lead to an undervaluation of installed capital.

4.2 Main Results: Estimation of RATIO

Table 2 shows our estimation results for RATIO using equation (3). The upper part of the table shows parameter values for the prices of tangible and intangible capital. As was shown in Figure 3, the prices of tangible and intangible capital evolved stably until the middle of the 1990s.[10]

The middle part of Table 2 shows our estimates of reproducible costs and fundamental values of tangible and intangible capital, as well as our baseline estimates of RATIO (labelled RATIO1). Finally, the lower part of the table shows the estimates of RATIO when land capital is not considered (RATIO2).[11]

[9] MP estimate that, in 1998–2001, the reproducible cost of domestic intangible capital was 0.65 times GDP in the United States and 0.51 times GDP in Britain. Previous evidence on the magnitude of intangible capital in Japan is very scarce and to the best of our knowledge, METI (2004) is the only study that does provide some estimates. According to METI (2004), which relies on the method used by Corrado, Hulten, and Sichel (2006), the average ratio of the reproducible cost of intangible capital to GDP in Japan during 1993-1995 was 0.069 (Table 2-1-59). Note, however, that the ratio for the United States using the same methodology was around 0.10 during 1988-90 and 1993-95 (Corrado, Hulten, and Sichel 2006). Hence, the methodology developed by Corrado, Hulten, and Sichel (2006) tends to provide much smaller estimates of reproducible costs of intangible capital than MP's methodology.

[10] For details on the calibration of the parameters, refer to the Appendix.

[11] We provide this information because some Japanese economists prefer not to include

The estimates of reproducible cost of tangible capital K_m are based on CFD data, the construction of which is documented in the Appendix, while those of intangible capital K_u are from Table 1. The first finding here is that the ratio of the fundamental value of domestic intangible capital to that of domestic tangible capital is much higher for Japan (2.559 for 1981-1989; 3.460 for 1993-1997) than the estimates for the United States (0.418 for 1998 -2001) and Britain (0.264 for 1998 -2001).

This seemingly excessive result comes from (i) our low estimate of the reproducible cost of tangible capital K_m and (ii) our high estimate of the reproducible cost of tangible capital K_u. Regarding (i), we may be able to compare the estimate from the CFD with the value implied by the model's prediction. From the construction of the model, it holds that, in equilibrium,

$$K_m^t = \frac{X_m}{\gamma + \eta + \sigma_m},$$

where the superscript t on K_m indicates that this is the value implied by theory. With the information on X_m used in estimating K_u, we can calculate K_m^t for each sub-period and obtain values of 0.661 times GDP (1981-89), 0.673 times GDP (1981-1986), 0.638 times GDP (1987-1989), and 0.929 times GDP (1993-1997). Hence, K_m^t is around 50% higher than K_m for each sub-period. However, even when we use K_m^t, the Japanese ratio of the fundamental value of domestic intangible capital to that of domestic tangible capital remains much higher than the ratios for the United States and Britain. We also find that the results for RATIO1 in Table 2 remain unchanged when we use K_m^t instead of K_m.[12] Regarding (ii), we will provide some sensitivity tests below.

The second finding from RATIO1 in Table 2 is that Japanese stock markets tended to undervalue installed capital. We find that throughout the 1980s, RATIO1 is 0.608, while in the mid-1990s, it is 0.440. This finding

land capital when examining asset pricings in the macro economy. See, for example, Ando (2002). The results for RATIO2 suggest that our findings documented below remain unchanged when land capital is excluded from our considerations.

[12]With K_m^t, the values we obtain for RATIO1 and RATIO2 for 1987-1989 are 0.901 and 0.822, respectively.

of undervaluation of the fundamental value of installed capital contradicts previous studies such as Hoshi and Kashyap (1990) and Hayashi and Inoue (1991). They showed that averages of estimated Tobin's average q were greater than one in investment models with adjustment costs. In this paper, we consider the value of intangible capital, which was neglected by these previous studies, and show that Japanese stock markets undervalued installed capital. This finding in itself suggests a malfunctioning in Japanese stock markets.

The third and main finding is obtained when we proceed to the analysis of the two sub-periods of 1981–1986 and 1987–1989. Regarding the first sub-period, we obtain the same finding as before. Namely, Japan's stock markets seem to have undervalued the total fundamental value of tangible and intangible capital (RATIO1 =0.437).

However, for the second sub-period, the so-called "bubble era," we obtain an intriguing pattern for the estimate of RATIO1. As can be seen from the middle part of Table 2, RATIO1 is fairly close to one, suggesting that that the pricing of the fundamental value of tangible and intangible capital in stock markets was correct. This finding is in sharp contrast with the typical description of the period as the "bubble era."

