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Abstract

This paper examines the hypothesis that the depreciation of yen had a deleterious effect on the Japanese banking sector and led eventually to a reduction in the loans, a development that has become known as “credit crunch” experience during fiscal year 1997-98. In contrast to the current literature focusing on the impact of the domestic currency depreciation on the countries having excessive foreign currency denominated debt, this paper highlights a case of the world’s largest possessor of foreign currency assets. The mechanism that linked yen depreciation and credit crunch is the BIS capital adequacy ratio requirement. Using a panel of Japanese bank balance sheets for fiscal years 1997–1998, this study shows that the yen depreciation combined with low stock prices made capital adequacy ratio binding. Faced with the need to satisfy capital adequacy ratios, the banks had strong incentives to try to reduce their assets, loans in particular.

Keywords: yen depreciation, banking crisis, stock prices, credit crunch, intervention
JEL Classification: E44, F31, G21

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1. Introduction

It is widely acknowledged that the depreciation of the domestic currency damages a nation's economy which has debt denominated in foreign currency, but relying on assets that yield income denominated in the home currency. If currency of this country depreciates, for whatever reason, the balance sheet effect of an increase in the debt burden relative to assets might push agents into default and, as a result, provoke or deepen a crisis. What is even more interesting is that the depreciation of the domestic currency may be equally harmful for the country having foreign currency denominated assets as already experienced in Japan.

This study examines the hypothesis that exchange rate depreciation had an adverse impact on the Japanese banks by reducing their BIS capital adequacy ratio, i.e. ratio of their own capital to the risk-weighted assets, and, as a result, constrained their ability to lend in 1997-98, an upshot that has been dubbed as a "credit crunch". It is shown that yen depreciation led to an increase in the yen-value of foreign currency assets held in reserve by Japanese banks and the denominator of the capital adequacy ratio. In addition, in 1997 falling yen triggered low stock prices – it is an interesting finding itself - which, in turn, instigated a sharp drop in the unrealized gains on securities and, consequently, in the numerator of the capital adequacy ratio. Moreover, falling yen contributed to an increase in Japan premium, i.e. the additional amount that the Japanese banks have to pay over the market rate for short-term loans. This market event also reduced the numerator of the capital adequacy ratio by constraining the profitability. In the attempt to achieve an international standard, the Japanese banks reduced their assets, especially loans.

The previous studies on the problems of the Japanese banks include Ueda (1993) and Ito and Sasaki (1998). In contrast to this paper, these studies focus on the period 1990-93. Ito and Harada (2003) investigate movements in Japan premium, stock prices, and credit derivative spreads of Japanese banks. They have come to the conclusion that prior to the capital injection of 1999, the markets were sensitive to bank vulnerability and, as a result, higher premiums were required. Fukao (2004) provides an extensive analysis of the profitability, actual capital adequacy ratio and non-performing loans problem of the Japanese banking sector. However, none of these papers deals with a problem of the exchange rate depreciation.

The rest of the paper is organized as follows. Section 2 describes working hypothesis and literature. Section 3 provides an overview of the macroeconomic developments and the yen-dollar rate movements in 1997-98. Section 4 provides the empirical findings and assesses the effectiveness of the government's response. Some policy implications are summarized in Section 5. Section 6 concludes the paper.

2. Working Hypothesis

This paper studies a hypothesis that the depreciation of yen had a deleterious effect on the Japanese banking sector and led eventually to credit crunch in 1997-98. The mechanism that linked yen depreciation and credit crunch is the BIS capital adequacy ratio requirement, i.e. a requirement to maintain no less than 8% of their own capital to risk-weighted assets for internationally active banks and 4% their own capital for banks performing only domestic transactions². The yen depreciation affected the capital adequacy ratio in three ways (Table 1). First, with falling yen the yen-value of foreign currency assets held in reserve by Japanese banks ballooned, since the foreign currency-denominated assets held by the Japanese banks are to be evaluated at the exchange rate at the account end. This means that the denominator of the capital adequacy ratio increases. Second, in 1997 falling yen triggered low stock prices which, in turn, provoked a precipitous drop in the unrealized gains on securities and consequently in the numerator of capital adequacy ratio³. Third, falling yen contributed to an increase in Japan premium, i.e. the additional amount that the Japanese banks have to pay over the market rate for short-term loans. This market event also reduced the numerator of the capital adequacy ratio by constraining the profitability. Faced with the need to satisfy capital adequacy ratios, the banks had strong incentives to try to reduce their assets, loans in particular⁴. And there was indeed a reduction in loans outstanding, a development that has become known as a “credit crunch”. As can be clearly seen from Figure 1, during 1997 the lending attitude of the Japanese banks changed abruptly from accommodative to restrictive, improving only after the capital infusion of the public funds was made.

In the present literature, the problem of domestic currency depreciation is widely discussed in the context of the high exposure to the foreign currency debt by the emerging countries having pegged their exchange rates. This phenomenon was dubbed “original sin” by Eichengreen and Hausman (1999). This is a case of a country whose domestic currency cannot be used to borrow abroad or to borrow long term, even domestically. In the presence of this incompleteness, financial fragility is inevitable

² The Basle Accord requires that Tier I capital must be at least 4% of risk-weighted assets and the sum of Tier I and Tier II must be at least 8% of the risk-weighted assets. However, the details of definitions and categorization were left to the discretion of the national authorities. The banks conducting only domestic operations are subject to less stringent requirements. See Table 2 for the details.

³ In Japan, banks are allowed to add 45% of their unrealized capital gains on securities holdings to their Tier II capital.

⁴ A reduction of the risk assets can be achieved with the least effect on the total banks assets by cutting those assets with the highest risk weightings. Among the assets with the highest risk weightings lending occupies the greatest part (63% as of end March 1998). See Table 2 for the detailed weighting.

because either domestic projects generating profits in domestic currency will have to be financed with foreign currency (a currency mismatch), or long-term projects will have to be financed with short-term loans (a maturity mismatch). This means that both fixed and flexible exchange rates are complications that may pose a problem. If the government allows the currency to depreciate, the currency mismatch will cause bankruptcies. If instead it defends the peg by selling reserves and hiking interest rates, it will trigger defaults on short-term domestic debts.

Japan neither has pegged its currency nor does it have huge foreign currency debt. To the contrary, Japan has the largest foreign currency assets in the world. Why are both debtors and creditors worse off because of the weak domestic currency? In theory, when loans are repaid or foreign currency-denominated securities are sold, the bank should enjoy exchange gain due to yen depreciation. However, the Foreign Exchange and Foreign Trade Control Law⁵ prevented this situation from occurring. According to this Law, the Japanese banks were forced to procure foreign denominated resources in order to buy foreign currency denominated assets. In other words, under this Law the Japanese banks have approximately equal foreign-currency denominated assets and debts and, thus, fluctuations in the exchange rate do not stimulate exchange gain nor exchange loss. As a result, in case of the yen depreciation, the foreign currency denominated assets increases while their own capital, which should have increased due to exchange gain, does not. The fluctuations in the exchange rate also do not affect the capital ratio if the bank holds both yen-denominated and foreign currency-denominated aspect of their own capital in the same proportion as assets. In this case, yen depreciation leads to an increase in assets and equal increase in their own capital. However, the capital under the auspices of the Japanese banks is mostly yen-denominated. Consequently, yen depreciation increases risk assets, i.e. denominator, and their own capital, i.e. the numerator, remains the same.

The previous studies on the problems of Japanese banking sector include Ueda (1993) and Ito and Sasaki (1998). In contrast to the objectives of this paper, these studies focus on the period 1990-93. They found that while the risk-based capital requirement had a definite effect on the lending of the city banks, and the lending behavior of the regional banks has not changed. Several studies examined the impact of the non-performing loans on the lending behavior, but the results are ambiguous. Although Ito and Sasaki (1998) argue that the lending and non-performing were positively correlated, Yoshikawa, Eto and Ike (1994) found that the correlation was negative. Why did these two works reach contradictory conclusions? One possible explanation is the difference in analyzed samples. While the former paper analyzes major banks and large-sized enterprises, the latter focuses on regional banks and small

⁵ Foreign Exchange and Foreign Trade Control Law was abolished beginning from April 1, 1998.

and medium-size enterprises. Kim and Moreno (1994) find that the stock price fluctuations contributed significantly to the fluctuations in the banks lending in 1984-1993. Fukao (2004) analyzes profitability and non-performing loan issues experienced in the Japanese banking sector. Based on his work, he concluded that the capital adequacy ratios of the major Japanese banks when adjusted for unrealized capital gains, underreserving for loan losses, were less than 2% in 1998.

