

# Japanese Journal of Monetary and Financial Economics

## ■ Inaugural introduction

.....Naoyuki Yoshino

## ■ Invited articles

An Injection of Base Money at Zero Interest Rates: Empirical Evidence from  
the Japanese Experience 2001–2006

.....Yuzo Honda, Yoshihiro Kuroki, and Minoru Tachibana

Coping with Capital Inflow Surges: Reviewing the IMF's New 'Institutional View'

.....Akira Ariyoshi

Are Chinese Stock Investors Watching Tokyo? International Linkage of Stock  
Prices Using Intraday High-Frequency Data

.....Yoshiro Tsutsui and Kenjiro Hirayama

Japanese Banking Regulations and SME Finance under the Global Financial Crisis

···Nobuyoshi Yamori, Kazumine Kondo, Kei Tomimura, Yuko Shindo, and Kenya Takaku

## ■ Articles

Required Return on Investment and Its Financing

.....Yukitami Tsuji

## **Inaugural Introduction**

Naoyuki Yoshino, Keio University, Japan

Editor in Chief, Japanese Journal of Monetary and Financial Economics

This journal is a publication from the Japan Society of Monetary Economics (JSME). In 1987-1990, Japan suffered from the asset price bubble, which led to a severe banking crisis. During this period, some foreign economists criticized Japan's economic policy. However, studying the US subprime loan crisis showed that there are parallels between the banking behavior of Japan and the US. After the burst of the bubble in Japan, the non-performing loan problem took a considerable amount of time to be resolved. This problem experienced by Japan served as a learning point for the US and Europe, who adopted a better policy to face their own economic crises. Currently, China seems to be experiencing an asset price bubble in its stock and property markets. Japan on the other hand, is facing serious challenges such as the ageing population and the reduction of households' savings rate. However, it is expected that China and several other Asian countries will follow Japan's economic path in the near future. In the early 2000s, Zero interest rate policy and quantitative easing policy were introduced in Japan for the first time. Japan's monetary and government policies for banks and other financial institutions have often been criticized by outsiders. However, Japan is experiencing various crises prior to other countries. There have been many studies on these crises in Japan. However, many of these works were written in Japanese, which made it difficult for the researchers in other countries to understand the Japan's economic situation. The objectives of this journal are to inspire various papers that analyze monetary and financial subjects in Japan and Asia, and to urge the birth of various discussion topics related to monetary and financial issues. This journal will be recognized not only in Japan, but also in China, Korea and many other Asian countries. The editorial board intends to invite papers from various countries that study monetary and financial economics.



## **An Injection of Base Money at Zero Interest Rates: Empirical Evidence from the Japanese Experience 2001–2006\***

**Yuzo Honda**

Kansai University

2-1-1 Ryozenji-cho, Takatsuki-shi, Osaka 569-1095, Japan

E-mail:honda@res.kutc.kansai-u.ac.jp

**Yoshihiro Kuroki**

Chiba University

1-33 Yayoi-cho, Inage-ku, Chiba-shi 263-8522, Japan

**Minoru Tachibana**

Osaka Prefecture University

1-1 Gakuen-cho, Nakaku, Sakai, Osaka 599-8531, Japan

### **ABSTRACT**

Many macroeconomists and policymakers have debated the effectiveness of further injection of base money at zero short-term interest rates. This paper takes up the Japanese experience of the quantitative monetary-easing policy (QMEP) that was conducted in 2001—2006. In particular we measure the effect of the QMEP on aggregate output and prices, and examine its transmission mechanism, based on the vector autoregressive (VAR) methodology. To ascertain the transmission mechanism, we include several financial market variables in the VAR system. The results show that the QMEP increased aggregate output through the stock price channel. This evidence suggests that further injection of base money is effective even when short-term nominal interest rates are at zero.

**Keywords:** Quantitative easing; Money injection; Portfolio rebalancing; Stock price channel; Vector autoregression

**JEL Classification:** E44; E52

## 1. Introduction

The bursting of bubble in U.S. housing markets, together with high leverage by financial institutions, triggered the instability of the financial system in 2008, and put credit conditions extremely tight in the U.S. The turmoil in financial markets was extended to the real sector of the economy especially after the bankruptcy of Lehman Brothers in September 2008, and the economy has weakened dramatically.

In order to cope with the deteriorating economic conditions, the Federal Reserve (Fed) decided to establish a target federal funds rate of 0 to 1/4 percent on December 16, 2008. The Fed also made it clear to purchase large quantities of agency debt and mortgage-backed securities to provide support to the mortgage and housing markets. The Fed called their operation “credit-easing policy”, emphasizing their activity on the asset side of their balance sheet.

On the other hand, when the Bank of Japan (BOJ) continued to inject a massive quantity of base money to the economy for the period from March 2001 to March 2006 to overcome a long-lasting economic slump and deflationary pressures, the BOJ chose the current account balance (CABs) held at the BOJ as its operating target. Their operating target was on the liability side of their balance sheet. To this extent, the Fed’s policy adopted on December 2008 was different from the BOJ’s policy for the period from March 2001 to March 2006, but these two policies are very similar to each other in that they inject ample liquidity into the economy, even though short-term nominal interest rates are zero or almost zero. We call this policy of injecting a massive quantity of base money to the economy under zero or almost zero short-term interest rates quantitative monetary-easing policy (QMEP) in this paper.

The most serious question which the monetary authorities face in conducting QMEP is whether or not expanding monetary base is effective when short-term nominal interest rates fall to zero. There are two distinct views on this question. The first view at least dates back to Hicks (1937), who shows in his famous IS-LM model that an increase in money supply has no effect if the interest rate is at its lower bound, because money and bonds are perfect substitutes (that is, a liquidity trap happens in this case). Eggertson and Woodford (2003) also show the ineffectiveness of the QMEP by analyzing a dynamic general equilibrium model.

The second view, on the other hand, advocated by Bernanke and Reinhart (2004), Bernanke, Reinhart and Sack (2004), and Clouse, Henderson, Orphanides, Small, and Tinsley (2003), argues that, even when short-term nominal interest rates are at zero, increases in monetary base might be effective through the *portfolio rebalancing effect* and the *signaling effect* (we will explain these two effects in the next section).

Both of these two lines of thought are logically correct under their respective assumptions, and yet their conclusions are opposite to each other. The question is, therefore, an empirical matter. Unfortunately, however, there are little empirical data to test these two distinct hypotheses. The only exception is the recent Japanese experiences from March 2001 to March 2006. This paper will contribute to such arguments by empirically analyzing the Japanese experience in 2001–2006, which provides a good opportunity to examine the impact of the further injection of liquidity at zero interest rates.

In this paper, we use the standard vector auto-regressive (VAR) methodology. Since the purpose of this paper is to assess the effect of the QMEP, not to estimate and evaluate a macroeconomic model under zero interest rates, we choose a VAR approach rather than a dynamic, stochastic, general-equilibrium (DSGE) approach. The VAR approach allows us to gauge the effect of the QMEP with minimum restrictions on the macroeconomic model structure.

We first estimate a minimal VAR model, which consists only of output, prices, and the monetary policy instrument. This examination provides a preliminary assessment about the effect of the QMEP on the two key macroeconomic variables, aggregate output and prices. The estimation result shows that a quantitative-easing shock increases output, but it has little effect on the price level.

This result raises the question of the transmission mechanism through which the QMEP affected the output level. If the QMEP worked through the *portfolio rebalancing effect* or the *signaling effect*, financial market variables would play an important role in transmitting these effects. Therefore, we next add each of several financial variables to the above three-variable VAR to investigate the transmission mechanism of the QMEP. The financial variables we consider are short- to long-term nominal interest rates, stock prices, foreign exchange rates, and bank lending. From these four-variable VAR estimations, we find that the QMEP was effective through the stock price channel.

Furthermore, in order to check the robustness of the stock price channel, we control for the effects of several factors that the above four-variable VARs do not incorporate. The following four factors are considered: increases in the BOJ's outright purchase of long-term government bonds; introduction of the BOJ's purchase of stocks held by the commercial banks; large increases in the value of exports; and large decreases in the outstanding amount of nonperforming loans (NPLs) of the banking sector. They might have some effects on the economy, independent of increases in monetary base. Therefore, we include each of these four factors in the VAR model to control for their possible effects. The estimation results show that the stock price channel is robust even if we control for these effects.

The remainder of the paper is organized as follows. Section 2 gives an overview of the QMEP adopted in Japan for the 2001–2006 period, discusses the possible effects of the QMEP, and surveys the related empirical literature. Section 3 explains our VAR models, identification strategy and data. Section 4 reports the estimation results for the three- and four-variable VARs. Section 5 estimates alternative VAR specifications that control for the effects of the above-mentioned four factors. Section 6 offers concluding remarks.

## 2. Background

### 2.1. Overview of the QMEP

Even though the BOJ kept lowering the call rate during the 1990s and eventually adopted the zero-interest-rate policy in February 1999, the Japanese economy could not escape from the prolonged stagnation and deflationary pressures that occurred from the bursting of the asset price bubble in the early 1990s.<sup>1,2</sup> In March 2001, the BOJ introduced the QMEP to create a further monetary-easing environment under the situation where the call rate was almost zero. The BOJ changed its operating target from the call rate to the current account balances (CABs) held at the BOJ, and it continued to inject ample liquidity into the CABs beyond the level needed to maintain the call rates at zero.<sup>3</sup> The target level of the CABs was publicly announced immediately after every monetary policy meeting. Table 1 describes dates of policy changes (the left column) and announced targets of the CABs (the middle column). The CAB target increased eight times from 5 trillion yen at the introduction of the QMEP to 30–35 trillion yen in January 2004.

Table 1  
Policy Changes during the QMEP Period

Dates of policy changes	Announced targets of the CABs (trillion yen)	Values of the CAB target variable (trillion yen)
19 March 2001	Introduction of QMEP	
19 March 2001	5	5 (March 2001 to July 2001)
14 August 2001	6	6 (August 2001)
18 September 2001	Above 6	8 (September 2001), 8.7 (October 2001), 9.3 (November 2001)
19 December 2001	10–15	12.5 (December 2001 to September 2002)
30 October 2002	15–20	17.5 (October 2002 to March 2003)
30 April 2003	22–27	24.5 (April 2003)
20 May 2003	27–30	28.5 (May 2003 to September 2003)
10 October 2003	27–32	29.5 (October 2003 to December 2003)
20 January 2004	30–35	32.5 (January 2004 to February 2006)
9 March 2006	Termination of QMEP	

On 1 April 2003, the BOJ raised the CAB target to 17–22 trillion yen for necessary adjustment due to the establishment of the Japan Post.

At first, the BOJ promised that it would continue the QMEP until the year-on-year rate of change in the consumer price index excluding perishables (core CPI) became stably zero or above. Then, in October 2003, the BOJ provided a more detailed description of the commitment: it would maintain the QMEP until (1) not only the most recently published core CPI inflation became zero or above, but also such tendency was confirmed over a few months, and (2) the future core CPI inflation was not be expected to register below zero percent.<sup>4</sup> Since October 2005, core CPI inflation rates have been zero or positive, which satisfied the first condition in the commitment statement. Furthermore, the BOJ judged that future inflation rates would remain positive due to a steady economic recovery at that time, which satisfied the second condition in the commitment statement. Under this environment, the BOJ terminated five years of the QMEP in March 2006.

## *2.2. Possible Effects of the QMEP and Related Empirical Literature*

There are some empirical studies measuring the effect of the QMEP in Japan. Bernanke et al. (2004), Okina and Shiratsuka (2004), and Oda and Ueda (2007) show that the QMEP was effective in shifting the yield curve downward. In particular, Okina and Shiratsuka (2004) and Oda and Ueda (2007) argue that this downward shift of the yield curve was caused by the *policy-duration effect*.<sup>5</sup> The *policy-duration effect* means that the central bank's commitment to keeping the policy rate at zero can stabilize market expectations for the path of short-term interest rates and hence reduce long-term interest rates. Therefore, their findings suggest that the QMEP worked through the commitment to maintaining the zero-interest-rate policy.

Measuring only the *policy-duration effect*, however, is not enough to understand the effects of the QMEP completely. In the QMEP period, the BOJ had provided abundant money by increasing the CAB target several times, even though short-term nominal interest rates were already at the zero lower bound. As discussed in Bernanke and Reinhart (2004), Bernanke et al. (2004), and Clouse et al. (2003), such further expansions of base money might have an impact on economic activity through the *portfolio rebalancing effect* and the *signaling effect*.