It is important to state here that we have an important factor which is absent in previous studies and explains why we arrive at the "no bubble" conclusion. On the one hand, previous studies using micro-data showed that pricing in stock markets was correct both during the pre-bubble period and the bubble era. They suggested that the reason for this was the fact that the stock price surge during the "bubble era" was cancelled out by the price surge in land capital (namely, the increase in the fundamental value of tangible capital).

On the other hand, in the present analysis, we found that Japanese stock markets tended to undervalue the fundamental value of installed capital, but that stock market pricing was corrected during the "bubble era." Our finding which throws a new light on the "bubble era" is that the fundamental value of intangible capital declined in the bubble era by 27% compared to the value in the early 1980s. Our preferred hypothesis here is that market traders in Japan could not take account of fundamental values of intangible capital, since accounting information on intangible capital was poorly provided. With intangible capital making up a smaller proportion of total installed capital, market traders were able to value a greater proportion of the total fundamental value of installed capital during the "bubble era," meaning that the information problem in valuing the fundamental value of installed capital became less severe.[13] To sum up, in the present analysis, the existence of intangible capital is of key importance in considering the time series of RATIO1.[14]

4.3 Estimate of Intangible Capital (CFD): Sensitivity Tests

In the analysis above, real interest rates were calibrated with the assumption of $\beta = 0.97$. Importantly, this assumption on the subjective discount factor provided values of $i - \gamma - \eta$ twice as large as those used in MP.[15] This means that in the present analysis, estimates of the reproducible cost

[13]Table 2 shows that in the mid-1990s, the fundamental value of intangible capital increased again. This increase in the fundamental value of intangible capital pulled RATIO1 below one.

[14]The full mechanism underlying our result of a RATIO1 of close to one during the "bubble era" can be summarized as follows. First, the actual market value of private corporations increased from 0.458 times GDP to 0.898 times GDP in the latter period. This stock price surge is usually referred to as the "bubble" in the Japanese stock market. This increase by itself may explain why the estimated RATIO1 increased from 0.437 to 1.017 in the latter sub-period. However, as Hoshi and Kashyap (1990) and Hayashi and Inoue (1991) pointed out, there was also a price surge in the land market, which increased the fundamental value of tangible capital. From the last two columns of Table 2 we see that the value of tangible capital increased by 14% in the latter sub-period. We find that among the different types of tangible capital, the fundamental value of land capital played the dominant role in this increase. Because this increase in the value of tangible capital lowers RATIO1, we would obtain a RATIO1 below one if the fundamental value of intangible capital were not considered. Interestingly, Table 2 shows that the estimated value of intangible capital declined by 27%, which pulled RATIO1 up. These three forces jointly raised our estimates of RATIO1 to close to one from a value of 0.437 in the first sub-period.

[15]Chen, Imrohoroglu, and Imrohoroglu (2006) and Braun, Ikeda, and Joines (2009) show that real interest rates were higher in Japan than in the United States during the 1980s. Hence, our assumption of $\beta = 0.97$ is innocuous.

of intangible capital K_u tend to be lower than in the case of MP.

Here, we provide some sensitivity tests for the estimates of K_u to our choice of β (and i). Specifically, we examine the following three cases: (i) a discount factor of $\beta = 0.9655$, calibrated using the method in Hayashi and Prescott (2002); (ii) a discount factor of $\beta = 0.98$, borrowed from MP; and (iii) a time series of the real interest rate calibrated from SNA information using the method in McGrattan and Prescott (2004). Regarding (iii), we constructed the productivity of capital by dividing after-tax capital income by the stock of tangible capital. The results are shown in Table 3.

When we use $\beta = 0.9655$, the estimate of K_u is lower than in the case of $\beta = 0.97$ because of the higher interest rate i. As can be seen from the table, the results obtained in this case remain unchanged from before: RATIO is well below one for 1981-86 and 1993-97, but is larger and close to one during the "bubble period."

In the case of $\beta = 0.98$ which is borrowed from MP, our estimates are much closer to those obtained by MP. In this case, however, the estimates of K_u get greater than our original values and become much larger than those obtained in MP. K_u during 1981-89 is 3.863 times GDP, which does not look plausible given the estimate of reproducible cost of tangible capital K_m of around 0.4 times GDP.