3. Overview of Macroeconomic Conditions and Exchange Rate Movements in 1997-98

Since the burst of the asset price bubble in 1990-91, the Japanese economy has entered into a prolonged slowdown. The average growth rate was around 1% as compared to the average of 4% from 1980 to 1992. While fiscal stimulus in 1995 brought about an ephemeral spell of growth in 1996 and in the first quarter of 1997, the series of shocks hit the economy forcing it to slump sharply. The first of them was fiscal tightening. An increase in the consumption tax had a much larger contractionary impact on the domestic spending than was anticipated. It was followed by the Asian crisis and finally by the collapse of several financial institutions. The recessionary risks moved up another notch. The growth rate fell to -0.1 in 1997 and further to -1.9 in 1998.

Let us take a closer look at the movements of the yen exchange rate vis-à-vis U.S. dollar and stock prices and compare them with the timing of the events (Table 3). Figure 2 shows the behavior of the yen exchange rate while Figure 3 depicts fluctuations in the stock prices.

In the beginning of 1997, the yen fluctuated near 120. The release of the data on trade indicated an increase in the U.S. trade deficit and Japanese trade surplus exacerbated the market concerns about the possibility of the intervention by the Japanese monetary authorities. In April, the statement of G-7 ministers and bankers put stress on the importance of avoiding exchange rate levels that could lead to the reemergence of large external imbalances. The yen depreciated to 127.15 on May 1. The economic data published in April appeared to deny the negative impact of the consumption tax hike on April 1. The spring issue of Quarterly Economic Outlook by the Bank of Japan stated that “Japan’s economy continues on a recovery trend despite some fluctuations caused by the rise in the consumption tax rate, with private demand showing underlying firmness”. However, these statements did not dispel concerns of the market that the economic recovery was not self-sustaining. At this time, the comments of officials on the exchange rate indicated that the yen buying intervention was a possibility. Moreover, Japanese officials commented that the Japanese economic recovery was stronger than perceived by market participants and that an interest rate hike could occur sooner than anticipated. In this environment, the Nikkei began to

increase, reaching 20489 in May for the first time in 1997; and the yen started to appreciate against the dollar.

After sharp appreciation in May, the trend was reversed. This is thought to be a result of market participants' reassessment of expectations of tighter monetary conditions in Japan and pessimism following a series of weaker-than-expected data releases. The summer issue of the Quarterly Economic Outlook by the Bank of Japan admitted that "the economic recovery was unlikely to gather significant momentum, as a result of fragility in some sectors, as well as the continued balance-sheet adjustment pressure."

On July 2, the Bank of Thailand abandoned the currency peg, allowing the Thai baht to depreciate against the dollar. The currency crisis in Thailand engulfed other countries in the region. The Indonesian rupiah, the Philippine peso and the Malaysian ringgit depreciated significantly vis-à-vis the dollar. On one hand, developments in East Asian countries, on the other hand, concerns over the health of the construction sector and scandals in the financial sector resulted in a dampening of sentiment in Japan. The Nikkei-225 index fell 13.2 percent, reversing the gains achieved in the previous months.

In September, the released economic data showed that the economy shrank by 2.9 percent as compared to the previous quarter and exacerbated the market participants concerns over a more and more pessimistic economic outlook in Japan and the health of the Japanese financial sector. The yen fell to 120 against the dollar. The autumn issue of the Quarterly Economic Outlook by the Bank of Japan acknowledged that "Japan's economic growth has been decelerating since April, partly reflecting the impact of the consumption tax hike". The September Bank of Japan's quarterly economic survey of business sentiment (Tankan survey) indicated the deterioration in sentiment among large manufacturers for the first time since August 1996. Ambiguous comments of the politicians on the economic reform and subsequent measures, including liberalization and tax cuts, failed to change increasingly negative market sentiment toward Japan's economic outlook. 3-month rates on treasury bills decreased sharply from 0.43% to 0.38%. In the beginning of November the Bank of Japan conducted a joint intervention with Singapore and Indonesia to support the Indonesian rupiah (Table 4).

Although during October, the yen fluctuated in the 120-122 range against the dollar, the yen fell to 125.80 and the Nikkei marked the level of 15,082 on November 14. The concerns over the health of Japanese financial institutions loaded with non-performing loans were fueled by the bankruptcies of Sanyo Securities, Hokkaido Takushoku Bank, and Yamaichi Securities in November. Such concerns undermined sentiment and led to an increase in the Japan premium. In the beginning of December, the Japanese banks had to pay a premium of over 100 basis points to borrow three-month funds, compared with a premium of about 30 basis points in the previous year. At the same time, short-term money market rates showed a rapid increase. The December Tankan survey recorded further erosion in business sentiment. In these

circumstances, the yen continued to depreciate, reaching as low as 131.25 on December 15. Following the announcement of a one-time 2 trillion yen personal income tax cut and other stimulus measures on December 17, large sales of yen occurred indicating that these measures were perceived by the market as insufficient. The yen rose to 126 due to the Japanese buying intervention. However, the interventions totaling 1, 059.1 billion yen during December 17-19 did not engender a desirable result. A short-lived appreciation was followed by further depreciation to 130.35 at the end of the year. The systemic vulnerability invited selling and short-selling of Japanese assets and currency. In this environment, the Bank of Japan adopted a more accommodative attitude in its monetary policy operations. In addition, the debates over the injection of public funds to support the financial sector intensified.

In January 1998, the increasing fragility of the Japanese economy and financial system, expectations of capital outflows, following the liberalization of the foreign exchange laws, pushed the yen further to the 130 level. The April Tankan survey recorded that the business sentiment deteriorated beyond the expectations. The subsequent Moody's revision of Japan's sovereign debt from stable to negative sent the Nikkei stock index to 15,518, and the yen to levels above 135. Following the announcement of details of the fiscal stimulus package, including 4 trillion yen in temporary tax cuts and intervention on April 9 and 10 amounting to a record amount of 2.82 trillion yen, the yen appreciated slightly. Despite the yen's gains, the market's sentiment toward the yen remained negative, indicating that market participants judged the planned stimulus measures insufficient to jump-start the Japanese economy. The following meeting of G-7 finance ministers and central bank governors ended up in a statement emphasizing "that it is important to avoid excessive depreciation where this could exacerbate large external imbalances" and that "appropriate steps by Japan aimed at stimulating domestic demand led growth and reducing external imbalances, thus also correcting the excessive depreciation of the yen" are welcomed.

In April unemployment rate reached 4.1 percent, the highest level in the post-World War II era. The yen depreciated to 139.25 against the dollar in the end of May. The yen's depreciation accelerated in June. The possibility of moving beyond the 140 level became a main matter of concern for the foreign exchange market participants. The yen rapidly declined to an eight-year low of 146.7 on June 16. On June 17, Japanese monetary authorities conducted a joint intervention with U.S. monetary authorities. The Japanese side bought 231.2 billion yen, while the U.S. monetary authorities sold 833 million dollars against the yen. The trading session this day closed at 143.2. Next day the yen appreciated to 136.2. Following the intervention, the yen fluctuated near the 137 level, supported by market expectations of economic and financial policy developments. However, it resumed to depreciate again since market participants judged a new financial reform package announced on July 2 inadequate to resolve the problems of the banking sector. The following defeat of the ruling party in

parliamentary elections contributed to further yen depreciation. The yen hovered at 140 until August, and gradually appreciated in September. It appreciated sharply by 6.7 percent on October 7, from 133.90 to 120.5, as hedge funds and other speculative accounts liquidated long dollar positions in an effort to reduce risk, deleverage balance sheets, and cover losses incurred in other markets. The yen continued to appreciate in October and reached 110 by the end of 1998.