The *portfolio rebalancing effect* stems from the assumption that there are several assets that are imperfect substitutes for each other. Even if short-term securities and money are perfect substitutes because of a zero short-term interest rate, money and other assets may be imperfect substitutes. Then, the additional supply of base money will cause investors to try to change their portfolios. This portfolio rebalancing will, in turn, raise prices (or reduce yields) of the assets, thereby stimulating economic activity. The idea of the *portfolio rebalancing effect* is based on the classic literature such as Brunner and Meltzer (1963) and Tobin (1969), in which multiasset

models were used for the analysis of monetary policy. Although the *portfolio rebalancing effect* might occur even in normal times when nominal interest rates are positive, it would be more important in the low-interest-rate period because the *liquidity effect* would diminish or disappear under such a situation.

The *signaling effect* occurs if an increase in monetary base reinforces the signal about the central bank's intention of keeping short-term interest rates at zero. In this case, the QMEP can stabilize public expectations of the future paths of short-term interest rates and thereby decrease longer-term interest rates. The lower interest rates will, in turn, provide stimulus to economic activity. Note that the *signaling effect* plays a role in enhancing the *policy-duration effect* by increasing monetary base at zero interest rates.

The empirical literature investigating the effect of the further injection of monetary base under a zero-interest-rate environment includes Kimura and Small (2004), Oda and Ueda (2007), Kimura et al. (2002), and Fujiwara (2006).

Kimura and Small (2004) and Oda and Ueda (2007) limit their research to the effect on financial markets. Kimura and Small (2004) examine the *portfolio rebalancing effect* and find that the expansion of the CABs caused lower risk premiums on high-grade corporate bonds, while it had the adverse effects of raising risk premiums on stocks and low-grade corporate bonds. Oda and Ueda (2007) find that the expansion of the CABs was effective in lowering medium- to long-term yields of Japanese government bonds through the *signaling effect*, but it was ineffective through the *portfolio rebalancing effect*. However, these two studies do not measure the effect on macroeconomic variables.

Based on the VAR approach, Kimura et al. (2002) and Fujiwara (2006) examine the effect of increases in base money on the two key macroeconomic variables, aggregate output and prices. They show that an expansion of base money at zero interest rates only slightly increases the output and price levels, suggesting little evidence for the effectiveness of the QMEP.

This paper also investigates the effect of base money increases on aggregate output and prices, using the VAR methodology. However, our approach differs from Kimura et al. (2002) and Fujiwara (2006) in two points. First, our sample covers the whole QMEP period and excludes the pre-QMEP period (2001M3–2006M2 in our research, but 1985Q3–2002Q1 in Kimura et al. (2002) and 1985M1–2003M12 in Fujiwara (2006), where Q and M denote quarterly and monthly frequencies of data, respectively). Extending the sample period to the end of the QMEP allows us to obtain more accurate estimates for the effect of the QMEP. Excluding the pre-QMEP period would also lead to more accurate estimates because the QMEP is a different regime from the earlier monetary policy, in that the BOJ's operating target is changed from the

call rate to the CABs. To avoid the issue of the regime change, Kimura et al. (2002) estimate a VAR with time-varying coefficients and Fujiwara (2006) adopts a Markov switching VAR method. In spite of these efforts, using only the implementation period of the QMEP seems to be the most appropriate approach for the investigation of the impact of additional money at zero interest rates.

Second, we examine the transmission mechanism of the QMEP more carefully and comprehensively. Other than the macroeconomic variables of prices, output, and the policy instrument (monetary base and call rate), no variable is included in Kimura et al. (2002) and only the yield on 10-year government bonds is included in Fujiwara (2006) (maybe because they obtain the result that the QMEP had no effect on output and prices, and there is no need to consider the transmission mechanism). If the QMEP was effective through the *portfolio rebalancing effect* or the *signaling effect*, then financial market variables would play an important role in transmitting these effects. For the *signaling effect*, short- to long-term nominal interest rates are key transmitting variables. For the *portfolio rebalancing effect*, those assets that are imperfect substitutes for money are all candidates for the transmitting variable. Therefore, we examine the transmission mechanism of the QMEP by including several financial variables in the VAR model.

### 3. VAR Model, Identification, and Data

Here we estimate two types of the VAR model to assess the effect of the QMEP. The first model is a minimal one that includes only output, prices, and the monetary policy instrument. This three-variable VAR provides a preliminary evaluation of the impact of a quantitative-easing shock on the two key macroeconomic variables, aggregate output and prices. As will be seen later, the estimated impulse response functions show that a quantitative-easing shock generates persistent increases in the output level.

However, its transmission mechanism is still unclear from the estimation of the three-variable VAR. To find out the transmission mechanism, we next estimate several four-variable VARs, each of which includes one of financial market variables as well as the above three variables. The financial variables we consider are short- to long-term nominal interest rates, stock prices, foreign exchange rates, and bank lending.<sup>7</sup> Through the *portfolio rebalancing effect* or the *signaling effect*, the QMEP might lower nominal interest rates, raise stock prices, or depreciate the yen, all of which would stimulate economic activity. In addition, commercial banks might increase their loans based on the additional money obtained by transactions with the BOJ in its

open market operations. For these reasons, we adopt these financial variables as possible transmitting variables, and add them one-by-one to the VAR model.

The lag length is set equal to two months for all VAR models, which is selected based on the Akaike information criterion for the baseline three-variable VAR (the maximum lag length is set equal to six months).<sup>8</sup>

To identify monetary policy shocks, we use a recursive strategy (that is, the Cholesky decomposition). This is the simplest identification scheme and hence has been used in several studies in the VAR literature. As described in the previous section, this paper is the first attempt to deal with the whole QMEP period and to investigate the transmission mechanism comprehensively. Thus, it seems to be plausible to employ this widely used identification strategy for our VAR models. For the three-variable VAR, we place the variables in order of output, prices, and the monetary policy instrument. This ordering assumes that the BOJ sees current output and prices when it sets the policy instrument, but that output and prices only respond to a policy shock with one lag. For the four-variable VAR, each financial variable is ordered last, implying that financial markets respond to a policy shock with no lag. This ordering is essentially the same as Christiano et al. (1996), Edelberg and Marshall (1996), Evans and Marshall (1998), and Thorbecke (1997), which place the VAR variables in order of macroeconomic variables, monetary policy variables, and financial variables.<sup>9</sup>

The frequency of our data is monthly and the sample period is from March 2001 to February 2006.<sup>10</sup> The measure of output is the index of industrial production (IIP). The measure of prices is the core CPI, which is the most crucial variable in the BOJ's commitment statement to maintain the QMEP.<sup>11</sup> As the measure of the monetary policy instrument, we use the BOJ's target of the CABs. See the right column in Table 1 for values of the CAB target variable. When the announced target of the CABs is a range rather than a level (six cases out of nine policy changes), we take a middle point of the range as a value of the CAB target variable. For the period from September 2001 to November 2001 when the announced target of the CABs is "above 6 trillion yen", we use the monthly average of the actual daily CABs (8 trillion yen in September 2001, 8.7 trillion yen in October 2001, and 9.3 trillion yen in November 2001).<sup>12</sup> We also use the monthly average of the actual daily CABs for the period before March 2001, which serve as the initial data for the VAR estimation (4.8 trillion yen in January 2001 and 4.3 trillion yen in February 2001). Our data of nominal interest rates are the London Interbank Offered Rates (LIBOR) with maturities of 1, 3, 6, and 12 months and the swap rates with maturities of 2, 3, 5, 7, and 10 years. The measures of stock prices, foreign exchange rates, and bank lending are, respectively, the Nikkei Stock Average, the real effective exchange rate, and the total amount of

loans and discounts of all banks.<sup>13</sup> All data except for nominal interest rates are transformed in logarithm and multiplied by 100.<sup>14</sup> More detailed information about the data is provided in the appendix. Finally, Figure 1 displays the time series of the data used in this paper.

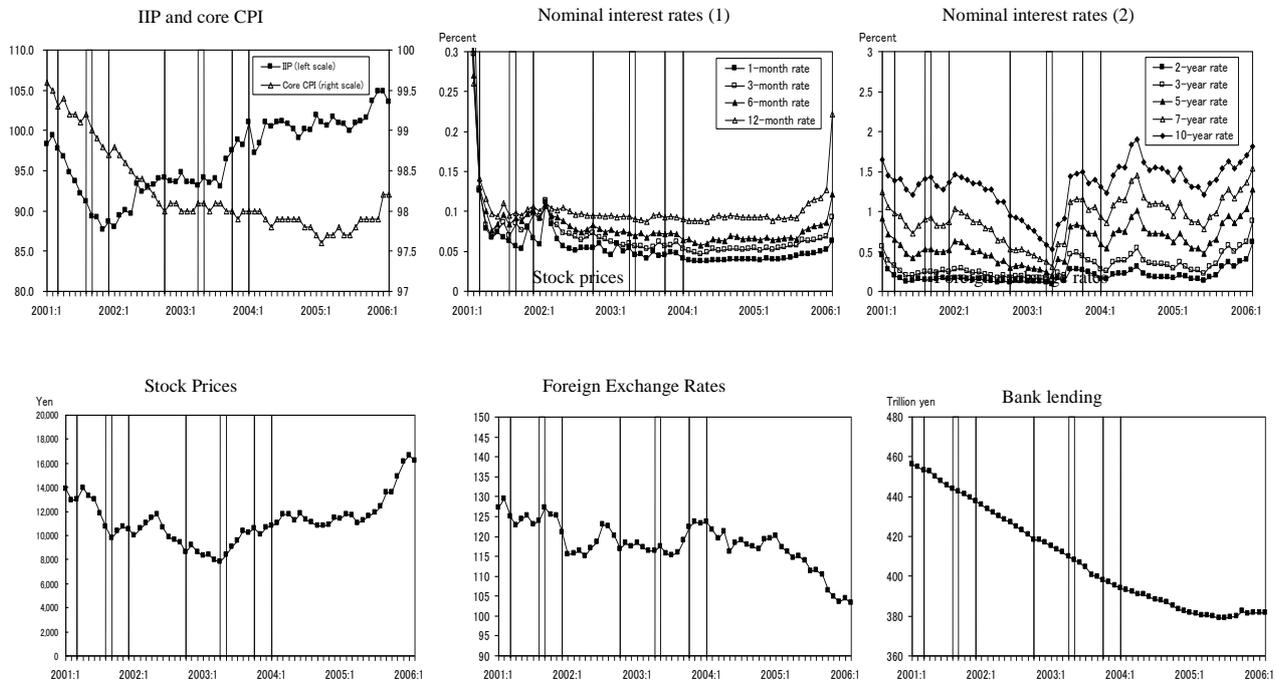


Figure 1  
Time Series Data

The figure displays the time series of the data used in the estimation. The vertical lines indicate the months when the BOJ changed the CAB target.

## 4. Empirical Results

### 4.1. A Three-variable VAR

We first estimate the simplest three-variable VAR that consists of IIP, core CPI, and the CAB target. Figure 2 displays all estimated impulse responses to a one-standard-deviation shock to each variable. The first to third columns represent the dynamic responses of the three variables to an IIP shock, a CPI shock, and a quantitative-easing shock, respectively. The solid lines represent the point estimates of impulse response functions, and the dotted lines denote plus and minus two-standard-error bands computed by Monte Carlo simulation with 500 repetitions.

There are three interesting points to be noted in Figure 2. First, a quantitative-easing shock generates persistent increases in output. In response to a quantitative-easing shock, IIP begins to increase from the second month and then peaks at the eighth month (the response of IIP at the first month is negative, but very small and insignificant). Notably, the positive response of IIP is statistically different from zero at the seventh and eighth months. In the next subsection, we will

examine the transmission mechanism through which the policy shock increases the output level. Second, the response of core CPI to a quantitative-easing shock is very small and not statistically different from zero throughout the period. Although the BOJ introduced the QMEP in order to escape from deflationary environment, we cannot see the statistical evidence that it succeeded in raising general prices. Third, the CAB target increases (decreases) in response to a negative (positive) core CPI shock, while it hardly reacts to an IIP shock, implying that the BOJ placed more emphasis on prices rather than output. This result is consistent with the BOJ's commitment statement, in which the two necessary conditions to terminate the QMEP refer only to the recent and expected future rates of inflation, but do not refer to real economic activity.