Finally, constructing a time series of the real interest rate calibrated directly from SNA information means that it is independent from choices of the discount factor. Note also that we can obtain an *upper bound* on the interest rate since intangible capital is not taken into account in the SNA. Thus, we obtain the *lower bound* of the K_u estimates from the SNA information available. In the bottom part of Table 3 we show that even though we are considering an *upper bound* on the interest rate from the information on capital income, calibrated real interest rates are still lower than those obtained from $\beta = 0.98$. With the lower real interest rates we obtain a K_u for 1981-86 of more than five times GDP, which is not plausible. Also, K_u during 1987-89 is falsely estimated while K_u during 1993-97 is 1.194 times GDP. These results indicate that the estimates based on the interest rate from the SNA are unstable and not reliable. Hence, all in all, our preference is for employing $\beta = 0.97$ or $\beta = 0.9655$ for the study of Japanese stock market valuations.

4.4 Discussion of the Undervaluation of Actual Corporate Value

The finding that actual corporate value is undervalued in Japanese stock markets may look similar to the findings obtained by Ando (2002) and Ando, Christelis, and Miyagawa (2003), who relied on national aggregate data of the SNA.[16] Using the SNA information they show that the Japanese household sector has lost some 300 trillion JPY in stock values (in 1990 consumption prices) since 1970, with the market value of Japanese corporations far less than their accounting value at reproduction costs. They attributed this capital loss from undervaluation to the unusual behavior of corporations, which attempted to maximize their productive capacity rather than their market value. This is known as the overinvestment hypothesis.

Although the conclusion of undervaluation is the same, the way in which the results in those studies and this study are obtained differs. On the one hand, the overinvestment hypothesis suggests that the unusual corporate governance structures of Japanese firms made it difficult for market traders to value capital in a standard fashion, resulting in the undervaluation. On the other hand, we apply MP's framework where firms are assumed to maximize their market value. We suspect that the reason that stock market traders in Japan undervalued corporations is that they could not account for the fundamental value of intangible capital. This looks plausible since the availability of accounting information on intangible capital is poor and this information does not reflect the prediction of formal economic analysis at all. We find that probably because of Japan's conservative accounting rules, the book value of intangible capital (recorded as

[16]Using aggregate data, Ito and Iwaisako (1995), Nakajima (2008), and Alpanda (2007) examined Japanese stock markets with special focus on land capital and secular changes in TFP, corporate taxes, and marginal taxes on land holdings. Stock prices predicted from these models are found not to fit the data well.

K1540 in the CFD) is negligible compared to our estimates.[17]

The main purpose of this paper is to construct time series of aggregate variables from accounting data and apply these to the framework of MP. However, despite possible measurement errors in the SNA and differences in the coverage of private non-financial sectors from the CFD, it still seems useful to provide results from the SNA data for a comparison with results of Ando's papers. The estimation of intangible capital from the SNA is possible using the following information.

In the SNA, inflation adjusted profits Π are given by (i) corporate profits ("3. Operating surplus" in "(21) Income and outlay accounts of private and public corporations") minus (ii) adjustments ("Change in assets" in "(2) Reconciliation *c* account") .[18]

The investment series X_m are reported in the flow section ("5. Supporting Tables, (22) Capital Finance Accounts of Private and Public Corporations") on a fiscal year basis. They are given by the sum of (i) investment in tangible capital ("1. Gross fixed capital formation") plus (ii) investment in inventories ("3. Changes in inventories"). We use GDP for the normalization of these aggregates.

Based on the calibrated parameters for the corporate tax rate, the growth of real GDP, the real interest rate, and the tangible depreciation rate, which are the same as those in Table 1, as well as the value of investment relative to GDP and the information on profits, the last row of Table 4 shows the estimates of the reproducible cost of intangible capital K_u from the SNA. One notable finding is that compared with the estimate using the CFD, the magnitude of K_u is still greater through all sub-periods than the ones we obtained from the CFD. Moreover, when we calculate RATIO from the SNA by constructing time series of K_m and V (not shown), we find that RATIO is at most 0.5, suggesting an undervaluation of the fundamental value of installed capital. This result of undervaluation based on SNA information is nothing new and is in line with the results obtained by Ando (2002) and Hayashi (2006). Since we take into account the fundamental value of intan-

[17]We would like to thank Ayumi Ikeda, a Japanese certified public account, for this point.

[18]See Hayashi (2006) for details on this adjustment of profits.

gible capital in equation (3), the undervaluation found in these previous studies is even more pronounced here.