4. Empirical Analysis

In this section, we present the results of the empirical analysis. As it was argued, the impact of the yen depreciation on the balance sheet of the banks is threefold. In the following, a distinction should be made between an indirect impact, which is impact attributed to low stock prices and increase in the Japan premium, and direct impact on the risk assets. However, before we look at the banking fragility reflected in the fluctuations of the banks' stock prices, we also assess the government's response at the end.

4.1. Banks' Stock Prices

The Japanese banks encountered large shocks in the 1990s. The burst of the asset price bubble in the first half of 1990s undermined banks profitability and exacerbated the problem of non-performing loans⁶. At this time, the Japanese banks had to undergo one more test – an introduction of BIS capital adequacy ratio. Coincidentally this event occurred during those days when the bubble economy collapsed and asset prices started falling. The situation was further aggravated by incomplete disclosure of bank balance sheet conditions and unwillingness of the Ministry of Finance to deal with problems of the banking sector. The deterioration of the balance sheet and impossibility to maintain 8% capital adequacy ratio forced some banks to withdraw from the overseas operations or even go bankrupt.

We would like to assess the behavior of bank stock prices as compared to that of other sectors. For this reason, we use the bank stock price index, referred as BANKS, and construct the index for all industries excluding banking by subtracting banking weights from TOPIX. TOPIX is the weighted average of indices of 33 sectors, so it is

⁶ Previous studies of the non-performing loan problems, the financial fragility and crisis in the Japanese financial system in 1990s include, for example, Cargill (2000), Ueda (2000) and Fukao (2004).

possible to construct the stock price index excluding banking sector ($NBANKS_t$) as follows:

$$(1) \quad NBANKS_t = \frac{TOPIX_t - \alpha_t BANKS_t}{1 - \alpha_t},$$

where is $\alpha_t = BANKSMV_t / TOPIXMV_t$, such that $BANKSMV_t$ is the current value of the banking market capitalization and $TOPIXMV_t$ is the all-sector market capitalization⁷.

The behavior of the two indices is depicted in Figure 4. The banks' stock prices can be observed to have steadily been declining since October, 1996, reaching its lowest level on April 10. During this period the banks' stock prices have declined by 38%. Although there was an upsurge at the end of June, the increasing trend was reversed with an outburst of the Asian crisis. After the three financial institutions failed in November 1997, $BANKS$ sharply dropped reflecting that the probability of the banks' closures was judged to have increased due to these bankruptcies. The deviation between $BANKS$ and $NBANKS$ has increased for a while. The stock market seems to have predicted the increased vulnerability of the banking sector, and possible bank closures. However, the deviation began to decrease toward the end of the year, meaning that the economy as a whole abruptly contracted.

We proceed with analyzing the co-movements of these two indices and the possibility of the structural transformation experienced during 1997. Since both the augmented Dickey–Fuller and Phillips–Perron unit root tests indicated a unit root in levels (Table 5), we apply dynamic OLS estimation (DOLS) of the co-integrating vector. Following Stock and Watson (1993) and Hayashi (2000) we augment the co-integrating regression with the current change, as well as past and future changes of the regressor. The number of leads and lags was chosen to be 2. The estimated DOLS regression is as follows:

$$(2) \quad NBANKS_t = \alpha + \beta \cdot BANKS_t + \gamma_0 \Delta BANKS_t + \gamma_1 \Delta BANKS_{t+1} + \gamma_2 \Delta BANKS_{t+2} + \gamma_{-1} \Delta BANKS_{t-1} + \gamma_{-2} \Delta BANKS_{t-2} + \eta_t.$$

⁷ Monthly market valuations are taken from Statistics Monthly of the Tokyo Stock Exchange. It was assumed that the number of issued stocks does not change within a month. Any possible problems with this assumption are corrected within the month. See Ito and Harada (2005).

The table reports the parameter estimates by DOLS. The Chow breakpoint test (Table 6) decisively rejects the null hypothesis of no structural change. Therefore, the regression is run for 3 sub-periods separately. The estimates of β for 3 sub-periods are different (Table 6). During January – April 1997 the stock prices of banking industry have been rapidly declining, but did not exert strong impact on the stock prices of other industries. The market reassessed the risks in May. The banks' stock prices had greater impact nearly twice. After November, the banks' stock prices started to influence NBANKS even more.

4.2. Impact of Yen Depreciation on the Risk Assets of the Japanese Banks

Here we try to estimate what impact further yen depreciation would have exerted on the BIS capital adequacy ratio. The risk exposure generated by foreign exchange cannot be accurately determined from the data provided in the institutions' annual reports. To overcome this, we are forced to make several assumptions. First, since the greater part of the foreign currency assets are dollar-denominated, we assume that all assets held by the Japanese banks are dollar-denominated. Second, it is impossible to grasp an exact amount of the foreign risk assets from the disclosed balance sheets. For this reason, we make an approximate estimation of the foreign risk assets by multiplying the total amount of risk assets by the proportion of the foreign currency assets in the operating assets. Third, it is assumed that the banks are willing to maintain the level of BIS capital adequacy ratio they reported in March, 1998 and to do this they reduce risk assets. The estimation is made for two cases, namely the case with and without the public funds injection.

The results are summarized in Table 7. At the end of March, the exchange rate fluctuated at 130 yen per dollar. If the exchange rate increased 5 yen, the banks would have been forced to reduce the risk assets by more than 3 trillion yen *ceteris paribus*. Depreciation equal to 10 yen would have resulted in roughly 6.5 trillion yen decrease in risk assets. If there had been no public fund injection, the banks would have been forced to reduce their risk assets by more than 10 trillion yen. Roughly speaking, in this case 1 yen depreciation would result in more than 1 trillion cut in assets. Certainly, this does not mean that the banks would have decreased domestic loans by 1 trillion yen, but still the damage to the economy would have been significant.

4.3. Yen Depreciation and Low Stock Prices

There is no theoretical consensus either on the existence of relationships between stock prices and exchange rates or on the direction of the relationship. In the present literature there are two views on this relationship. Classical economists argue that currency appreciation may affect international product competitiveness and trade balance position. As a result, firms' profits are affected due to output contraction and this, in turn, affects stock price. This is suggestive that the exchange rates lead stock prices with positive correlation. However, the proponents of the portfolio-balance model argue that, being part of wealth, equity may affect the exchange rates by inducing a demand for money. Higher stock prices, for example, may lead to a higher demand for money by ensuring higher interest rates. With a relatively higher interest rate, foreign capital inflows will result in an appreciation of domestic currency. This suggests that stock prices lead exchange rates with negative correlation.

To examine causal relation between the exchange rate and stock prices, we conduct a pairwise Granger causality test. Before proceeding to the estimation, pretesting of the variables for unit roots were performed using the augmented Dickey-Fuller and Phillips-Perron unit root tests. The results of ADF are summarized in Table 5. The results of PP test are not reported here since they are similar to that of ADF. According to the results, both series are non-stationary in levels, but are first-difference stationary. For this reason, we continue using the first differences of log variables.

It is noteworthy that the causality is period sensitive and is not clearly seen in 1998. The results for 1997 suggest that there is one-way causality running from exchange rates to stock prices (Table 8). During this period, stock market decline was led by the yen depreciation. This finding is inconsistent with the classical economist argument which suggests that exchange rates take the lead with positive correlation. One possible explanation is that, an anticipation of further currency depreciation encouraged international investors to liquidate their share holdings as further delay will cut down their profits. Capital flows reversal intensified the yen depreciation and stock market decline⁸. This suggests that the stability of the exchange rates is important for stock market stability.

In this way, yen depreciation does not only cause a direct increase in the denominator of the BIS capital adequacy ratio, but also seemed to cause an indirect decrease in numerator through a decrease in stock prices. The movements in stock prices, in turn, are expected to exert a significant impact on the position of the Japanese banks that traditionally hold equities of their customers and group companies. When the Nikkei 225 index peaked 38,915 yen in 1989, the banks were enjoying large unrealized

⁸ In 1997 market expected further yen depreciation. 3 month-forward spread on Tokyo dollar-yen market was 1.59 on average in 1997 with a peak of 1.88 on November 12, 1997. During August – December of 1997 foreign investors sold 2,350 million Japanese shares with a total amount of 1,617,305 million yen.

capital gains that helped to boost the capital adequacy ratio standard. During the first half of the 1990s, the stock prices were fluctuating in the vicinity of 20,000 yen, and unrealized capital gains dropped significantly, but were still positive. In 1997 the unrealized capital gains shrank 7 trillion yen or more than twice relative to their level in 1996 (Table 9). Taking into account that the total amount of capital is about 20 trillion yen, the impact of a decrease in stock prices on the equity capital is large.