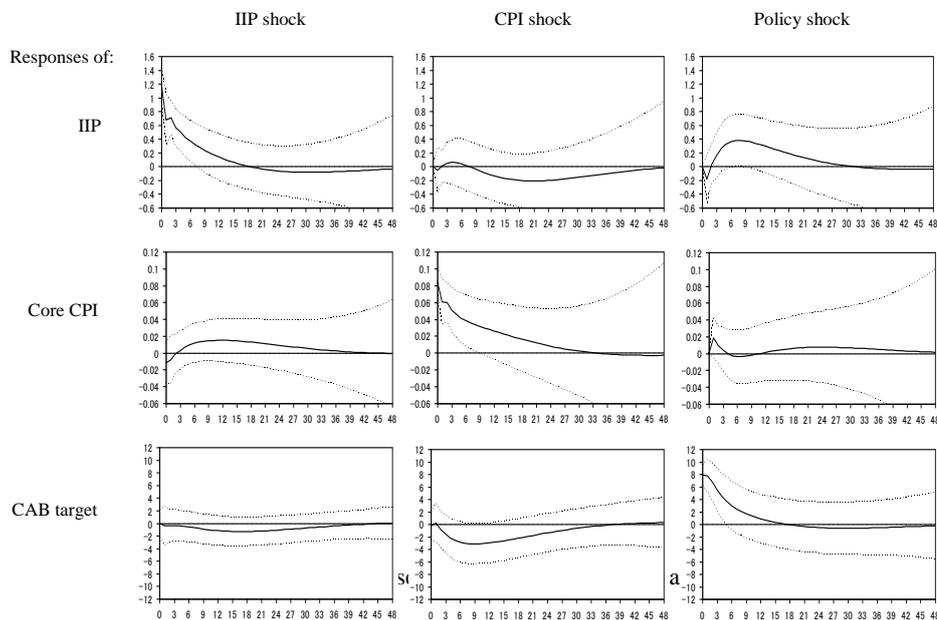


Figure 2  
Impulse Response Functions for the Three-variable VAR

The figure displays the estimated impulse response functions for the three-variable VAR, consisting of IIP, core CPI, and the CAB target. The dotted lines denote two-standard-error bands.

#### 4.2. Transmission Mechanism

Although we have found that the QMEP was effective in increasing the output level, the transmission mechanism is still an open question. We here investigate the transmission mechanism by estimating several four-variable VARs, each of which includes one of financial market variables.

Figure 3 displays the dynamic response of each financial variable to a quantitative-easing shock. Charts A to I present the estimated dynamic responses of nominal interest rates with various maturities and Charts J to L provide those of stock prices, foreign exchange rates, and bank

lending, respectively. First note that standard-error bands become extremely wide from a certain period in most charts. This would be due to a small number of observations relative to the large number of parameters to be estimated in the four-variable VAR. Nonetheless, standard-error bands appear to be relatively narrow for a short period of time (within about a year after a policy shock), implying that our empirical results are reliable at least about the short-run effect of the QMEP. Therefore, we will hereafter focus our discussion on the short-run impact of the policy shock.

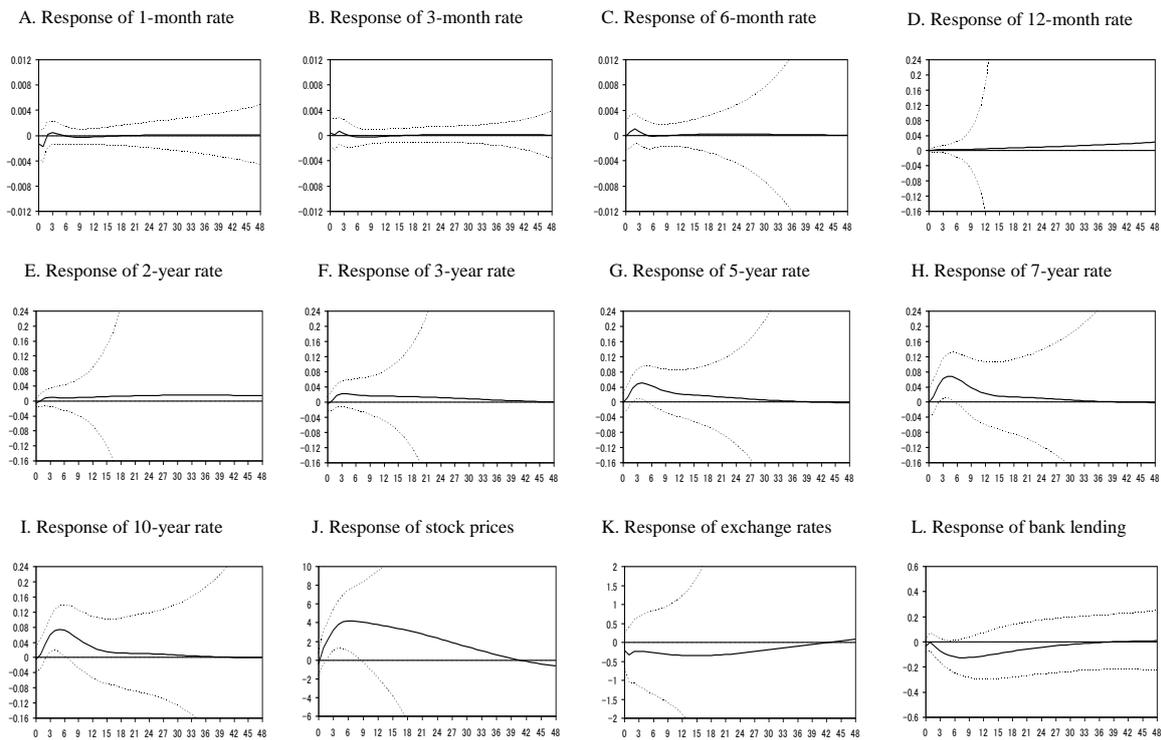


Figure 3  
Effects of Quantitative Easing Shocks on Financial Variables

Each chart displays the dynamic effects of a quantitative easing shock on a financial variable. The impulse response function is estimated from the four-variable VAR, consisting of IIP, core CPI, the CAB target, and a financial variable. Financial variables used include nominal interest rates with various maturities, stock prices, foreign exchange rates, and bank lending. The dotted lines denote two-standard-error bands.

The most notable result in Figure 3 is that a quantitative-easing shock raises stock prices persistently (see Chart J). The positive response of stock prices is statistically different from zero for between the second and eighth months. Hence, it is likely that the QMEP was effective through the stock price channel (we will later report all impulse response functions for the four-variable VAR with stock prices included and discuss the existence of the stock price channel). On the other hand, Charts A to I show that nominal interest rates do not decline in response to a

quantitative-easing shock (only the 1-month rate declines in the first two months, but the effect is very small and insignificant). Rather, positive responses are observed for long-term interest rates, and the longer the maturity is, the larger the positive response is. In Chart K, a quantitative-easing shock depreciates the yen (note that declines in effective exchange rates imply the depreciation of the yen). However, the depreciation is not statistically significant throughout the period. In Chart L, bank lending decreases rather than increases in response to a quantitative-easing shock.

Summarizing these results, a quantitative-easing shock significantly raises stock prices and slightly depreciates the yen, both of which would stimulate economic activity, while the policy shock raises nominal interest rates and decreases bank lending, which provide no stimulus.

At first glance, these results seem to be strange because short- to long-term interest rates do not decline and bank lending does not increase in response to a quantitative-easing shock. However, these results are consistent with the idea of the *portfolio rebalancing effect* and can be interpreted as follows.<sup>15</sup> With additional money from the BOJ, investors (including banks) intended to decrease an interest-bearing asset component (including bank lending) in their portfolios, increase an equity component considerably, and increase a foreign asset component slightly. Such investors' behavior can be explained by the Japanese financial market conditions for the QMEP period: the yields (prices) of interest-bearing assets were near zero (at very high levels); stock prices were at the lowest levels since the late 1980s; domestic financial assets yielded lower returns than foreign assets; and the banking sector suffered from the NPL problem. Under these circumstances, investors might feel that holding interest-bearing assets had a higher risk than holding equities or foreign assets, and therefore they might seek to rebalance their portfolios in such a way that they held more equities and foreign assets, and held less interest-bearing assets, when they received further liquidity from the BOJ. In addition, the result that the response of interest rates is larger at the longer end of maturities implies that investors intended to sell more long-term interest-bearing assets than short-term assets, because of the concern about rises in the future interest rates.

Our results also imply that the *portfolio rebalancing effect* dominates both the *liquidity effect* and the *signaling effect* for the QMEP period, because if either of the latter two effects occurs, nominal interest rates decline in response to a quantitative-easing shock. If nominal interest rates deviate from the lower bound as in normal times, the *liquidity effect* would dominate and the yields (prices) of several assets would move in the same direction in response to a monetary policy shock. However, we have found that the yields (prices) of several assets moved in the different direction in response to a quantitative-easing shock. This suggests that the *liquidity*

*effect* diminishes or disappears, and the *portfolio rebalancing effect* becomes significant in the low-interest-rate period.<sup>16</sup>

Our findings with regard to the effect of the QMEP on financial markets are different from Kimura and Small (2004) and Oda and Ueda (2007). Kimura and Small (2004) obtain the result that the QMEP raised risk premiums on stocks (lowered stock prices) through the *portfolio-rebalancing effect*. Oda and Ueda (2007) find that the expansion of the CABs lowered medium- to long-term interest rates through the *signaling effect*. These conflicting results stem from the differences in sample period, data frequency, and estimation method. Kimura and Small (2004) use daily data and regress risk premiums of stocks on the CABs and other relevant variables for the period 1/21/2000–6/30/2003 (or 1/21/2000–3/31/2004). Oda and Ueda (2007) estimate a simple macroeconomic model for the period 1980Q1–1999Q1 and use a macro-finance approach to decompose nominal interest rates into expectations and risk premium components for the period 1995Q1–2005Q1. And then, they regress a variable indicating the commitment effect for each component, on the CABs and other relevant variables for the period 1995Q1–2005Q1 (or 1996Q3–2005Q1).

We have found that it is better to include stock prices in the VAR model to capture the dynamics of the Japanese economy for the QMEP period. Figure 4 displays all impulse response functions for the four-variable VAR, which consists of IIP, core CPI, the CAB target, and stock prices. Interestingly, IIP shows a slower response than the stock price response: in response to a quantitative-easing shock, IIP begins to increase from the second month and peaks at the ninth month, while stock prices begin to rise from the first month and peak at the sixth month. This result suggests that there exists the stock price channel for the QMEP period. There are four possible channels through which higher stock prices boost the output level: an increase in consumption through a rise in households' wealth (the wealth effect); an increase in investment through higher Tobin's  $q$ ; an increase in bank lending through a decline in the external finance premium of borrowers (the balance sheet effect); and an increase in bank lending through an improvement in the banks' capital-to-asset ratios. Considering the result that a quantitative-easing shock does not increase bank lending (see Chart L in Figure 3), we suspect that the last two channels might have been weak and either or both of the first two channels mainly worked in the QMEP period.

There are three other remarkable findings in Figure 4. First, a quantitative-easing shock raises core CPI, but the response is very small and insignificant throughout the period as with the case of the three-variable VAR, suggesting that the QMEP had little effect on the price level. Second, the CAB target increases (decreases) not only in response to a negative (positive) core CPI

shock but also in response to a negative (positive) stock price shock. Third, a positive shock to stock prices raises IIP with the statistical significance in the second and third months.