5 Conclusion

Employing the methodology developed by McGrattan and Prescott (2005), we examined Japanese stock market phenomena in the 1980s and 1990s using a micro data set from the Corporate Financial Databank. Our findings can be summarized as follows. When we consider the fundamental value of intangible capital, our estimates of the ratio of corporate market value to the predicted fundamental value are considerably less than one. Hence, we can say that Japan's stock markets undervalued the fundamental value of installed capital. A likely explanation for this result is that in the Japanese accounting system, book information on intangible capital does not reflect the true fundamental value of intangible capital, which resulted in the undervaluation of stocks by stock market traders. We also find that from a theoretical point of view, the so-called "bubble economy" was not a bubble. This finding is in line with results obtained by Hoshi and Kashyap (1990) and Hayashi and Inoue (1991), but the underlying mechanism in our analysis differs from that in these studies. The key novel finding in this paper is that the fundamental value of intangible capital declined considerably in the "bubble era" when compared with the level of the early 1980s. This reduction in intangible capital and accompanied changes in capital composition in the "bubble era" mitigated information problems regarding the valuation of installed capital. This allowed market traders to value a greater proportion of the total fundamental value of installed capital, resulting in the seemingly counter-intuitive conclusion that stock pricing was correct during the so-called "bubble period."

Appendix

This Appendix provides a detailed description of the construction of the variables used for the analysis.

Aggregate Variables

Instead of using the national aggregate data of the SNA, we use accounting panel data of non-financial companies to construct aggregate variables. Consistent historical data for all entries used in our analysis are available for fiscal 1977-2002. (Fiscal years in Japan run from April to March of the next year). Because firms entered and exited during this period, the number of firms differs from year to year. All in all, data of 2,771 firms were used.

All entries in the CFD are based on book value. Therefore, we convert them to a market-value basis for each company and then calculate aggregate variables such as capital, investment, etc., by aggregating the firm-level data for each year. The following is a detailed description of how we convert book-value entries into market-value entries.[19]

Tangible Capital K_m

For tangible capital, we consider productive capital, inventories, and land.

We follow Hori, Saito, and Ando (2006) in considering productive capital. Regarding the CFD data, we have six categories for productive capital: (i) buildings [K1300], (ii) structures [K1310], (iii) machinery/equipment [K1320], (iv) ships [K1340], (v) autos/trucks [K1350], and (vi) tools/fixtures [K1360].[20] We consider fiscal 1977 as the benchmark year, setting the reported book value of capital in this year as the market value. As for firms which appear in the CFD data after 1977, the values in the first year in which they appear are assumed to be the market values. These simplifying assumptions are used due to limitations regarding the availability of data. Next, we obtain the book-value gross investment for each category from the CFD for (i) buildings [K6270], (ii) structures [K6280], (iii) machinery/equipment [K6290], (iv) ships [K6300], (v) autos/trucks [K6310], and (vi) tools/fixtures [K6320]. Then, for each company, we convert the book-value investment figures to real investment figures by dividing the former

[19] Below, we will construct current-price time series data for all the entries.

[20] The square brackets show the CFD codes.

by the relative price of capital. The relative price of capital in the benchmark year for the company is set to one.[21] Third, we use the following depreciation rates for the six categories taken from Hayashi and Inoue (1991) and Hori, Saito, and Ando (2006): (i) 4.7%, (ii) 5.64%, (iii) 9.489%, (iv) 14.7%, (v) 14.7%, and (vi) 8.838%. Then, for each company, from the capital stock in the benchmark year, we construct the real tangible capital series by the perpetual inventory method using the real investment obtained in the manner described above and the depreciation rates. We divide the capital series for each company by the relative price for the appropriate benchmark year and then aggregate the real capital obtained in this way across all companies. Doing so, we obtain the real capital stock historical data for which the benchmark year for all firms is set to 1977. Finally, we multiply the aggregate capital stock with the price series for capital, thus obtaining capital stock in current prices.

With respect to inventories, we follow Hoshi and Kashyap (1990) to construct the market-value series. We set the benchmark year for each firm in the same way as we did for productive capital and, again, the book values in the benchmark year are assumed to be market values. In general, the book value of inventories can differ greatly from the market value depending on the method of inventory valuation, so that we divide our CFD inventory categories into three parts: (i) inventories for which information about the valuation method is available, (ii) inventories for which information about the method of valuation is not available, and (iii) land for sale. Here, (i) includes inventories of commercial goods [K1040], inventories of finished products [K1060], inventories of half-finished goods [K1070], inventories of products in progress [K1080], inventories of materials [K1100], and inventories of merchandise and supplies [K1110], whereas (ii) includes inventories of other goods [K1120]. As stated in Hoshi and Kashyap (1990), when inventories are evaluated in the "last in, first out " (LIFO) fashion, the