In order to assess the impact of the yen depreciation through the decrease in the stock prices we carry out estimation in the following three steps. First, an impact of the falling stock prices on the capital ratios is estimated. Second, impact of 1 yen depreciation on the stock prices is estimated. Finally, the impact of the yen depreciation and the estimated drop in the stock prices is assessed.

Table 10 is an estimation how further decline in Nikkei 225 would have affected the capital adequacy ratio⁹. The estimates are based on published data. The analysis does not explicitly consider the possible spillover effects of contagion. The Japanese banking and insurance sectors are extensively interconnected through cross institution share and subordinated debt holdings. So losses in some institutions would likely have significant spillover effects on other institutions in the financial sector. Such contagion risks have not been quantified in the analysis. It is assumed that the market value of stocks held by the Japanese banks is changing in the same proportion as the Nikkei index, so all stock positions are re-priced using the same price change. The insufficient provisions for the non-performing loans are not taken into consideration. Unrealized losses on securities were deducted from Tier I capital. Although some banks used historical cost accounting, our analysis is based on the market method. Under the historical cost accounting, neither unrealized gains nor losses are reflected in the BIS ratio¹⁰, therefore the estimation of BIS ratio significantly differs. In this paper, we assumed that the BIS ratio is estimated on the market value basis because the banks rating is made on the market value basis, and unrealized gains or losses are publicly disclosed by all banks regardless what type of accounting they use. The estimation is made only for banks conducting overseas operations since there is no necessary information to make estimates for banks working only on the domestic market.

According to the results a further 10% drop in stock prices, i.e. a drop from 16,527.17 to 14,874.45, would have forced six internationally active banks to withdraw from the international operations and two banks to go bankrupt. If Nikkei had fallen by 20% to 13,221.74, twelve internationally active banks would have been forced to withdraw from the international operations and three banks would have gone bankrupt.

⁹ Fukao (2004) estimates how a further drop in the stock prices would have affected the unrealized capital gains and losses of the Japanese banks in 2003. He takes into account the insufficient provisions for the non-performing loans.

¹⁰ To be precise, under the historical cost accounting the banks are obliged to account for unrealized losses if the market value is less than 50% of the historical value.

The capital adequacy ratios of seventeen internationally active banks would have fallen short or close to fallen short of the 8% threshold. Furthermore, eight banks would have gone bankrupt at 11,569.02.

To estimate the impact of yen depreciation on the stock prices, we run a regression with Nikkei as a dependent variable and exchange rate as independent variable and use the estimated parameters. Analogously to the above estimation, the stocks held by the internationally active banks are re-priced using the same price change. The results are summarized in Table 11.

5 yen depreciation is estimated to lead to a drop in Nikkei to 14216.65. In this case, nine internationally active banks would have been forced to withdraw from the international operations and three banks would have failed. 10 yen depreciation to 140 yen per dollar would have entailed 12,831.61 level of Nikkei, in addition withdrawal of fifteen internationally active banks from the overseas operations and closures of four banks. At an exchange rate and Nikkei index equal respectively to 145 and 11446.57, the capital adequacy ratios of nineteen internationally active banks would have fallen short or close to fallen short of the 8% threshold, resulting in eight banks that would have become insolvent.

4.4. Yen Depreciation and Japan Premium

One more indicator of the banking fragility is Japan Premium, which is defined as the difference between the 3-month TIBOR (the Tokyo interbank offered rate) and LIBOR (the London interbank offered rate) in Euroyen market. Aside from two banks, the TIBOR market participants are comprised predominantly of Japanese banks. Thus, the TIBOR reflects Japanese banks' borrowing rate with the Japan premium. On the other hand, the LIBOR market has many western banks and only a few Japanese banks. Hence, the difference between the TIBOR and LIBOR is defined as the Japan premium (JP).

$$(3) \quad JP_t = TIBOR_t - LIBOR_{t-1}.$$

The behavior of Japan Premium is shown in Figure 5. It is necessary to note that both banks stock prices and Japan premium reflect the risks of the banking system, but banks stock prices reflect profitability and solvency risk, whereas Japan premium reflects liquidity risk. The results of the pairwise Granger causality test show that yen exchange rate influenced the Japan premium (Table 12).

In 1997 net business profits of all banks became 5.4 trillion yen, 14% less than in the previous year. Current profit became -5.2 trillion yen. The international business

gross margin fell by 10% as compared to 1996. This is partly due to widening of the Japan premium, and reducing overseas operations (Table 13).

4.5. Yen Depreciation and Banks' Lending

In the presence of obvious demand factors for decrease in bank lending (stagnant economy), it is difficult to determine to which extent the decrease in the lending should be attributed to supply factors and to which extent fluctuations in yen exchange rate contributed to that decrease. The descriptive data such as Tankan survey suggests that the willingness of the banks to lend dropped significantly in 1997-98 (Figure 1), i.e. there was a credit crunch.

However, there is a necessity to address this question in a more formal way. We expect that yen depreciation exerted impact mainly on the lending of internationally active banks, while it had little or no impact on the banks performing domestic operations. However, since the data are available only in the aggregated form, it is impossible to distinguish between the impact of the yen depreciation on internationally active banks and that on the other banks. For this reason, we limit our analysis only to the city banks all of which were internationally active. We first conduct a correlation analysis. The correlation between yen exchange rate and city banks' loans outstanding is positive and high (-0.98). The pairwise Granger causality test rejects the Null hypothesis that yen exchange rate does not cause loans of city banks at 5% significance level (Table 14). The results point on the yen impact on banks lending and the existence of credit crunch.

4.6. Government's Response

The government's response was nothing but slow. It seems that the authorities' approach to banking sector problems was predicated on the expectation that the economy would quickly rebound and that a resumption of growth would permit banks and borrowers to recover their financial strength. The first step taken by the government was intervention to support yen. However, as it can be seen from Figure 2 it has little impact on the yen exchange rate. It was only in 1998 just before the end of the accounting year when the government relaxed the regulatory framework to artificially increase the capital ratios of banks. These measures encompassed allowing banks to include 45% of revalued real estate holdings in their Tier II capital, an optional change from the lower of cost or market value accounting to cost basis accounting. The final and decisive measure was injection of public funds to 21 main banks amounting to 1.8 trillion yen. In this sub-section, we assess the effectiveness of intervention, its impact on

banks' stock prices, stock prices index and Japan premium. Impact of the public fund injection is also analyzed.

Intervention was conducted in December 17, 18, 19 and April 9, 10. Intervention conducted on June 18 was joint intervention. First, we evaluate intervention from the standpoint of tactical effectiveness, i.e. whether intervention had an impact on the exchange rate on the day of intervention. In evaluating the effectiveness of Japanese intervention we follow Ito (2002). The change in the daily exchange rate is regressed on the change in the past exchange rate (lagged once, and the cumulative change for a week in the past, and the deviation from the long-run average) and interventions (Japanese intervention, US intervention, and Japanese first-of-the-week intervention). The specification is:

$$(4) \quad \Delta s_t = \beta_0 + \beta_1 \Delta s_{t-1} + \beta_2 (s_{t-1} - s_{t-1}^{long}) + \beta_3 INT_t + \beta_4 INTUS_t + \beta_5 INTP_t + \varepsilon_t,$$

where $\Delta s_t = s_t - s_{t-1}$, s_t is the yen-dollar exchange rate, and s_t^{long} is the long-run, here 180 days, backward moving average. The first three terms in the right-hand-side are expected to capture movement of the yen-dollar rate without interventions. If the exchange rate follows a random walk, then a condition $\beta_0 = \beta_1 = \beta_2 = 0$ should be imposed. However, the above specification allows for a short-run bandwagon effect ($0 < \beta_1 < 1$) and a medium run mean-reversion ($\beta_2 < 0$). INT_t is the Japanese intervention amounts (in billion yen); $INTUS_t$ is the U.S. intervention amounts (in billion yen). $INTP_t$ denotes the first-in-the-week interventions and equal to INT_t if no intervention in five preceding days and 0 otherwise.