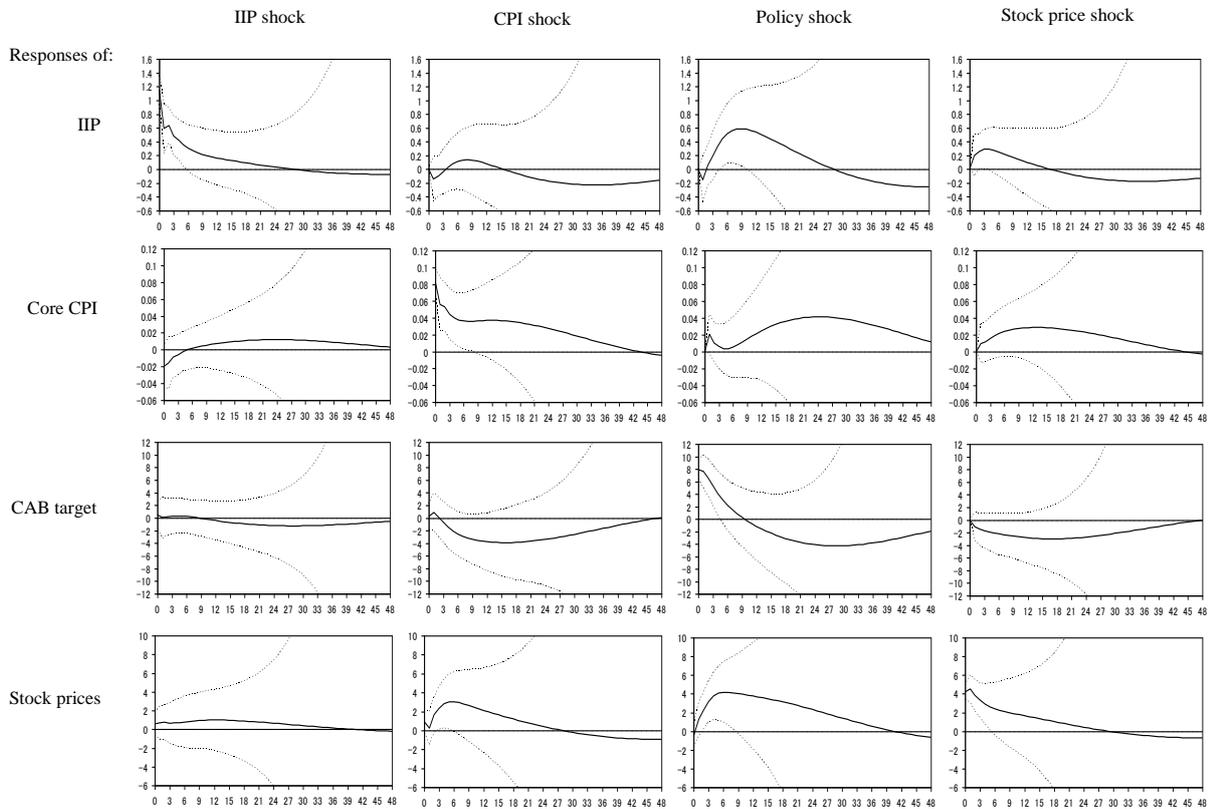


Figure 4  
Impulse Response Functions for the Four-variable VAR

The figure displays the estimated impulse response functions for the four-variable VAR, consisting of IIP, core CPI, the CAB target, and stock prices. The dotted lines denote two-standard-error bands.

Table 2  
Percentage of Forecast Error Variance Explained by Monetary Policy Shock

Variable	Period		
	2	6	12
IIP	1.14 (2.71)	16.48 (10.82)	40.89 (16.11)
Core CPI	3.75 (4.65)	2.79 (5.82)	6.67 (9.39)
CAB target	97.38 (6.06)	86.91 (11.53)	61.20 (17.40)
Stock prices	10.51 (8.42)	34.40 (13.19)	45.59 (14.34)

The table reports the percentage of the variance of the 2-, 6-, and 12-months-ahead forecast errors in IIP, core CPI, the CAB target, and stock prices that are accounted for by monetary policy shocks. The variance decomposition is conducted for the four-variable VAR, consisting of IIP, the CAB target, and stock prices. The standard errors are reported in parentheses.

Next, we conduct the variance decomposition analysis. Table 2 reports the results for the four-variable VAR with stock prices included. The value in the table denotes the percentage of the variance of the 2-, 6-, and 12-months-ahead forecast errors that are accounted for by monetary

policy shocks. The standard errors, computed by Monte Carlo simulation with 500 repetitions, are reported in parentheses. Monetary policy shocks account for a significant part of the volatility of IIP and stock prices (41% and 46% of the 12-months-ahead forecast error variance of IIP and stock prices, respectively). On the other hand, monetary policy shocks account for only a small part of the volatility of core CPI (only 7% of the 12-months-ahead forecast error variance of core CPI). Thus, monetary policy shocks are a major contributor to fluctuations of aggregate output and stock prices, but they are unimportant for explaining the fluctuation of general prices.

Table 3  
P-value for Granger Causality Test

From CAB target to:		From stock prices to:	
IIP	0.21	IIP	0.05
Core CPI	0.06	Core CPI	0.24
Stock prices	< 0.01	CAB target	0.39

The table reports p-values for the Granger causality test. The test is performed for the four-variable VAR, consisting of IIP, core CPI, the CAB target, and stock prices. The left column presents p-values for the test of the null hypothesis that the CAB target does not Granger-cause IIP, core CPI, and stock prices. The right column presents p-values for the test of the null hypothesis that stock prices do not Granger-cause IIP, core CPI, and the CAB target.

Finally, we perform the Granger causality test. Table 3 reports the results of the Granger causality test (F-test) for the four-variable VAR including stock prices. The left column presents *p*-values associated with the test of the null hypothesis that the CAB target does not Granger-cause IIP, core CPI, and stock prices. The right column provides *p*-values for the test of the null hypothesis that stock prices do not Granger-cause IIP, core CPI, and the CAB target. In the left column, the null hypothesis that the CAB target does not Granger-cause stock prices can be rejected at the 1% significance level, suggesting that there is a Granger-causality from the CAB target to stock prices. In the right column, the null hypothesis that stock prices do not Granger-cause IIP can be rejected at the 6% significance level, suggesting that there is a Granger-causality from stock prices to IIP. Therefore, the results of the Granger causality test complement evidence of the stock price channel found from the estimated impulse response functions.

## 5. Alternative Specifications

### 5.1. Controlling for the Effects of Alternative Policy Tools

In the QMEP period the BOJ conducted two unconventional policies other than expanding the CABs. One is the increases in the outright purchase of long-term government bonds (OPLTGBs). The target amount of the OPLTGBs per month was gradually increased from 400

billion yen to 600 billion yen in August 2001, to 800 billion yen in December 2001, to 1 trillion yen in February 2002, and to 1.2 trillion yen in October 2002. The other policy is the purchase of stocks held by commercial banks. This policy was conducted from November 2002 to September 2004, and the value of purchased stocks amounted to about 2 trillion yen in September 2004. According to the public announcement, the BOJ did not aim to stimulate economic activity directly by introducing these two policies. In fact, the BOJ expanded the amount of the OPLTGBs to achieve the increased CAB target smoothly. The BOJ also began to purchase the stocks held by commercial banks to reduce the risk pertaining to the shareholdings of the banks, who suffered from the serious NPL problem. However, in spite of such BOJ's intentions, these two policies might have effects on output, prices or stock prices, independent of the increases in the CAB target. Thus, in this subsection, we control for such possible effects so as to check the robustness of our results obtained in the previous section.

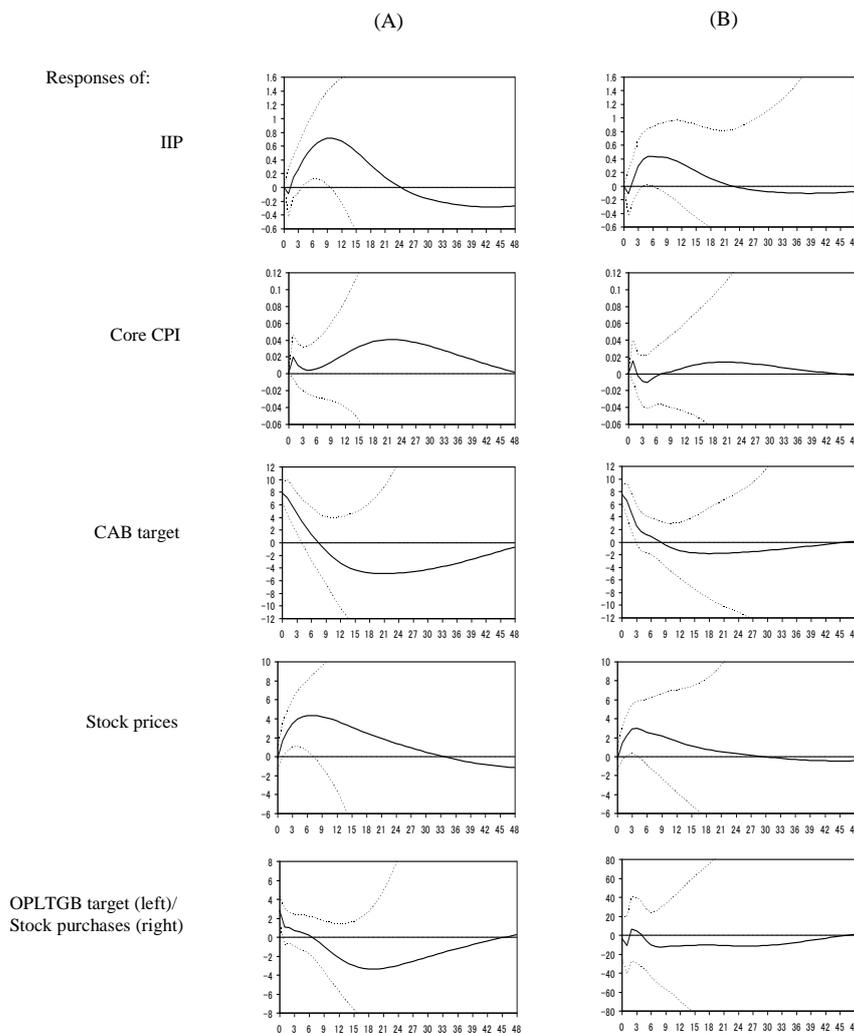


Figure 5  
Effects of Quantitative Easing Shocks with Two Alternative Policy Measures Included

Column (A) displays the dynamic effects of a quantitative easing shock estimated from the five-variable VAR, consisting of IIP, core CPI, the CAB target, stock prices, and the OPLTGB target. Column (B) displays those estimated from the five-variable VAR, consisting of IIP, core CPI, the CAB target, stock prices, and BOJ's stock purchases. The dotted lines denote two-standard-error bands.

To this end, either the target amount of the OPLTGBs or the total amount of the purchased stocks (both transformed in logarithm and multiplied by 100) is added to the four-variable VAR with stock prices.<sup>17</sup> In each VAR model, an additional variable of the alternative policy measure is ordered just after the CAB target. Column (A) in Figure 5 displays the dynamic responses of the VAR variables to a quantitative-easing shock for the five-variable VAR model, which consists of IIP, core CPI, the CAB target, stock prices, and the OPLTGB target. We find that the shapes of the impulse response functions do not change compared with those in the third column in Figure 4, and that there is still evidence of the stock price channel. Column (B) in Figure 5 displays the corresponding results for the five-variable VAR in which the OPLTGB target is replaced by the total amount of the purchased stocks. Inclusion of the purchased stocks appears to change the shapes of the impulse response functions. In particular, the positive responses of IIP and stock prices become much smaller. Nevertheless, they are statistically different from zero for some periods, and stock prices show an earlier response than IIP. Therefore, we can still see evidence of the stock price channel even in this case.<sup>18,19</sup>

## *5.2. Controlling for the Effects of Alternative Contributors to Economic Recovery*

The economic recovery experienced in the QMEP period seems to be attributable not only to the QMEP of the BOJ but also to the following two alternative factors: the large increases in the values of exports due to strong overseas economy; and the large decreases in the outstanding amount of NPLs of the banking sector. In this subsection, we control for the possible effects of these two factors to check the robustness of our results. For this purpose, we add to the four-variable VAR with stock prices either the export values or the outstanding amount of NPLs (both transformed in logarithm and multiplied by 100).<sup>20</sup> The measure of exports is ordered first since it depends on foreign economic activities (that is, treated as most exogenous), and the measure of the outstanding amount of NPLs is ordered last since it is a financial sector variable (that is, treated as most endogenous).