[21]The price of capital is taken from the Bank of Japan. Specifically, we use the price of "construction materials" for (i) buildings and (ii) structures, the price of "machinery and equipment" for (iii) machinery/equipment and (vi) tools/fixtures, and the price of "transport machinery" for (iv) ships and (v) autos/trucks.

book value differs greatly from the market value; alternatively, if inventories are evaluated in any other fashion, the book value will approximate the market value. Therefore, for inventories in (i), we assume that the book value equals the market value if firms do not follow the LIFO method of inventory valuation.[22] We also use this method to calculate category (ii) inventories in current prices. With respect to category (iii), land for sale [K1050], we have neither information on the inventory valuation method nor a price index. Hence, we assume that book values equal market values

On the other hand, when firms follow the LIFO method with respect to category (i) inventories, we construct market-value inventory series as follows. First, if an inventory item increases from time $t-1$ to time t, the addition is assumed to be recorded in the books at the current price. Hence, the inventory stock at time t is the sum of the inflation adjusted value of the inventory carried from time $t-1$ to time t and the book value of the addition. Second, when the book value of a firm's inventory decreases from time $t-1$ to time t, we assume that the cleared inventories are one year old and make the appropriate correction for inflation for the stock of inventory carried from time $t-1$ to time t. Finally, if a firm uses both the LIFO and another inventory valuation method for an inventory category, then we assume that half of the inventories are valued using the LIFO method.

Information related to land holdings is available in the CFD under [K1390]. Following Ogawa and Kitasaka (1998), we convert the book-value variables into market-value variables as follows. The SNA provides information on the estimated market-value land holdings of the non-financial private corporate sector. In addition, the Financial Statements Statistics of Corporations by Industry (FSSCI) published by the Policy Research Institute, Ministry of Finance, provides book-value information on land holdings for the sector. Theoretically, we could obtain the market-to-book-value ratio by dividing the SNA values by the FSSCI values if the coverage of corporations were identical in the two statistics. However, in practice, the coverage is known to be different. Therefore, we need to adjust the two sets of data

[22] We can see how firms value each inventory item using the CFD information [K4610] –[K4690].

by calculating the coverage ratio. Both the SNA and the FSSCI contain information on cash holdings for the non-financial corporate sector. Because cash is nominal, the difference in the amount of cash holdings between the two statistics will reflect the difference in coverage. Consequently, we can adjust for the difference in coverage and obtain the appropriate market-to-book-value ratios for land holdings. Finally, we obtain our market-value land holding series by multiplying the CFD land holding with the ratios.

Finally, we consider "other capital," which is the sum of tangible capital for rent [K1370], other productive capital [K1380] and other tangible capital [K1410]. Because we have no information to obtain market value series, we assume that the book value variables are equal to the market value variables.

We obtain K_m for each year by aggregating the above capital entries across firms.

Intangible Capital K_u (X_m and Π)

We need to estimate intangible capital using equation (3) above. To do so, we need information on investment in tangible capital, X_m, and on operating profits, Π.

For investment, we use investment in fixed capital [K6260], while we use income from operations [K2980] as corporate profits, thus obtaining X_m and Π for each year. These variables are flow variables. Therefore, the book values will be equal to current market values. By applying equation (3), we obtain the series of K_u.

Actual Corporate Value V

Finally, we obtain the total value of corporate equity, V, as follows. Following MP, we define V as the sum of the actual value of outstanding equity and the value of net corporate debt. Regarding equity, we have information on the highest and the lowest stock price within the year, [K0370] and [K0380], respectively, and information on the number of shares outstanding [K5440]. Thus, we can estimate the series of actual values of outstanding equity by using the product of the average of the highest and the lowest prices and the number of shares issued in the sample.

The value of net debt we obtain as follows. Regarding financial assets, we consider quick assets [K0870], other liquid assets [K1130], allowances for doubtful accounts [K1270], intangible capital [K1540], other investment assets [K1760] and deferred assets [K1870]. As for financial debt, we consider total debt [K2630]. Therefore, the value of net debt is given by financial debt minus total financial assets, multiplied by one less the tax rate on distributions.[23]

Output Y

For the normalization of aggregate variables, we use the GDP data from the flow section of the SNA.

Parameters

We next present the calibration of the parameters.