Equation (4) has been estimated for the whole period and for two sub-periods, namely 1997 and 1998; the results are summarized in Table 16. When the intervention by the Japanese authorities is effective, we expect $\beta_3 < 0$. For example, if the yen-purchasing intervention ($INT_t > 0$) by the Japanese monetary authorities tends to appreciate the yen ($\Delta s_t = s_t - s_{t-1} < 0$) then the negative sign of β_3 should be obtained.

β_3 is negative for the entire sample, but it turns out that the Japanese intervention was ineffective in 1997 and effective in 1998. The possible reason for the ineffectiveness of

the intervention in 1997 is that the market participants were overly pessimistic about the Japan's economic outlook.

The U.S. interventions (which take a positive value for yen purchasing) are judged to be effective when β_4 is negative. The total effects of the joint interventions are measured by $\beta_3 + \beta_4$. The joint intervention by the Japanese and U.S. authorities was effective and the magnitude of $\beta_3 + \beta_4$ was much higher in joint intervention than the unilateral intervention by the Japanese authorities. The coefficient of β_5 shows the effectiveness of the first intervention in more than a week beyond, similar to one of the interventions.

Another test for effectiveness of the intervention is whether it had impact on the stock prices, stock prices of banks and Japan premium. To see this, we run regressions with dummy variables for days of intervention. If the intervention was effective, a positive dummy value exists for stock prices and stock prices of banks and negative value for JP. The results summarized in Table 16 suggest that intervention had slight but positive impact on the stock prices of banks, but TOPIX decreases as a result of the intervention. The Japan premium decreased due to intervention.

Another measure taken by the government to support banks was injection of public funds. Without a doubt, it helped banks to boost their capital adequacy ratios, but there remain several questions how public fund injection contributed to fluctuations in bank stock prices, stock prices as a whole and the Japan premium. To address these questions, we run regressions, the results of which are shown in Table 17. The impact of the public fund injection was similar to that of intervention. It forced the stock prices of banks to increase and Japan premium and stock prices as a whole to decrease.

5. Policy Implications

Certainly, the fact that loans are not increasing while the banks are willing to lend suggests that the problem lies in the demand factors. Probably, this was the main reason why the credit crunch was not widely discussed in Japan at that time¹¹ and why the Japanese officials procrastinated on taking measures. However, the banks'

¹¹ It was only Nihon Keizai Shimbun issued on October 27, 1997 that reported that the major banks would have to reduce their risk assets by 15 trillion yen if they were to meet the capital ratio requirements at the end of March 1998.

reluctance to lend in 1997-98 should be attributed mainly to the supply factors, although the main reason may be traced to yen depreciation.

Weak yen is definitely good for the export industries, but it is disastrous to the undercapitalized banking sector. The fact that the credit crunch in 1997-98 did not make a significant impact on the economy suggests that the demand for loans fell below supply at that moment. However, if the yen depreciated further, there was a possibility that the supply of credit fell below demand, adversely affecting the economy. In this case, fiscal stimulus measures to boost the overall economy would not generate the desirable result.

The proposals of letting the yen fall in value on foreign exchange markets in order to stimulate economy are dangerous. If the problem of yen depreciation was left unattended or postponed, there was a strong possibility of the Japanese economy falling into a vicious circle of credit crunches. Heightening of financial uncertainty and economic deceleration would have led to the further decrease in bank lending and shrinkage of other credit extensions coupled with further drop in stock prices, further yen depreciation and the lowering of banks capital adequacy ratios and their ratings. Such a credit crunch will give a deflationary impact to the Japanese economy in which the possibility of economic slowdown was already high. It would also instigate further drop in stock prices, which would further pressure the credit crunch.

One more question that arises here is whether there was a policy mistake. Would the banks have suffered from the yen depreciation if the former Exchange and Foreign Trade Control Law had not been effective? This law put limitations on the net foreign exchange position of the Japanese banks and was designed to prevent the Japanese banks from the excessive foreign exchange losses that might be caused by the exchange rate fluctuations. On the other hand, it artificially created a situation similar to that of the developing countries having foreign-currency denominated debt. Although it aggravated the problems of the Japanese banks, the main problem is thought to be their undercapitalization.

6. Conclusion

This paper spotlighted the impact of exchange rate depreciation on the banking sector. It was shown that yen depreciation caused an increase in risk assets, decrease in stock prices and increase in Japan premium. Thus, the denominator of BIS capital adequacy ratio increased while numerator did not. As a result, the banks ability to lend was squeezed. Because of a variety of contractionary shocks having affected the Japanese economy at that period, it is impossible to rule out completely sluggish demand as a contributor to the marked decline in loans growth. However, evidence contained in this paper suggests that credit crunch existed. Although the degree to which

the lower bank loans caused an actual impact on the economy is beyond the scope of this paper, this would be an interesting theme for future research.

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Appendix

Table 1: Yen Depreciation and Credit Crunch

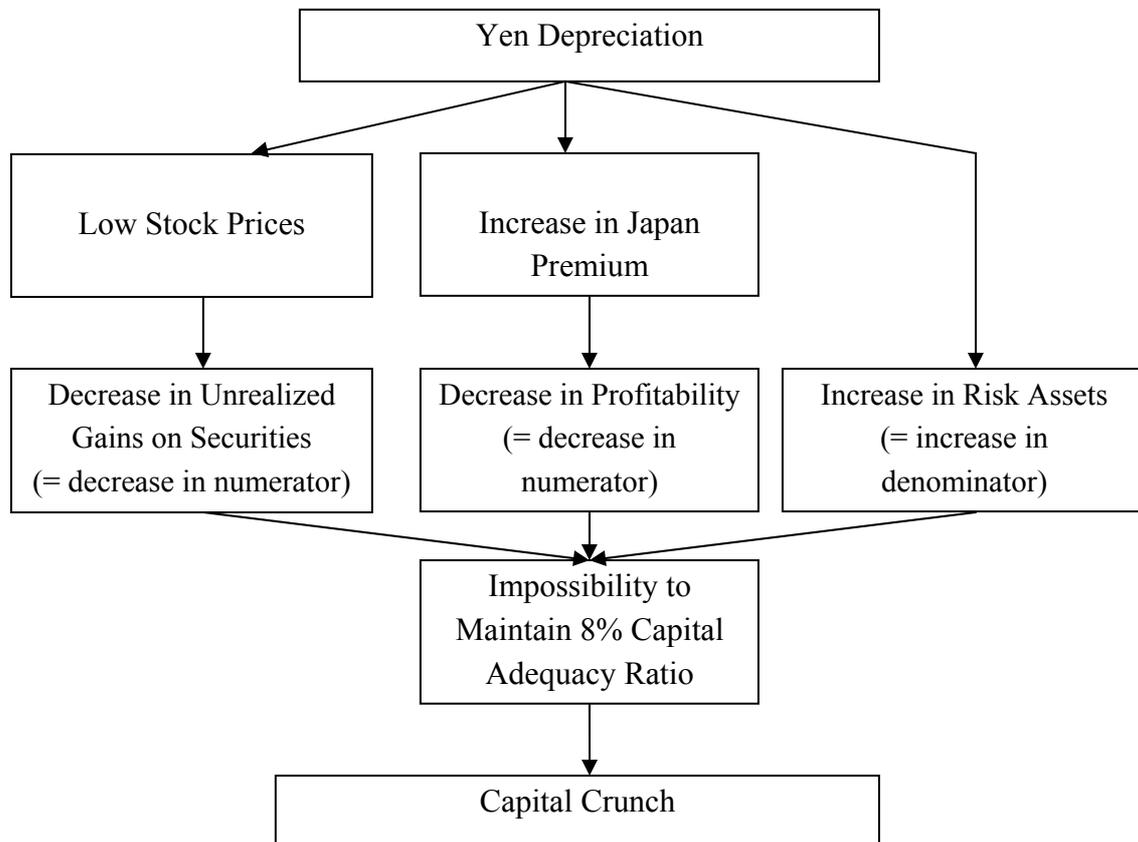


Table 2: Calculation of Capital Adequacy Ratio for Banks (BIS)

$$\text{Capital Adequacy Ratio} = \frac{\text{Tier I} + \text{Tier II} + \text{Tier III} - \text{Deductions}}{\text{Risk Weighted Credit Exposures} + \text{Market Exposures}}$$