Column (A) in Figure 6 displays the dynamic responses of the VAR variables to a quantitative-easing shock for the five-variable VAR with exports included, and column (B) displays the corresponding results for the five-variable VAR with NPLs included. The estimated impulse response functions are somewhat different from the third column in Figure 4: in column (A), the response of core CPI is larger and the response of stock prices is more persistent; and in column

(B), the responses of IIP, core CPI, and stock prices are smaller. However, for both VAR specifications, the positive responses of IIP and stock prices are statistically different from zero for some periods and stock prices exhibit an earlier response than IIP. Therefore, we can still see evidence of the stock price channel even if we control for the effects of exports and NPLs.<sup>21</sup>

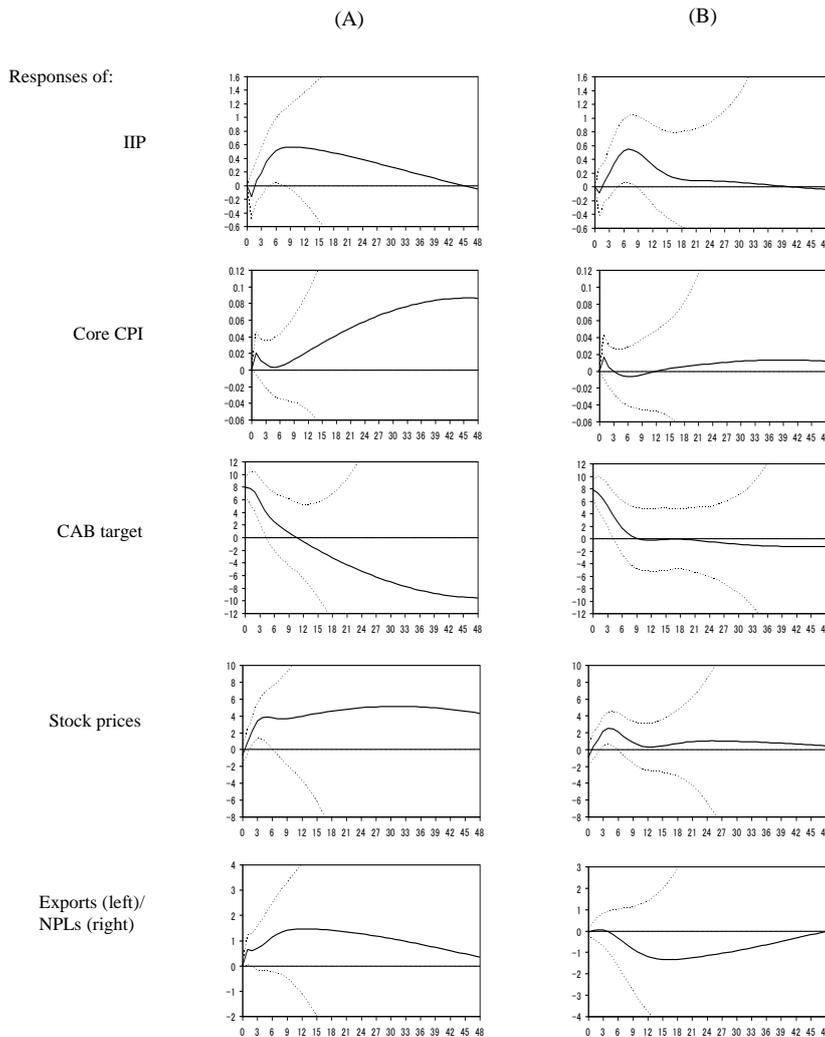


Figure 6  
Effects of Quantitative Easing Shocks with Exports and NPLs Included

Column (A) displays the dynamic effects of a quantitative easing shock estimated from the five-variable VAR, consisting of IIP, core CPI, the CAB target, stock prices, and exports. Column (B) displays those estimated from the five-variable VAR, consisting of IIP, core CPI, the CAB target, stock prices, and NPLs. The dotted lines denote two-standard-error bands.

There are two other interesting findings from Figure 6. First, in column (A), a quantitative-easing shock increases exports persistently (but the response is not statistically significant throughout the period, except for the first month after a policy shock). As seen in Chart K of

Figure 3, a quantitative-easing shock depreciates the yen (but the depreciation is also insignificant). Therefore, the QMEP might be effective through the exchange rate channel, though the evidence is not strong enough to be supported statistically.<sup>22</sup> Second, in column (B) a quantitative-easing shock generates persistent declines in NPLs (but the response is insignificant throughout the period). Interestingly, the negative response of NPLs appears to be slower than the IIP response, suggesting that the QMEP contributed to the decreases in NPLs by boosting the Japan's real economy.

## 6. Concluding Remarks

Many macroeconomists and policymakers have discussed whether the further injection of monetary base at zero interest rates is effective. This paper has addressed this issue by examining the effect of the QMEP implemented in Japan for the 2001–2006 period. Using the VAR approach, we have found that the QMEP stimulated real economic activity through the stock price channel: in the impulse response function analysis, a quantitative-easing shock firstly raises stock prices and then increases the output level; in the variance decomposition analysis, monetary policy shocks account for a significant part of the volatility of output and stock prices; and in the Granger causality test, the target level of the CABs Granger-causes stock prices, and stock prices in turn Granger-cause the output level. All of the above results suggest the existence of the stock price channel.

We have also found that evidence of the stock price channel is robust, even if we control for the effects of two alternative policies of the BOJ (the increases in the outright purchase of long-term government bonds and the introduction of the purchase of stocks held by commercial banks) and even if we control for the effects of two alternative contributors to the economic recovery (the large increases in exports and the large declines in NPLs).

The results obtained in this paper have two implications. First, multiasset models would be useful when we discuss the effectiveness of monetary policy under the situation of low interest rates. Usual two-asset models such as the IS-LM model include only money and bonds. Such two-asset models implicitly assume that the yields (prices) of several assets move in the same direction in response to a monetary policy shock. However, we have found that the yields (prices) of several assets moved in the different direction in response to a quantitative-easing shock. This finding implies that the *portfolio rebalancing effect* becomes significant in the low-interest-rate period. For this reason, we need to build and use multiasset models that take into

account the *portfolio rebalancing effect*, in order to examine the effect of monetary policy in the low-interest-rate period.<sup>23</sup>

Second, the Japanese economy might not have fallen into a *liquidity trap* in the QMEP period. *Liquidity trap* is defined as the situation where people spend no money to purchase non-monetary assets and thus money demand is infinitely elastic, when the nominal interest rate is at its lower bound. Our empirical evidence is consistent with the liquidity trap hypothesis in that people did not spend injected money to purchase bonds. However, our findings also imply that people used injected money for the purchase of stocks, which is inconsistent with the liquidity trap hypothesis. Therefore, even if short-term interest rates are zero, it does not necessarily mean that a *liquidity trap* occurs. At least in the recent Japanese case, there was room for monetary easing, even though short-term interest rates were zero.

### Data Appendix

Variable	Description	Source
IIP	Seasonally adjusted series, 2000 average = 100	Website of Ministry of Economy, Trade and Industry
Core CPI	Seasonally adjusted series, 2000 average = 100	Website of Ministry of Internal Affairs and Communications
LIBOR (1, 3, 6, 12 months)	JPY, end of month	Website of British Bankers' Association
Swap rates (2, 3, 5, 7, 10 years)	Yen-yen, average of offered and bid rates, end of month	NEEDS Financial QUEST
Nikkei Stock Average	End of month	Website of BOJ
Real effective exchange rate	March 1973 = 100	Website of BOJ
Bank lending	Loans and discounts of banks, seasonally adjusted by using Census X-12	Website of BOJ
BOJ's stock purchases	Total amount of purchased stocks reported in BOJ's accounts, end of month	Website of BOJ
Exports	Balance of payments, seasonally adjusted series	Website of Ministry of Finance
NPLs	Based on the definition in the Financial Reconstruction Law, all banks	Website of Financial Services Agency

### ACKNOWLEDGEMENTS

\*We would like to thank Mikio Araki, Kazumi Asako, Yuichi Fukuta, Masaharu Hanazaki, Ryuzo Miyao, Masaki Nakabayashi, Katsuyuki Takiguchi, Hisashi Yaginuma, and participants at the Japanese Economic Association Annual Meeting held at Osaka Gakuin University and seminars held at Osaka University and Development Bank of Japan for helpful comments and discussions. We also thank Takayuki Ugomori for his research assistance. Honda gratefully acknowledges funding by the 21st Century Center of Excellence Program and the Global Center of Excellence Program at Osaka University by the Japanese Ministry of Education, Culture, Sports, Science and Technology. The original version of this paper was made public as a discussion paper in Honda et al.(2007) in English, and then in Honda et al.(2010) in Japanese. Policy Research Institute, Ministry of Finance generously allows us to reprint the Japanese

version in this form. Also Toshiki Jinushi and Yutaka Kurihara made arrangements to publish our paper in this Journal, which we greatly appreciate.

### NOTES

1. The call rate is a short-term interbank rate, like the federal funds rate in the United States. The BOJ has used the uncollateralized overnight call rate as a policy instrument except for the QMEP period.
2. In August 2000, the BOJ terminated the zero-interest-rate policy with the judgment that deflationary pressures receded due to the economic recovery, and it raised the call rate to 0.25. However, faced with the subsequent deterioration in Japan's economy, the BOJ lowered the call rate to 0.15 in February 2001.
3. The CABs include not only reserve balances but also deposits of other financial institutions (e.g. securities companies) that are not subject to the Reserve Requirement System.
4. The BOJ also stated that these two conditions were the necessary condition and that, even if these two conditions were fulfilled, it might maintain the QMEP depending on the economic situation.
5. Fujiki and Shiratsuka (2002), Okina and Shiratsuka (2004), and Oda and Ueda (2007) also report evidence of the presence of the *policy-duration effect* for the period of the zero-interest-rate policy (from February 1999 to August 2000).
6. When the central bank supplies money to the private sector, the nominal interest rate declines until supply and demand of money rebalance. This effect is called "liquidity effect" in this paper.
7. There is little VAR literature studying the impact of the Japanese monetary policy on financial markets even for the period when short-term nominal interest rates are positive. Braun and Shioji (2006) investigate the relationship between monetary policy and the yield curve. Miyao (2000) includes foreign exchange rates in the VAR system while Miyao (2002) uses stock prices.
8. Using alternative lag lengths of one, three, and six months did not essentially change the results, but impulse response functions with six lags showed jagged shapes, suggesting that the number of parameters to be estimated is too large relative to the number of observations.
9. We obtained similar results even when four-variable VARs were estimated with alternative six orderings, (P, Y, M, F), (Y, P, F, M), (M, Y, P, F), (M, F, Y, P), (F, Y, P, M), and (F, M, Y, P), where P, Y, M, and F denote prices, output, the monetary policy instrument, and a financial variable, respectively.
10. We exclude March 2006 from the sample period because the QMEP was implemented for only a short time in this month (it terminated on March 9, 2006).
11. The Ministry of Internal Affairs and Communications started to release the 2005-base CPI from August 2006, instead of the 2000-base CPI. The 2005-base CPI surprised markets due to a large downward revision of the CPI inflation rate for July 2006. The differences between the two measures also seem to be large for the QMEP period. For example, the inflation rate for February 2006 computed from the 2000-base (seasonally adjusted) core CPI is 0.6 percent, but that computed from the 2005-base is 0.0 percent. We here use the 2000-base core CPI, because the BOJ and market participants perceived it as a true measure of general prices for the QMEP period and they behaved based on it (for example, if the 2005-base CPI had been available to the BOJ in March 2006, the QMEP would not have been terminated in this month).
12. The daily data of the CABs are obtained from the Financial QUEST of Nikkei Economic Electronic Databank System (NEEDS).
13. We checked the robustness of our results to the use of alternative measures, which include the *actual* level of the CABs, yields on 10-year government bonds, the Tokyo Stock Price

Index (TOPIX), *real* stock prices (deflated by core CPI for both Nikkei Stock Average and TOPIX), *nominal* effective exchange rates, and *real* bank lending (deflated by core CPI). Even when we estimated the VARs using them one-by-one instead of a baseline measure, we obtained similar results.