τ_{dist}

The tax rate for corporate distributions, τ_{dist}, is computed with data of the personal capital income tax and of the amount of corporate dividends. Note that Japanese corporations only rarely make distributions by buying back shares or liquidating operations. Therefore, the relevant tax rate is the tax rate on personal income. For the amount of dividends, we use the "amount of dividends" in the Actual State of Corporate Enterprises Seen from the Taxation Statistics (ASCESTS) published by the National Tax Agency. Similarly, for the amount of dividend tax, we use the "tax on dividends" in the ASCESTS. These figures are on a fiscal year basis and and are consistent with the CFD data.

[23] See footnote 23 of MP for details on this point.

τ_{corp}

Following Japanese studies such as those by Hoshi and Kashyap (1990) and Nomura (2004), the tax rate on corporate profits, τ_{corp}, is computed using corporate tax data from the FSSCI, which include the corporate income tax, the prefectural residents' tax, the municipal residents' tax, and the enterprise tax, together with the corporate income data from the ASCESTS. These data are available for the non-financial private corporate sector on a fiscal year basis and are consistent with the CFD data. For corporate taxes we use "corporation tax, residents' tax and enterprise tax" from the FSSCI, while for corporate profits we use the "amount of income" from the ASCESTS.

δ_x

In Japan, capital subsidies through investment tax credits are known to be quite small.[24] For this reason and because of the lack of relevant information, we set $\delta_x = 0$.

$\hat{\delta}_x$

As for the allowed rate of immediate expensing of investment, $\hat{\delta}_x$, and the allowed rate of depreciation on book value capital, $\hat{\delta}_m$, following MP, we assume that $\hat{\delta}_x = \hat{\delta}_m = \hat{\delta}$. The SNA reports tangible capital depreciation based on the tax code, not the economic code. We therefore obtain the allowed rate of depreciation on a book-value basis using the SNA data. $\hat{\delta}$ is computed as the ratio of "book value depreciation" minus the "replacement cost adjustment" of the subsequent year to "productive capital," which excludes land holdings. These figures are available for the private non-financial sector in the SNA. The estimated value of $\hat{\delta}$ is consistent with the coverage of the CFD data.

[24]See, for example, Hoshi and Kashyap (1990), Ogawa and Kitasaka (1998), and Nomura (2004).

δ_m

The economic rate of depreciation of tangible capital δ_m is borrowed from Nomura (2004). The depreciation rate is computed using capital stock excluding land holdings. These values are taken from Nomura (2004, p. 228), Table 3.5.

γ

The growth rate of labor augmenting technology, γ, is calculated following Hayashi and Prescott (2002) and is defined as the growth rate of total factor productivity. We update their series with the newly available SNA data on an SNA93 basis.

i

From the log preference assumption, the real interest rate i is obtained as $i = [(1+\gamma)/\beta] - 1$, where β is the subjective discount factor. We set $\beta = 0.97$ for our benchmark analysis.

π

The inflation rate, π, is obtained from the growth rate of the "GNP deflator" in the SNA.

η

The population growth rate η is given by the growth rate of the working-age population in the SNA. We follow Hayashi and Prescott (2002) in computing the rate.

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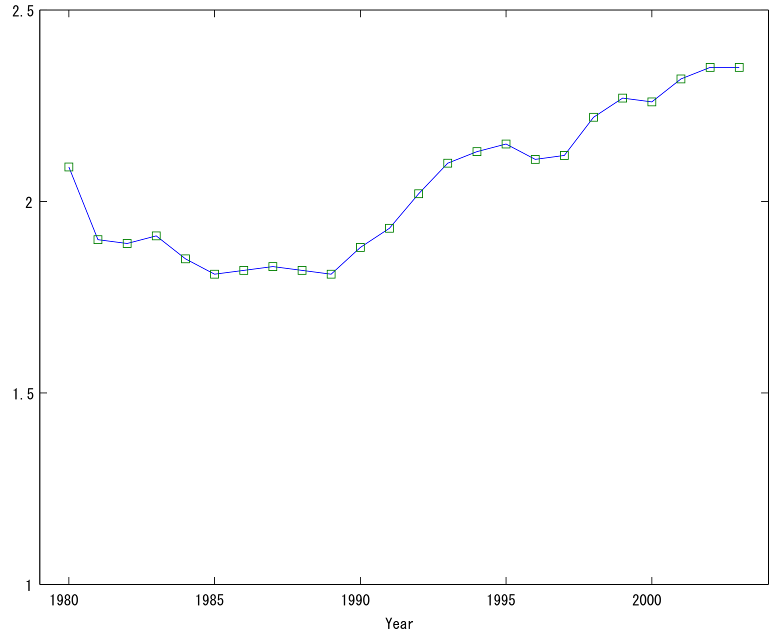
Figure 1: Capital-Output Ratio in Japan



Note: The figure shows the capital-output ratio for Japan following the method of Hayashi and Prescott (2002) using 93SNA data.