(*) Tier I Capital \geq Tier II + Tier III

Capital		
	Tier I Capital	<ul style="list-style-type: none"> the ordinary share capital (or equity) of the bank; non-cumulative perpetual preferred stocks audited revenue reserves, e.g. retained earnings; less current year's losses; consolidated subsidiaries minority interest
	Tier II Capital	<ul style="list-style-type: none"> 45% unrealized revaluation gain on securities holdings revaluation reserves; general provisions for bad debts; perpetual cumulative preference shares (i.e. preference shares with no maturity date whose dividends accrue for future payment even if the bank's financial condition does not support immediate payment); perpetual subordinated debt (i.e. debt with no maturity date which ranks in priority behind all creditors except shareholders).
	Tier III Capital	<ul style="list-style-type: none"> subordinated debt with a term of at least 5 years; redeemable preference shares which may not be redeemed for at least 5 years.
	Deductions	<ul style="list-style-type: none"> goodwill reciprocal holdings of capital instruments of banks aimed at raising capital ratios
Risk Weighted Credit Exposures (A+B)		
	A: On-balance sheet exposures weighted by risk coefficients	

Example:

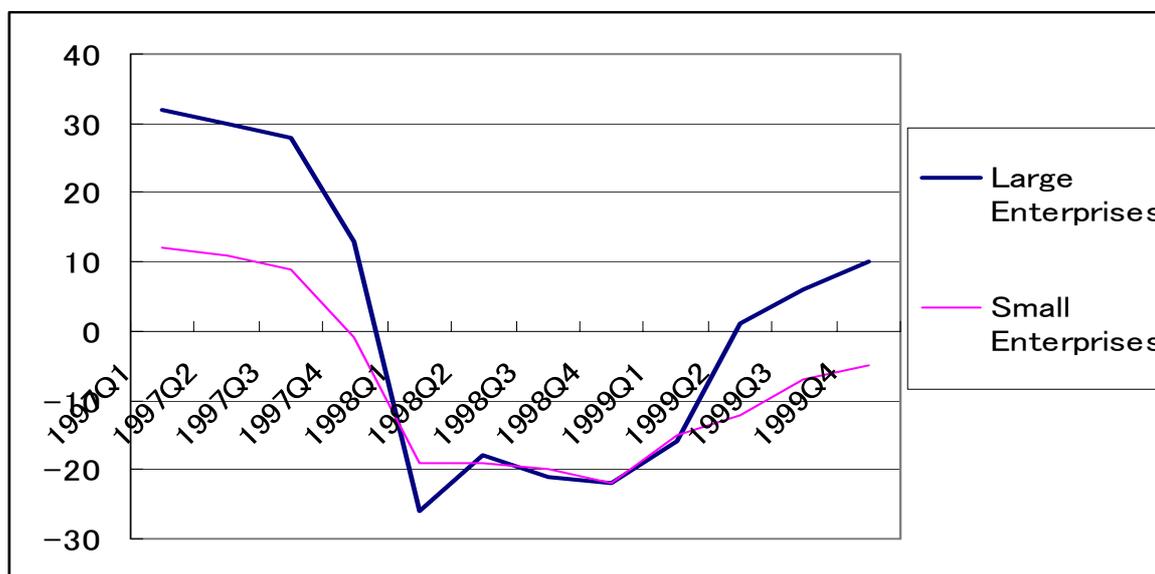
Credit Exposure Type	Percentage Risk Weighting
Cash	0
Short term claims on governments	0
Claims fully collateralized by cash	0
Long term claims on governments (> 1 year)	10
Claims on banks	20
Claims on public sector entities	20
Residential mortgages	50
All other credit exposures	100

B: Off-balance sheet credit exposures weighted by risk coefficients

Market Exposures

Source: Basle Capital Accord, Kin'yu Zaisei Jijo, various issues

Figure 1: Lending Attitude of Financial Institutions (Diffusion index of "Accommodative" minus "Severe")



Source: Short-term Economic Survey of Enterprises in Japan (Tankan Survey), Bank of Japan

Table 3: Chronology of events in the world and Japan during 1997-1998

Date	Main Events
Apr. 1997	Consumption tax is raised from 3% to 5%. Meeting of the G-7 Finance Ministers and Central Bank Governors Washington, D.C.
Jul. 1997	Baht devaluation, Malaysia's central bank intervenes to defend its currency, the ringgit, devaluation of the Philippine peso
Aug. 1997	Indonesia abandons the rupiah's trading band and allows the currency to float freely, triggering a plunge in the currency. The Hong Kong dollar is attacked by speculators, leading to a hike on interest rates overnight
Oct. 1997	Merger of Fukutoku Bank and Naniwa Bank, Kyoto Kyoei Bank announces liquidation plan. Hong Kong's stock index falls 10.4% after it raises bank lending rates to 300% to fend off speculative attacks on the Hong Kong dollar. The plunge on the Hong Kong Stock Exchange wipes \$29.3 billion off the value of stock shares. The South Korean won begins to weaken.
Nov. 1997	Sanyo Securities Co. Ltd., one of Japan's top 10 brokerage firms, goes bankrupt with liabilities of more than \$3 billion. It is the first Japanese securities house to go bust since World War II. Hokkaido Takushoku Bank Ltd. collapses under a pile of bad loans. The Bank of Korea abandons its effort to prop up the value of the won, allowing it to fall below 1000 against the dollar, a record low. South Korea's stock market's index falls sharply, while its currency the won keeps losing value to reach an all-time low. Foreign investors sell \$71 million of shares in the half-day trading. Taiwan's stock and currency market plunges on. Japan's fourth largest brokerage house, Yamaichi Securities, announces its decision to shut down. Concern about Japan's financial and economic condition rise. Tokuyo City Bank announces its closure and the transfer of its operations to other regional banks.
Dec. 1997	2 trillion yen special tax-cut measures are announced. Russia's central bank raises interest rates for the second time in less than a month, giving up efforts to shore up the country's slumping currency and bond markets with direct intervention.
Jan.1998	Asian currencies plunge as investors return to the foreign currency markets. The Indonesian rupiah, the Thai baht, and the Philippines peso plunge to new lows each day.
Feb. 1998	The Diet passed two finance-related laws, which enabled the government to use 30 trillion yen of public money to bail out banks and protect depositors. Following criticisms from the G-7 leading industrialized countries, Japan's market marks a sharp decline, closing at its lowest in a month amid doubts about economic reform.
Mar. 1998	Public fund injection of 1.8 trillion yen to the main 21 banks

	The news of an economic stimulus package only temporarily cheers the market.
Apr. 1998	Prompt corrective action (PCA) procedures established.
May 1998	Bankruptcy of Midori Bank
Jun. 1998	Russia's stock market crashes and Moscow's cash reserves dwindle to \$14 billion amid unsuccessful attempts to prop up the ruble and pay off burgeoning debts. Japan announces that its economy is in a recession. Financial Supervisory Agency established under Financial Reconstruction Commission (FRC) to oversee rehabilitation of the financial sector and improve supervision. Inspection manual prepared and published, designed to promote more effective loan valuation and provisioning practices (introducing so-called self-assessment process). Securities and Exchange Surveillance Commission (SESC) moved from the Ministry of Finance (MoF) to the Financial Supervisory Agency
Sep. 1998	Tokyo's Nikkei index hits a 12-year low amid steep declines in Hong Kong, France, Britain and the US. The Dow drops 216 points. Pushed by the New York Federal Reserve, a consortium of leading US financial institutions provides a \$3.5 billion bailout to Long Term Capital Management, one of the largest US hedge funds, amidst fears that a the panic in the financial markets.
Oct. 1998	Banking law reform; the augmentation of public funds to a total of 60 trillion yen—more than 12 percent of GDP—for financial support for banks. Bankruptcy and temporary nationalization of Long-Term Credit Bank of Japan
Dec. 1998	Bankruptcy and temporary nationalization of Nippon Credit Bank