14. We estimate the VAR in levels, since it yields consistent estimates even if each variable is nonstationary (see Hamilton (1994, pp. 651–653)).
15. There are alternative interpretations for the responses of interest rates and bank lending. The positive responses of interest rates may reflect an increase in inflation expectation (the *Fisher effect*). For the negative responses of bank lending, the QMEP did not increase bank lending, but it might have mitigated the downward pressure on bank lending. In fact, bank lending had decreased for the entire QMEP period (see Figure 1), which was caused by the weak demand (due to excess debt, excess capacity and excess employment on firms) and by the weak supply (due to the NPL problem and low capital-to-asset ratios on banks).
16. Note that our results do not necessarily deny the existence of the *policy-duration effect* found by Okina and Shiratsuka (2004) and Oda and Ueda (2007). The yield curve shifted downward through the *policy-duration effect*, but our results imply that “increases in base money” could not move the yield curve further down.
17. The BOJ reports the total amount of the purchased stocks for the period from December 2002 to September 2004. We set its values before this period equal to zero (in logarithm). We also set the values after this period equal to the value in September 2004, because the BOJ did not sell the stocks during the QMEP period.
18. With regard to the impacts of these two alternative policy measures on output, prices, and stock prices, we could not find clear evidence indicating the presence of their effects.
19. To save space, here we do not report the results of the variance decomposition and the Granger causality test in table form. However, these results support the existence of the stock price channel for both five-variable VARs: in the variance decomposition analysis, monetary policy shocks account for at least more than 20% of the 12-months-ahead forecast error variance of IIP and stock prices; in the Granger causality test, we can reject the null hypothesis that the CAB target does not Granger-cause stock prices and also reject the null hypothesis that stock prices do not Granger-cause IIP at conventional significance levels.
20. Since the NPL data are only available for end-March and end-September in each year, we use the interpolation method to construct the monthly data of NPLs.
21. The results of the variance decomposition and the Granger causality test also support the presence of the stock price channel, except for one case (the null hypothesis that stock prices do not Granger-cause IIP cannot be rejected even at the 10% significance level for the five-variable VAR with exports).
22. Even when the exchange rate was added to this five-variable VAR, we obtained results suggesting the existence of the exchange rate channel (but the evidence is not strong enough to be supported statistically).
23. Andrés et al. (2004) develop a multiasset model which includes both short- and long-term bonds.

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**Coping with Capital Inflow Surges:  
Reviewing the IMF's New 'Institutional View'**

Akira Ariyoshi<sup>1</sup>  
Hitotsubashi University  
2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8439  
Email: aariyoshi@ics.hit-u.ac.jp

**ABSTRACT**

This paper reviews the IMF's recently published 'institutional view' on capital flows management, focusing on its views on the management of capital inflow surges. The IMF's acceptance of the use of capital controls and other capital flow management measures (CFMs) in certain circumstances, is a step forward. However, we argue that the IMF's recommendations as to when CFMs may be legitimately used are difficult to apply in practice, as it is difficult to ascertain whether the conditions that the IMF prescribes are fulfilled, such as whether exchange rates are overvalued. Moreover, the premise that macroeconomic and other measures should be preferred over CFMs, and that any CFMs should therefore be temporary, targeted and transparent, are unduly restrictive. We argue that CFMs could be particularly useful and appropriate in a financial environment where global push factors rather than country specific factors tend to be the dominant drivers of capital flows, and that CFMs should be considered as a potentially useful policy in the toolkit, on par with other policy measures.

**Keywords:** Capital Flows, Capital Control, International Monetary Fund

**JEL Classification:** F32; F33

## **1. Introduction**

The International Monetary Fund (IMF) recently published what it defines as the ‘institutional view’ on the liberalization and management of capital flows (IMF 2012a). The published view codifies its stance on these contentious issues, on which its view has been evolving gradually over the past decade or so. The IMF view is important because it represents a ‘consensus’ view of the international policy community, on which policy advice and surveillance by the IMF will be based. The view will also shape the debate on the design of the international monetary system. Some have heralded this new view as representing a ‘substantial ideological shift’ (Beattie 2012), but while welcome, the changes appear incremental and is underpinned by continued skepticism towards the use of capital control measures. This paper will review the IMF’s new policy stance on the management of capital flows, and argue that while the IMF view offers a consistent conceptual framework to guide policy, the actual implementation is not straightforward, and that capital control measures should have a more important role to play than suggested by the IMF.

The IMF’s institutional view covers capital account liberalization as well as management of capital inflow and outflows. However, this paper will focus on the management of capital inflows into emerging markets. Capital inflow surges have posed serious challenges for emerging markets in recent years. Against the background of aggressive monetary easing by the monetary authorities of major currencies combined with periodic bouts of financial uncertainty, global capital flows have shown large volatility, characterized by the so-called ‘risk-on’ and ‘risk-off’ episodes that reflect shifts in market risk appetite. This has resulted in strong upward pressure on the exchange rate and asset prices during ‘risk-on’ periods from inflow surges, while sudden stops or reversals of inflows in ‘risk-off’ periods have resulted in heightened volatility of exchange rate and asset prices.

## **2. The IMF’s Institutional View**

The IMF recognizes that excessive inflows can lead to financial and economic volatility as well as build-up of vulnerabilities, and acknowledges that countries may need to respond to these inflow surges. It summarizes its advice on what policy measures may be used to manage capital inflows surges, as follows (IMF 2012a):

- ‘Allowing the currency to strengthen if it is not overvalued relative to fundamentals.’
- ‘Lowering interest rates in the absence of overheating or asset price inflation.’
- ‘Intervening in the foreign exchange market to accumulate international reserves if reserves are not more than adequate.’

It is only when these options are not available does the IMF acknowledge that countries may legitimately employ capital flows management measures (CFMs). The IMF defines CFMs to encompass not just residency based restrictions on capital account transactions (i.e., traditional capital control measures), but also other measures that such as prudential financial regulations that are specifically designed to limit capital flows though not necessarily tied to residency.<sup>2</sup> The IMF would prefer countries to deploy macroeconomic and exchange rate policies where possible, and considers CFMs to be policies of last resort.<sup>3</sup> Moreover, the IMF places further restraint on the use of CFMs by urging countries to be ‘transparent, targeted and temporary’ and to be ‘non-discriminatory’ between residents and non-residents in the event that they resort to these measures.

The IMF’s position raises a number of issues. The first question is whether the IMF framework provides a clear guidance on whether to use CFMs or not in a specific setting. The second question is whether CFMs should be considered as a policy instrument of last resort, as the IMF paper implies. The third question is whether CFMs should be used restrictively in a transparent, targeted and temporary fashion, as well as being non-discriminatory. We shall review these issues in turn.

### *2.1 Clarity of Guidance*

The three conditions for the use of CFMs, namely overvalued exchange rates, no overheating and more than adequate reserves, seem fairly straightforward. But in practice, they are quite difficult to judge definitively. Consider the judgment on whether a currency is overvalued. As discussed in some detail in the appendix, it is difficult provide a clear-cut answer to this question, even when using the IMF’s own methodology on exchange rate evaluation.

Similarly, the existence of overheating, especially whether there is an asset price bubble, is difficult to judge. Since asset prices reflect expectation of the future, it is difficult to say whether expectations that are embodied in current prices are overly optimistic. Excessive credit growth is widely considered as a factor that could be used to judge the existence of overheating, but rapid credit growth may also occur in the process of financial deepening, so that this indicator may not be as reliable as indication of potential overheating.

Judging the adequacy of foreign reserves is also problematic. There are a number of popular criteria, ranging from the traditional 3 months of imports, the Greenspan-Guidotti rule of 100 percent coverage of short-term debt, to percentage (20% sometimes cited) of M2. Not only do these different criteria produce a wide range of numbers, but the criteria themselves are essentially rules-of thumb without much theoretical or empirical underpinning. The IMF

(2011a) has proposed a risk based index that attempts to combine and expand the idea behind the existing metrics and link it to observed vulnerabilities during crisis. But the exercise remains exploratory and the IMF admits that there may be country specific factors that are not adequately captured in the model. It may nonetheless be noted that for some countries in Asia, the actual reserve level is well above the levels based on any reasonable criteria, so if one takes the view that intervention should not be undertaken when there is clearly excess reserves, then it may be a useable guideline for these countries.

When it is not clear whether condition for deployment of each measure is met, countries will be faced with shades of grey rather than a black and white answer as to whether, following IMF advice, it may legitimately resort to CFMs.

## *2.2 Should CFMs be Policy Instruments of Last Resort?*

Beyond the feasibility of application of the IMF advice, there is a more fundamental issue of whether CFMs are inherently inferior to other measures. The IMF's recommendation that other measures be considered over CFMs implies that they are regarded as being more costly, less effective or creating greater negative spillovers. This position seems somewhat biased, in that it emphasizes the shortcomings of CFM measures without comparing them with costs and benefits of other measures. Let us consider the various aspects in turn.

### *2.2.1. Costs*

In terms of costs, as the IMF view itself acknowledges, any policy measure is bound to have some costs. Allowing a large and sudden appreciation would result in some existing businesses becoming unprofitable, generating stranded costs for businesses and leading to increased unemployment which could be difficult to be absorbed rapidly by other sectors, resulting in high short-run costs to the economy.<sup>4</sup> Moreover, greater exchange rate variability in itself imposes costs to the economy even when the exchange rate is not apparently overvalued. Volatility of exchange rates generates uncertainty about the profitability of investment in the tradables sector, and thus may lead to misallocation of resources in the form of underinvestment in that sector.

The use of interest rate policy may also have costs. A reduction in interest rates to offset the deflationary impact from strengthening exchange rates may be appropriate to some extent, but in an inflation targeting framework, employing monetary policy to stabilize exchange rates may confuse the objective of monetary policy and reduce the credibility of the central bank.

Holding of international reserves could generate the quasi-fiscal costs of carrying international reserves (i.e. the difference between the domestic interest rate and the interest rate on reserves, when the former exceeds the latter) as well as possible capital losses in the event of local currency appreciation. There are also possible opportunity costs of investing in low-yielding foreign assets rather than in productive domestic investment, which is typically thought to generate a higher real return in emerging market economies. However, it should be noted that these costs exist regardless of the level of reserves, and costs should be judged against the benefits of insurance provided by the reserves and the reduced volatility of exchange rates achieved through intervention. It is also useful to note that a country may also invest in less liquid but higher yielding foreign assets through sovereign wealth funds, which will tend to reduce the quasi-fiscal costs of holding reserves.

As with any regulation, CFMs could impose costs on the economy. The IMF cites a number of possible costs, including the possibility that they ‘reduce discipline in financial markets and public finances, tighten financing constraints’ and notes that CFMs can be ‘costly to monitor and enforce, promote rent-seeking behavior and corruption, and facilitate repression of the financial sector’ (IMF 2012a). It is worth noting that the former observation does not apply in the case of CFMs introduced in response to inflow surges, as excessive inflows is what is loosening funding constraints.

Then, on surface, it is not obvious that CFMs should be considered to be more costly when compared with other measures. Perhaps the IMF’s true concern can be inferred from their repeated warning that CFM’s should not substitute for necessary macroeconomic policies, namely that endorsing capital controls too readily may encourage countries to avoid taking unpopular but necessary decisions.

### *2.2.3 Spillovers*

The costs above pertain to those that impact the countries adopting the measures. The IMF also considers the possible spillovers to other countries, so that even if a measure may be desirable from a domestic perspective, the negative spillovers to other countries might argue for moderation of their use. In the case of CFMs, the potential spillover could come from deflection of flows to other countries.

Again, other measures could also have spillover effects. Generally, any policy by a country to counter inflows will necessarily result in some deflection of flows to other countries and/or relative depreciation vis-à-vis other inflow receiving countries that do not take countermeasures.

### *2.2.2 Effectiveness*

Whatever the costs of CFMs and other measures, they need to be judged against the benefits from these measures; namely whether the measures are effective. This cannot be judged a priori, as effectiveness will depend on a host of factors including country conditions and external environment, as well as response of the private sector and expectations regarding policy.

Again, it is worth noting that all of the policies proposed are subject to uncertainty as to their effectiveness:

- Appreciation may lead to expectation of further appreciation and thus encourage further inflows. (Band wagon effect.)
- Lower interest rates may increase asset prices, and lead to more capital inflows.
- Sterilized intervention does not fundamentally change the basic attractiveness of domestic assets. (There might be the need to continue intervening, even if effective in keeping appreciation in check.)