Figure 2: Value of Japanese Corporations, 1980 – 2002 (CFD)

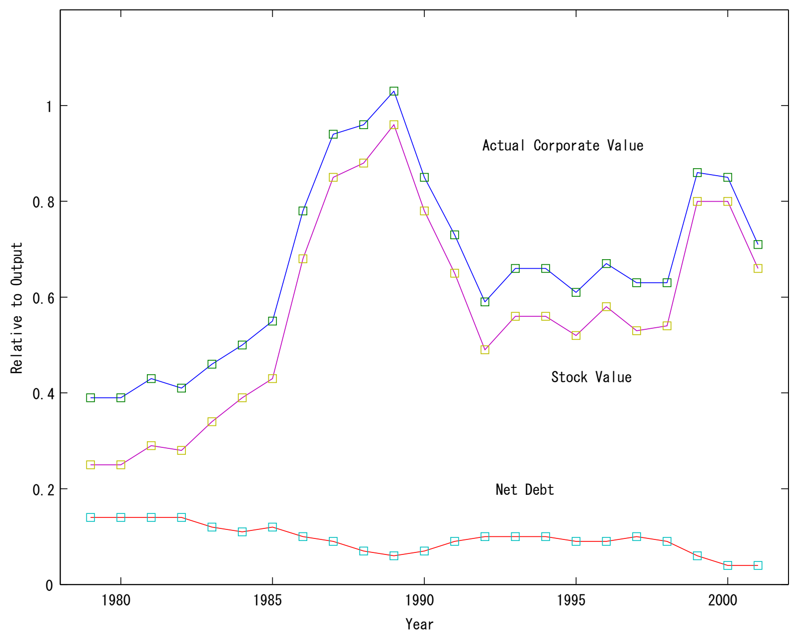


Figure 3: Price of Tangible and Intangible Capital

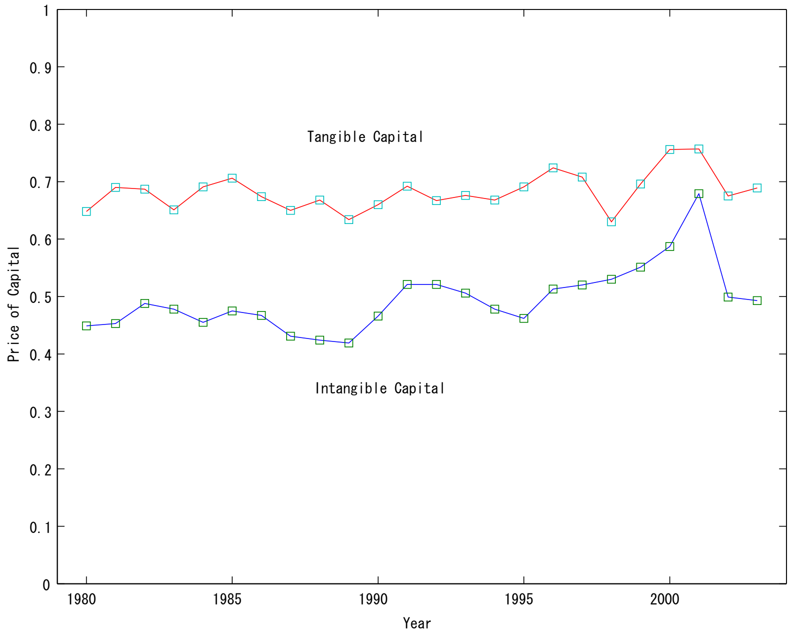


Table 1: Estimating Intangible Capital in Japan (CFD)

	1981-1989	1981-1986	1987-1989	1993-1997
Corporate tax rate τ_{corp}	0.413	0.405	0.428	0.392
Growth of real GDP $\gamma + \eta$	0.052	0.049	0.059	0.023
Real interest rate i	0.076	0.073	0.082	0.048
Tangible depreciation rate δ_m	0.057	0.057	0.058	0.059
Average corporate investment* X_m	0.072	0.071	0.074	0.076
Contributions to domestic pre-tax profits*				
Tangible assets $iX_m/[(1-\tau_{corp})(\gamma+\eta+\delta_m)]$	0.086	0.083	0.091	0.073
Intangible assets $(i-\gamma-\eta)K_u$	0.037	0.041	0.031	0.056
Total Π	0.123	0.124	0.122	0.128
Estimate of intangible capital* K_u	1.571	1.667	1.356	2.274

*These values are relative to output.