Source: Nihon Keizai Shinbun, various issues

Figure 2: Exchange Rate Movements (yen per \$)

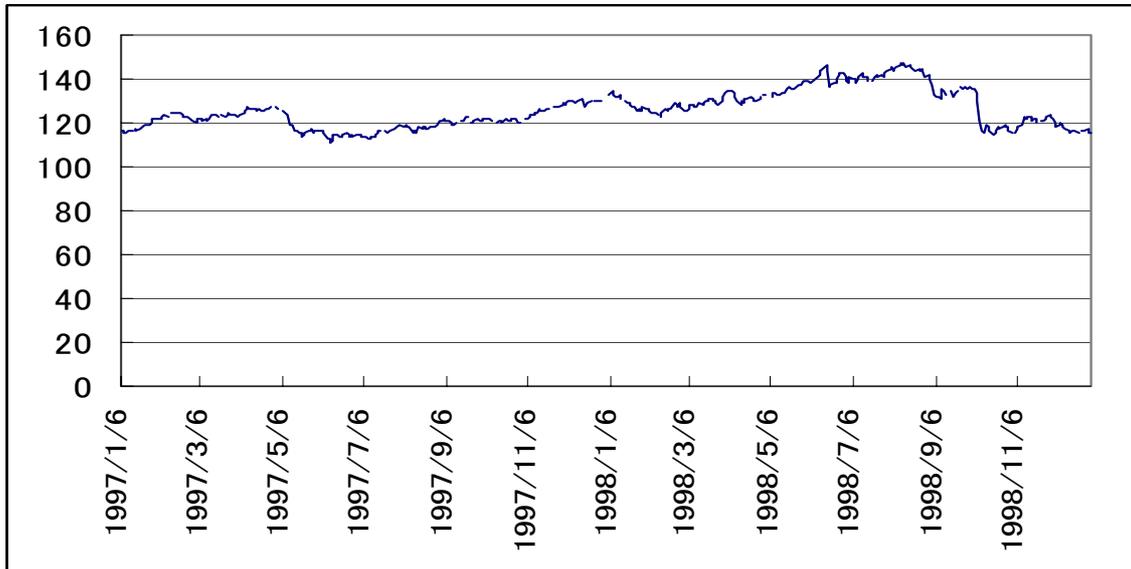


Figure 3: Fluctuations in Stock Prices

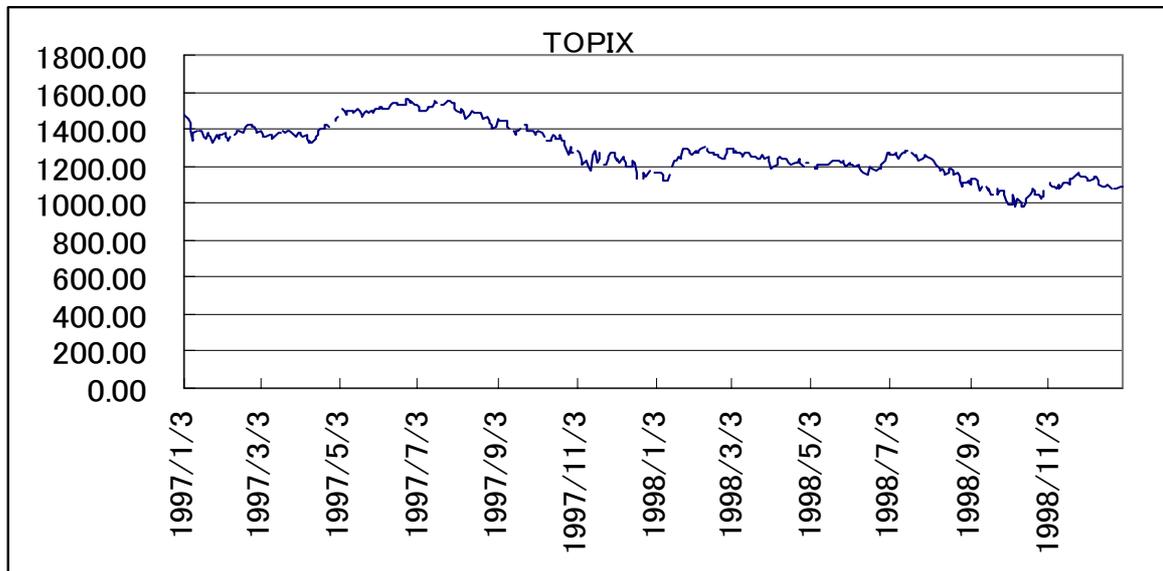


Table 4: Exchange Intervention Operations 1997-1998

Date	Total amount of the day (¥)	Currency pairs
Jan – Mar 1997	0	
Apr –Jun 1997	0	
Jul- Sep 1997	0	
3-Nov-97	39.0 billion	the US dollar (sold), the Indonesian rupiah (bought)
5-Nov-97	11.0 billion	the US dollar (sold), the Indonesian rupiah (bought)
6-Nov-97	16.6 billion	the US dollar (sold), the Indonesian rupiah (bought)
17-Nov-97	2.3 billion	the US dollar (sold), the Indonesian rupiah (bought)
18-Nov-97	0.4 billion	the US dollar (sold), the Indonesian rupiah (bought)
17-Dec-97	280.4 billion	the US dollar (sold), the Japanese yen (bought)
18-Dec-97	76.4 billion	the US dollar (sold), the Japanese yen (bought)
19-Dec-97	702.3 billion	the US dollar (sold), the Japanese yen (bought)
Oct - Dec 1997	1,128.2 billion	
Jan - Mar 1998	0	
9-Apr-98	195.7 billion	the US dollar (sold), the Japanese yen (bought)
10-Apr-98	2,620.1 billion	the US dollar (sold), the Japanese yen (bought)
17-Jun-98	231.2 billion	the US dollar (sold), the Japanese yen (bought)
Apr –Jun 1998	3,047.0 billion	
Jul – Sep 1998	0	
Oct - Dec 1998	0	

Source: Homepage of Ministry of Finance, Japan

Figure 4: TOPIX and BANKS Indices

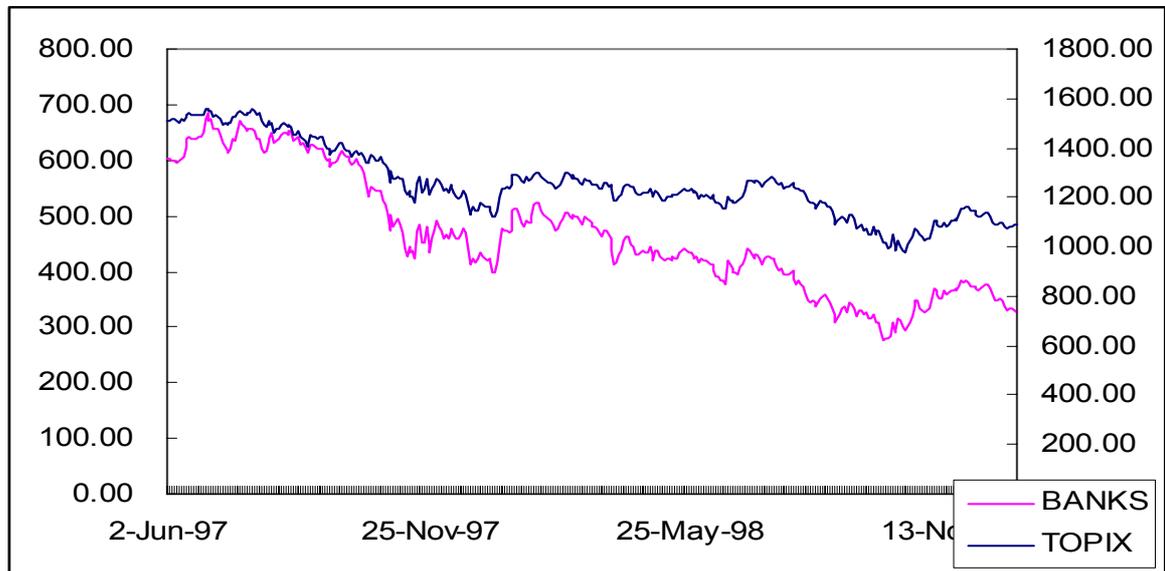


Table 5: Unit Root Test (ADF)

Series	Probability	Lags Retained
Nikkei	0.8440	0
JPY	0.2413	1
BANKS	0.7769	1
NBANKS	0.7234	1

* All series are first-difference stationary.