With CFMs, experience suggests that effectiveness could be a major issue (Ariyoshi et.al., 2000). Capital controls may easily be circumvented, especially in an open economy with developed financial markets, while prudential measures can also suffer from reduced effectiveness through attempts by sophisticated financial institutions to circumvent regulations. In order to ensure effectiveness, the measures may need to be broad based and possibly even draconian, but such a measure will have large side effects in that they will also restrict economically desirable flows and transactions. Indeed, beyond any consideration of costs, lack of effectiveness with targeted capital control measures is a major reason why advanced economies have been reluctant to use capital control measures.

### *2.2.3 Drivers of flows*

An important factor that will bear on the choice of policy measures is the driver of flows. If the main driver of inflow surges is external environment that temporarily ‘pushes’ capital into a country, then it will not be optimal for the country to adjust its own macroeconomic or structural policies, as policies taken to suppress inflows will not be based on domestic needs. A better strategy may be to absorb the inflows through sterilized intervention or to deploy CMFs to limit the inflows directly. Also, measures that directly respond to the problem are preferable to indirect measures that attempt to limit the secondary spillovers (such as build-up of vulnerabilities), as they may also impose negative side effects.

When the source of the inflows is ‘pull’ due to expected high returns on domestic assets, or when external environment causing the ‘push’ is more permanent, structural or macroeconomic responses may be required as a sustainable response. Nonetheless, CFMs may be warranted when inflows exceed the ability of the economy to absorb these flows productively. (See section 2.3 below on whether such measures may be a permanent feature.)

#### *2.2.4. CFMs as a Standard Policy in the Toolkit*

The above considerations suggest that CFMs should not be considered as being fundamentally inferior to other measures in formulating policy response to capital inflow surges. Rather, they should be options that are available to countries in all circumstance, including in cases where the IMF view does not endorse their use. To the extent that our understanding of the likely effectiveness, costs and the causes or duration of the flows is limited, a strategy of relying on a limited set of measures is neither optimal nor desirable. In that sense, while the IMF acknowledges that capital controls and other CFMs are policies ‘in the toolkit’, its insistence that they be used when other option are not available, thus effectively putting it at the bottom of the toolbox, reduces the flexibility in employing policies.

#### *2.3 Should CFMs be Temporary, Targeted, Transparent and non-discriminatory?*

While the recommendations for CFMs to be temporary implicitly assumes that any flows that are the result of structural factors should be accepted, there could be cases when more permanent measures are desirable from a macroeconomic perspective. Suppose a country is expected to maintain high growth and high rate of return over some time; then with an open capital account, capital inflows will occur to equalize the domestic and global real rate of return. Capital inflows will continue until the domestic real rate of return declines or real exchange rates appreciates sufficiently to create an expectation of real depreciation, or a combination of both occurs, so that the expected risk-adjusted rate of return on domestic and foreign investment is equalized. As the required degree of reduction in real rates or real appreciation is likely to be vary large, what is likely to happen in practice is that the increased investment and/or substantial appreciation generates a high enough risk premium to offset the difference between the expected rate of return on domestic investment and the global return.

That increased vulnerabilities are necessary in order to produce the required risk premium is troubling, to say the least. In this case, it would be desirable for capital account liberalization to be delayed until the gap between domestic and global returns are sufficiently reduced, or, if the

country experienced an increased rate of return or a reduction in country risk premium under an open capital account, to reintroduce more permanent capital control measures.

Even when capital surges are seen to be temporary in nature, there may be grounds for not making CFMs temporary. CFMs require administrative infrastructure to manage effectively. Thus, a system that needs to be set up from scratch or one that is not utilized often will be hard to administer. This could argue for a more permanent measure (with intensities being adjusted) rather than a temporary measure.

On the issue of whether the measures should be targeted, one issue to consider is that if measures are narrowly targeted at a transaction or an instrument, the measures may be easily circumvented and result in being ineffective, while still causing distortions in that specific market. This could argue for measures with a broader scope rather than narrowly targeted measures, which are more difficult to circumvent and will result in smaller distortions being distributed across a wider spectrum of assets and transactions. A case in point is the experience in Indonesia,<sup>5</sup> where a minimum holding period regulation on short-term central bank paper led to deflection of flows to government bonds, resulting in sharp increases in external demand for bonds with concomitant instability in the government bond market. A narrowly targeted measure, on the other hand, is more likely to be successful in countries with less developed financial markets, where scope for arbitrage is smaller.

Transparency is usually preferable, but more transparent the measure, the easier it will be to devise transactions that circumvent controls. Authorities may have to play constant catch up with market developments, which could mean less predictability in regulations. Previous episodes of controls show that they were most effective when the precise rules were not clear (Ariyoshi et al., 2000). While it would not be desirable to deliberately create ambiguities, principle-based regulation/controls, where possible, may be more effective than a rules-based regulation/control. Such a principle-based regulation is more likely to be implementable when they are prudential measures that apply to a well-defined group of institutions such as banks, rather than with regulations that need to be applied across a broad spectrum of regulated and non-regulated agents.

Finally, on non-discrimination between residents and non-residents, while it is generally preferable for measures not to be discriminatory, it is not clear that one can, or even should attempt to have a superficially non-discriminatory rule, in cases where the flows that are targeted are non-resident's purchase of domestic assets. The policy objective is to manage the externally driven inflows, so that an effective rule must mean that it target non-residents; trying

to devise rules so that it covers residents equally can either make the rule less efficient or create side effects that restrict desirable transaction by residents.

### **3. Concluding Comments**

The IMF's continuing reluctance to endorse capital flow management measures except under certain circumstances and to implement them restrictively preserves the stigmatization of these otherwise potentially useful policy tools. It is true that there has been a tendency for some government to resort to capital controls even when fundamental adjustments in its own macroeconomic or structural policies are needed. However, much has changed over the last decade; with the growing integration of global capital markets, volatility that is caused by global factors rather than recipient country specific factors have become more common.

In these circumstances, managing capital flows at the border would be more desirable than attempting to mitigate the secondary detrimental impact of these flows in the domestic economy. Of course, it may well be the case that a country with open capital account and developed financial market will find it difficult to construct CFMs that are effective and not unduly restrictive. But there appears to be no need to put off considering the introduction of CFMs as a policy instrument that can be used by countries faced with challenges poses by large and volatile capital inflows.

## **APPENDIX**

### **Does the IMF's methodology give a reliable evaluation of currency misalignment?**

The IMF provides estimates of the 'equilibrium exchange rate' for many industrial and emerging market countries based on its CGER approach.<sup>6</sup> These estimates provide a benchmark for judging whether a currency is overvalued or not, and by extension, whether the country may legitimately resort to CFMs in the eyes of the IMF.

The estimates based on CGER are less precise than one would wish. The CGER methodology itself uses three separate methods that typically produce different estimates, and the IMF usually cites a range for the likely equilibrium exchange rate. It is not uncommon for this range to be wide as 10 to 20 percent and may encompass both overvaluation and undervaluation. Moreover, the estimates generated by the Macroeconomic Balance (MB) approach, which the IMF regards as the most reliable, is subject to large margins of error.

The MB approach first estimates the 'current account norm'; i.e. the current account deficit or surplus that a country 'should' have based on its economic characteristics. The estimate is based

on a cross country regression of the current account of countries, regressed on around ten variables that include demographic factors, country income and fiscal variables. It then assumes that any difference between the actual current account balance and this current account norm is due to exchange rate misalignment, and calculates, based on elasticities of trade with respect to exchange rates, how much change in effective real exchange rates is required to close this gap.

The main problems with this approach are that; first, it uses a point estimate of the predicted current account balance from the panel regression estimate as the current account norm, when the standard error of the regression is reported to be as much as 2 to 3.5 percent of GDP.

Second, the accuracy of the second step of deriving the actual extent of misalignment from the current account imbalance is also made uncertain by the fact that the elasticities of exports and imports are not known with certainty. The IMF only notes that it uses country specific estimates of elasticities, which makes it difficult to evaluate the reliability of the estimates of exchange rate misalignment. In an earlier article (Isard & Mussa, 1998), the IMF noted that it used a common elasticity of about 0.6, so that a 10 percent change in the real exchange rate will result in a correction of the current account by 0.6% of GDP when the trade/GDP ratio is 10 percent. Using the same trade elasticities, countries with higher trade/GDP ratio will show a proportionately larger adjustment relative to the same change in the real exchange rate; e.g. if the trade/GDP ratio were 30%, then a 10 per cent real exchange rate change will result in a 1.8 percentage point of GDP swing in the current account.

As the history of empirical work attempting to ascertain the validity of Marshall-Lerner condition shows, the estimates of elasticities themselves are subject to a wide margin of error. This means that there is a very large uncertainty in the extent of the estimates of misalignment, even if we accepted that the estimates of current account norm were accurate. At the extreme, if the current account balance were assumed to be very insensitive to the real exchange rate, the estimated degree of misalignment could be huge even for a small deviation of the current account from its estimated norm.

Notwithstanding the debate on whether one can judge misalignment, the estimate may be useful if it correctly predicted future large movements of the exchange rate; that is to say, if the country judged to be undervalued always experienced a large appreciation of the exchange rate in the following years, then it may make sense for a country not to try to buck this trend. Again, the evidence is mixed. An IMF staff study (Abiad, Kannan & Lee, 2009) shows that the performance of the estimated under- or over-valuation in predicting subsequent appreciation or depreciation respectively over the following three- to five-year horizon is not large: estimated

measure of misalignment from CGER gets the direction of subsequent movement right only about two-thirds of the time.

#### NOTES

1. The paper is based on a presentation made at a seminar ‘Managing Capital Flows: What Worked and Why’, jointly organized by Hitotsubashi University and the IMF Regional Office for Asia and the Pacific, held in Tokyo on May14-15, 2013. The author is grateful for the participants for the seminar for their comments and discussions on the presentation, including in particular to Mr. Marshall Mills of the IMF who presented the IMF’s view. Responsibility for any errors or perceived misrepresentations of the IMF view rests with the author.
2. Typical prudential measure targeted to influence capital flows include required reserve on foreign exchange borrowings by banks.
3. IMF staff stresses that the IMF does not consider CFMs to be measures of last resort, but that it also recognizes that they have a role to play, when for example macroeconomic adjustment takes time to take effect. Semantics aside, it seems clear that the IMF prefers other policy instruments over CFMs.
4. Counter-cyclical policy will compensate for the loss of aggregate demand from net exports and help the movement of resources into profitable sectors, but it will not be able to reduce the loss on existing capital nor fully avoid a temporary increase in unemployment.
5. See for example Annex IV in IMF (2011b).
6. Descriptions of the CGER approach include Isard and Mussa (1998) and IMF (2006). The IMF is currently developing a successor methodology to CGER called The External Balance Assessment (EBA) (IMF 2012b), but much of the limitations of CGER apply to EBA as well.

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## **Are Chinese Stock Investors Watching Tokyo? International Linkage of Stock Prices Using Intraday High-Frequency Data**

**Yoshiro Tsutsui**

Osaka University

1-7 Machikaneyama-cho Toyonaka Osaka 560-0043 Japan

E-mail: tsutsui@econ.osaka-u.ac.jp

**Kenjiro Hirayama**

Kwansei Gakuin University

1-155 Uegahara-1bancho Nishinomiya Hyogo 662-8501, Japan

E-mail: hiraken@kwansei.ac.jp

### **ABSTRACT**

Intraday minute-by-minute data of Tokyo and Shanghai stock exchanges from January 7, 2008, to January 23, 2009, are analyzed to investigate the interaction between the Japanese and Chinese stock markets. We focus on two windows of time each day during which the two stock exchanges trade shares simultaneously, and specify appropriate lags in vector autoregression (VAR) estimations. Granger causality tests, variance decompositions, and impulse response functions show that, while Tokyo is impacted by Chinese stock price movements, China is relatively isolated. This implies that investors in Japan are more internationally oriented and alert to foreign markets than those in China.