Table 2: Predicted and Actual Corporate Values and RATIO (CFD)

	1981-1989	1981-1986	1987-1989	1993-1997
Corporate tax rate τ_{corp}	0.413	0.405	0.428	0.392
Tax on distributions τ_{dist}	0.226	0.211	0.257	0.185
Investment subsidy rate τ_x	0.000	0.000	0.000	0.000
Tax credit due to depreciation allowance τ_σ	0.129	0.131	0.126	0.150
Price of tangible capital $(1-\tau_\sigma)(1-\tau_{dist})$	0.674	0.686	0.650	0.693
Price of intangible capital $(1-\tau_{corp})(1-\tau_{dist})$	0.454	0.469	0.425	0.496
Tangible capital* K_m	0.413	0.388	0.464	0.470
Value of tangible capital* $K_m(1-\tau_\sigma)(1-\tau_{dist})$	0.279	0.266	0.302	0.326
Estimate of intangible capital* K_u	1.571	1.667	1.356	2.274
Value of intangible capital $K_u(1-\tau_{corp})(1-\tau_{dist})$	0.714	0.783	0.576	1.128
Total fundamental value*	0.992	1.049	0.878	1.454
Actual market values* V	0.603	0.458	0.893	0.639
RATIO1 V/Total fundamental value	0.608	0.437	1.017	0.440
Calibration Excluding Land				
Tangible capital excl. land* K_m	0.291	0.288	0.295	0.330
Value of tangible capital* $K_m(1-\tau_\sigma)(1-\tau_{dist})$	0.196	0.198	0.192	0.229
Estimate of intangible capital* K_u	1.571	1.667	1.356	2.274
Value of intangible capital $K_u(1-\tau_{corp})(1-\tau_{dist})$	0.714	0.783	0.576	1.128
Total fundamental value excl. land*	0.909	0.980	0.768	1.357
Actual market values excl. land* V	0.480	0.359	0.724	0.499
RATIO2 V/Total fundamental value	0.528	0.366	0.943	0.368

*These values are relative to output.

RATIO1: benchmark.

RATIO2: benchmark - land.

Table 3: Estimate of Intangible Capital: Sensitivity Test

	1981-1989	1981-1986	1987-1989	1993-1997
Benchmark $\beta = 0.97$				
Real interest rate i	0.076	0.073	0.082	0.048
Estimate of intangible capital * K_u	1.571	1.667	1.356	2.274
RATIO	0.608	0.437	1.017	0.440
$\beta = 0.9655$ *(Hayashi and Prescott, 2002)*				
Real interest rate i	0.081	0.078	0.087	0.052
Estimate of intangible capital * K_u	1.106	1.195	0.913	1.645
RATIO	0.772	0.554	1.294	0.559
$\beta = 0.98$ *(MP)*				
Real interest rate i	0.065	0.062	0.071	0.037
Estimate of intangible capital * K_u	3.868	3.948	3.673	5.234
RATIO	0.296	0.216	0.480	0.219
Real Interest Rate from Capital Income/Capital (SNA)				
Real interest rate i	0.060	0.059	0.058	0.057
Estimate of intangible capital * K_u	7.404	5.729	-80.965	1.194
RATIO	0.166	0.155	N.A.	0.694

*These values are relative to output.

Table 4: Estimating Intangible Capital in Japan (SNA)

	1981-1989	1981-1986	1987-1989	1993-1997
Corporate tax rate τ_{corp}	0.413	0.405	0.428	0.392
Growth of real GDP $\gamma + \eta$	0.052	0.049	0.059	0.023
Real interest rate i	0.076	0.073	0.082	0.048
Tangible depreciation rate δ_m	0.057	0.057	0.058	0.059
Average corporate investment* X_m	0.074	0.066	0.090	0.027
Contributions to domestic pre-tax profits*				
Tangible assets $iX_m/[(1-\tau_{corp})(\gamma+\eta+\delta_m)]$	0.088	0.077	0.111	0.026
Intangible assets $(i-\gamma-\eta)K_u$	0.049	0.056	0.036	0.038
Total Π	0.137	0.132	0.146	0.064
Estimate of intangible capital* K_u	2.067	2.284	1.560	2.949

*These values are relative to output.