Table 6: Cointegration and Chow breakpoint Test

	β	R^2	St. error of regression
DOLS Estimates (Rescaled standard errors)	1.439 (0.043)	0.870	34.742

Chow Breakpoint Test

Chow Breakpoint Test: 4/30/1997 11/04/1997

F-statistic	4.375	Probability	0.000001
Log likelihood ratio	58.678	Probability	0

DOLS Estimates (Rescaled standard errors)	β	R^2	St. error of regression
Jan-Apr 1997	0.632	0.687	16.046
May-Oct 1997	1.164	0.647	37.771
Nov-Dec 1997	1.184	0.654	20.582

Table 7: Impact of Yen Depreciation on Risk Assets (millions of yen)

Yen Level	Necessary Decrease in Risk Assets given public fund injection	Necessary Decrease in Risk Assets if no public fund injections were made
135	3,231,829	7,247,317
140	6,463,659	10,479,147
145	9,695,488	13,710,976

Table 8: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
1997		
JPY/USD does not Granger Cause Nikkei	3.573*	0.030
Nikkei does not Granger Cause JPY/USD	0.920	0.400
1998		
JPY/USD does not Granger Cause Nikkei	0.273	0.762
Nikkei does not Granger Cause JPY/USD	2.834	0.063

* - denotes rejection of the Null hypothesis at 5% level.

Table 9: Unrealized Revaluation Gain and Loss on Securities Holdings (millions yen)

	April 1996 - March 1997	April 1997 - March 1998	April 1998 - March 1999
All Banks	13,095,545	5,618,423	5,152,246
City Banks	7,004,801	2,890,640	2,406,795
Regional Banks	3,848,459	2,607,975	2,256,499
Regional Banks II	570,608	304,105	176,842
Trust Banks	1,550,100	246,972	296,822
Long-term Banks	121,577	-431,269	15,288
Reference			
Nikkei 225	18,003.4	16,527.17	15,836.59

Estimation includes 142 Japanese banks. Long-term Bank of Japan is excluded from the estimation April 1998 – March 1999.

Source: Disclosed balance sheets.

Table 10: Impact of Decrease in Stock Prices on BIS Capital Adequacy Ratio of Internationally Active Banks

Nikkei 225	Capital Adequacy ratio				
	City Banks	Regional Banks	Trust Banks	Long-term Banks	
- 10%	-0.0139	-0.0040	-0.0196	-0.0238	Six internationally active banks would have been forced to withdraw from the international operations. Two banks would have gone bankrupt.
- 20%	-0.0295	-0.0054	-0.0338	-0.0348	Twelve internationally active banks would have been forced to withdraw from the international operations. Three banks would have gone bankrupt.
- 30%	-0.0470	-0.0079	-0.0517	-0.0487	The capital adequacy ratios of seventeen internationally active banks would have fallen short or close to fall short of the 8% threshold. Eight banks would have gone bankrupt.

There is no necessary information to calculate capital adequacy ratios for banks working on the domestic market only.

Source: Disclosed balance sheets

Table 11: Impact of Yen Depreciation and Decrease in Stock Prices on BIS Capital Adequacy Ratio of Internationally Active Banks

Yen Level and Nikkei 225	Capital Adequacy ratio				
	City Banks	Regional Banks	Trust Banks	Long-term Banks	
135 – 14216.65	-0.0198	-0.0053	-0.0253	-0.0284	Nine internationally active banks would have been forced to withdraw from the international operations. Three banks would have gone bankrupt.
140 – 12831.61	-0.0338	-0.0075	-0.0372	-0.0385	Fifteen internationally active banks would have been forced to withdraw from the international operations. Four banks would have gone bankrupt.
145 – 11446.57	-0.0497	-0.0098	-0.0507	-0.0546	The capital adequacy ratios of nineteen internationally active banks would have fallen short or close to fall short of the 8% threshold. Eight banks would have gone bankrupt.

Source: Disclosed balance sheets

Figure 5: Japan Premium

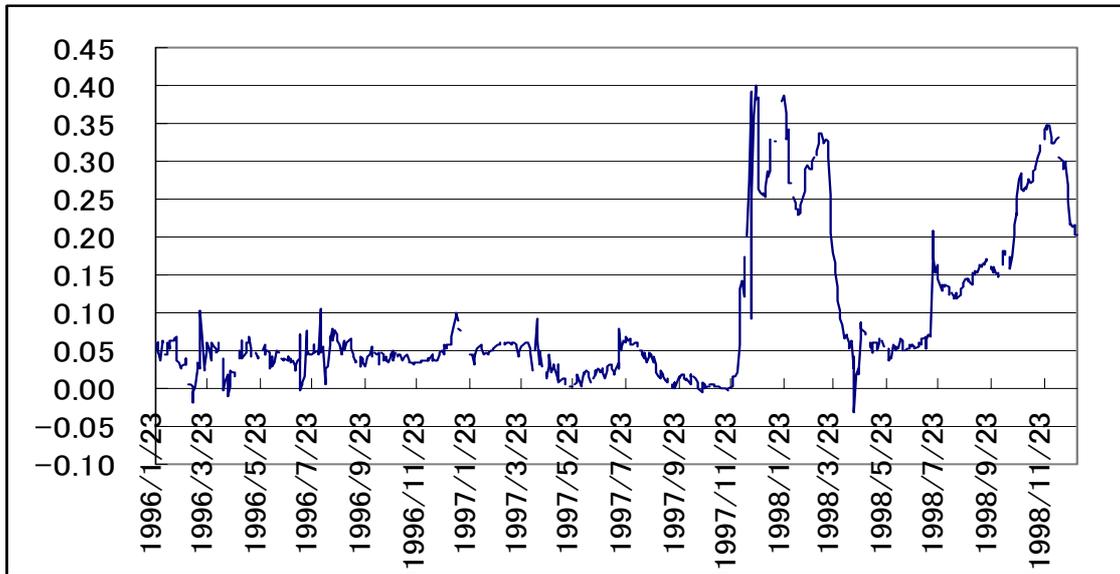


Table 12: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
JPY does not Granger Cause JP	2.978*	0.05
JP does not Granger Cause JPY	1.148	0.32

* - denotes rejection of the Null hypothesis at 5% significance level.

Table 13: Profits (trillion yen)

	Current profit		Business profit	
	Sum	% change	Sum	% change
All banks	-5.257	-	5.447	-14.2
City banks	-3.482	-	2.365	-10.1
Regional banks	-0.241	-	1.398	5.0
Regional II	-0.462	-	0.480	-6.0
Trust banks	-0.410	-	0.678	-48.1
Long-term banks	-0.661	-	0.526	-8.0

Source: Disclosed balance sheets

Table 14: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
JPY does not Granger Cause LOANS	4.275*	0.024
LOANS does not Granger Cause JPY	2.478	0.101

* - denotes rejection of the Null hypothesis at 5% significance level.

Table 15: Effectiveness of the Intervention

	1997-1998	1997	1998
β_0	0.023767	0.079144	-0.01347
β_1	0.175601	-0.0054	0.241927
β_2	-0.0012	-0.0038	-0.00183
β_3	-0.00044	0.00223	-0.00058
β_4	-0.00836	-	-0.01959
β_5	-0.01145	-0.01680	-0.00575

Table 16: Impact of Intervention on BANKS, TOPIX and JP

	BANKS	TOPIX	JP
Constant	0	3.75E-13	-2.42E-17
Intervention (coefficient)	1.38E-13	-1.40E-13	-4.24E-17

Table 17: Impact of the Public Fund Injection

	BANKS	TOPIX	JP
Constant	0	3.75E-13	-2.42E-17
Public Fund Injection (coefficient)	1.14E-13	-1.59E-13	-3.64E-17