**Keywords:** International linkage of stock prices, High frequency data, Inefficiency, Overreaction, China

**JEL Classification:** G14; G15; F36

## **1. Introduction**

The growth of Chinese stock market has been phenomenal. In about two decades since its establishment in 1990, the market capitalization of the Shanghai Stock Exchange at the end of 2011 was roughly 3.34 trillion dollars, which trails Tokyo's 3.54 trillion dollars by a narrow margin, and Tokyo is second only to New York (15.64 trillion dollars).<sup>1</sup> China's stock market, as well as her economy, now exerts significant influence on other countries. When the Shanghai Composite Index dropped by 8.84% on February 27, 2007, it precipitated drops in stock prices in all the major stock markets of the world. However, this huge drop may have been a sign of weakness or inefficiency in the Chinese stock market. This inefficiency, if any, should affect not only Chinese investors, but also investors in other countries because of international linkage of stock prices as well as international portfolio holdings. To the best of our knowledge, the efficiency and performance of the Chinese stock market has not yet been examined in detail. In this paper, we attempt to shed light on this issue.

Our approach to this task is to focus on intraday interactions between the two countries' stock prices during overlapping trading hours. There is a substantial body of literature on the international linkage of stock prices (e.g., Jeon and von Furstenberg (1990), Hirayama and Tsutsui (1998), Masih and Masih (1999), Heimonen (2002), Bessler and Yang (2003), Worthington, Katsura, and Higgs (2003), and Darrat and Zhong (2005)). Almost all studies report on a bidirectional causality between pairs of stock prices. However, while Chinese stock prices are little affected by other markets, some major stock markets do respond to changes in Chinese stock prices (Huang, Yang, and Hu (2000), Groenewold, Tang, and Wu (2004), and Zhang (2008)).<sup>2</sup> This finding suggests that the Chinese stock market is isolated from others and that its efficiency may still be in a fledgling stage. We find the lack of response of Chinese stock prices to other markets interesting and worth exploring.

However, the existing studies that analyze stock price linkages between Japan and China utilize daily data, which has a following disadvantage. The stock markets of Tokyo and Shanghai both close at 3 pm local time, but due to a one-hour time difference, Shanghai actually closes one hour later than Tokyo. If one uses daily closing prices to investigate the stock price linkage between the two markets, one is faced with an asymmetry in detecting mutual influence. Since Shanghai closes just one hour after Tokyo, the effect of Tokyo on Shanghai is easily examined by comparing the two closing prices. But, the effect of Shanghai on Tokyo is observed with a 23-hour lag. In the meantime, we obtain new daily closing prices of other major markets in Europe and North America, which will affect the subsequent closing price in Tokyo. Namely, closing price in Tokyo is contaminated by new information from European and American

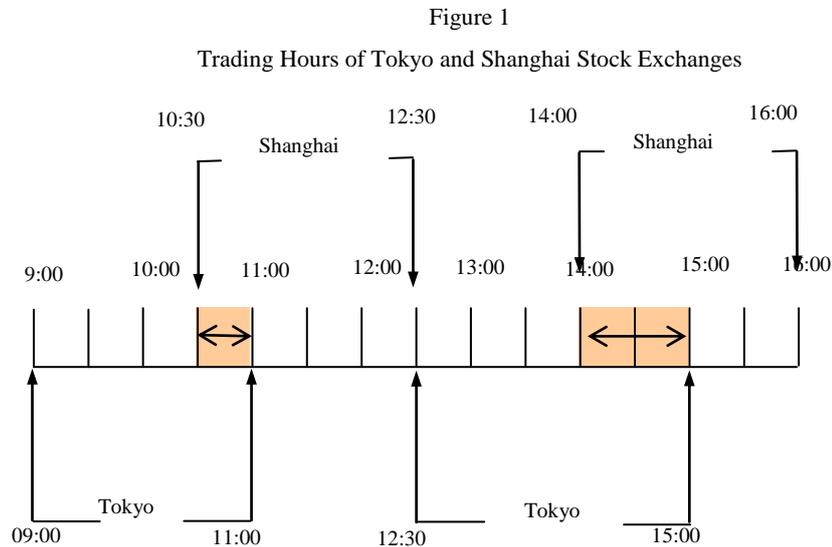
markets. It is not simple to extract the effect of China on Japan using daily data. Thus, the use of daily data is characterized by a strong asymmetry in detecting influence from Japan to China more clearly than the other way around.

Therefore, since the Japanese and Chinese stock exchanges are open at the same time, albeit for limited time periods each day, it is appropriate to use such real-time high-frequency data to explore stock price linkages between the two markets. As we will see in more detail later, the two markets are open simultaneously between 10:30 and 11:00 and between 14:00 and 15:00 JST each day. Since Japan is eight hours ahead of Europe and 14 hours ahead of the U.S., no markets in Europe and North America are open during these time periods. Thus, there is no influence from these markets on mutual interactions between Japan and China. Analyzing simultaneous high-frequency data of these two markets is ideal in exclusively focusing on their mutual interactions.

Despite this advantage of high-frequency data, there have been few studies utilizing such data to analyze simultaneous stock price linkages. To the best of our knowledge, there are only two papers that analyze intraday stock price indexes for several stock exchanges observed simultaneously (Černý and Koblas (2008) and Égert and Kočenda (2007)). Both analyze European markets, but neither pays sufficient attention to the following problems inherent in using high-frequency data. In the first place, we have to carefully select lagged values in estimating a vector autoregression (VAR) system. We usually select a time window each day in which all markets are open simultaneously. Observations on a certain stock price (or index) are chosen from these time windows and are joined consecutively to form one long time series. When a VAR is estimated with such a data series, each regression equation has many lagged values on the right-hand side. But, this estimation has a couple of problems as follows.

The trading hours of Tokyo and Shanghai are shown in Fig. 1. As is apparent from this figure, the overlapping trading hours between the two exchanges are from 10:30 to 11:00 and from 14:00 to 15:00 each day. Since we work with minute-by-minute returns, the actual time window is between 10:31 and 11:00 (30 observations) and between 14:01 and 15:00 (60 observations). A researcher would typically pick values from these time windows and join them to form one long time series data. When a VAR model is estimated, lagged values are extensively used on the right-hand side. Since each variable is observations during two time windows, i.e. between 10:31 and 11:00 and between 14:01 and 15:00, lagged values are falsely chosen from these windows in conventional VAR models. Then, the equation to explain a return at 10:31 in Tokyo has lagged values which are from the previous day. However, in the case of Tokyo returns, the true lags at 10:30, 10:29, 10:28, etc. are available. The first problem with our dataset generation

is that wrong values are specified as lagged variables if the conventional VAR method is used. Thus, we will propose in this paper a new approach to using true lagged values in VAR estimation.



Note: Hours are according to time in Tokyo (Japan Standard Time, JST). Overlapping hours (windows of simultaneous trading) are shaded.

The second problem with VAR estimation is related to volatility at market opening. Since the Shanghai market opens later than Tokyo, each of our daily time windows inevitably starts with the opening of the morning (and afternoon) session in Shanghai. Opening prices are, however, known to be especially volatile because they have to respond to information flows accumulated over long non-trading hours. When Shanghai opens in the morning, its stock market has to digest news accumulated during overnight non-trading hours since previous day's close. While these opening prices of Shanghai are included in the dataset, those of Tokyo are not included because they are not part of the common time window. The asymmetry that the dataset includes opening prices of Shanghai but not those of Tokyo is likely to produce biased estimation results. To remove this asymmetry, it is desirable to exclude opening prices of Shanghai as well.

Exclusion of several observations at the beginning of each time window leads us to devise a novel method to use those excluded observations as lagged values in regressions. Suppose, as we will do later, we delete the first 10 observations from each window. The dependent variables are from two truncated time windows: 10:41-11:00 and 14:11-15:00. Suppose further that the lag order of the VAR model is 10. Then, in the equation to explain the return at 10:41, 10 lagged values are recovered from those deleted observations between 10:31 and 10:40. Though

the first 10 observations of each time window is excluded from the dependent variable, they are used as lagged, explanatory variables on the right-hand side of regressions. In the next equation to explain the return at 10:42, observations from 10:32 to 10:41 are used as lagged variables on the right-hand side, etc., etc.

In summary, we note there are two problems with using observations from common trading hours (time windows). Firstly, the lagged variables for Tokyo in a VAR equation do not use true lags, because they have been discarded in the process of creating the dataset. Secondly, the volatile opening prices of Shanghai are not suitable to analyze effects of Tokyo on Shanghai due to influence of information flows accumulated during the non-trading hours. To cope with these two problems, we propose to delete the first ten observations from each time window. But, the deleted observations are used as lagged variables on the right-hand side of regressions, because they are actually the true lagged values. This method solves the above two problems at the same time. It catches two birds with one stone.

Another feature of this paper is the fact that our sample period includes the incidence of the collapse of the Lehman Brothers in September 2008. It is well known that the global stock price linkage intensified after the Black Monday of 1987 (Tsutsui and Hirayama (2009), pp. 170-171). Similarly, the Chinese stock market may have undergone 'globalization' after the meltdown of 2008 and consequently their stock prices are routinely and significantly swayed by global stock market movements. Investigation of this possibility is one of the purposes of this study.

The rest of this paper is organized as follows. Section 2 explains the data and methodology. Section 3 presents estimation results. Section 4 examines whether the Chinese market became more efficient after the global financial crisis of 2008. Section 5 checks whether our lag methodology produces more plausible results and discusses possible causes of our results. The final section concludes the paper.

## **2. Data and Methodology**

### *2.1. Methodology: Cointegration Tests and VAR Model Estimation*

After preliminarily testing for unit roots that confirm commonly found nonstationarity in the indexes of the Tokyo and Shanghai stock exchanges, we check for cointegration between the two indexes. Since we employ a bivariate system, the number of cointegrating relationships is one, at most, and thus there is no need for system estimation by Johansen tests. We apply Engle-Granger two-step estimation to check for cointegration.<sup>3</sup> If cointegration exists, the VAR model should be modified to a vector error correction (VEC) model. As shown later, our results

indicate no evidence of cointegration between the two indexes. Consequently, we can make our estimations by conventional VAR models only, without an error correction term.

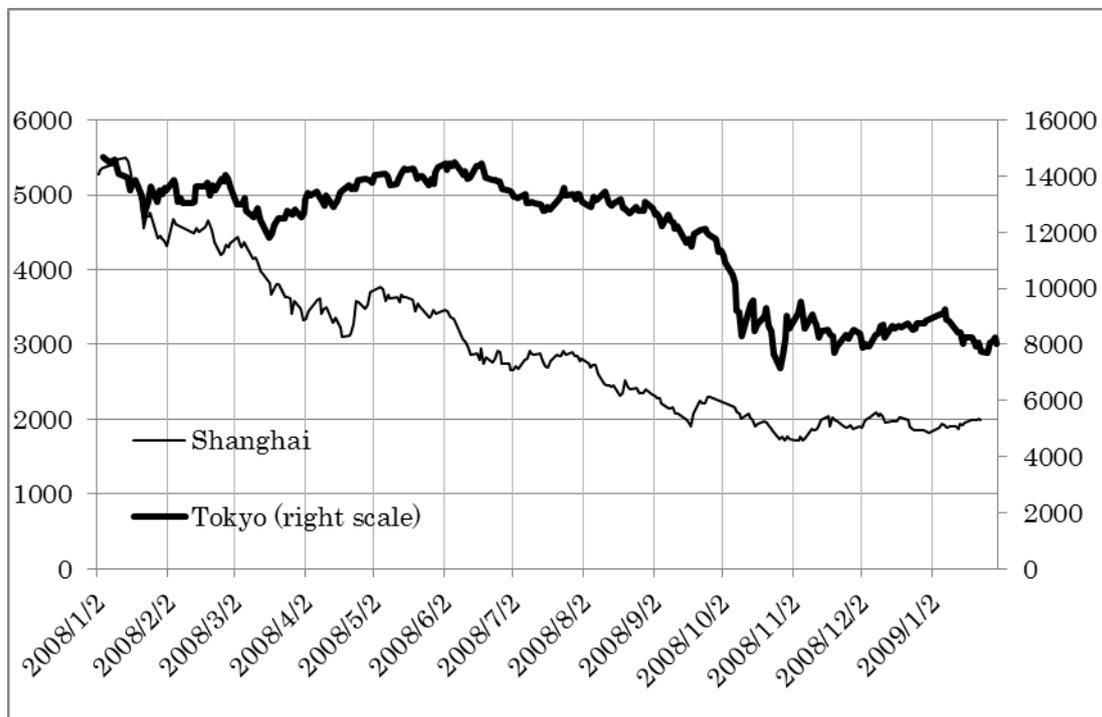
While long-run relationships are examined by cointegration tests, short-run dynamic interactions are analyzed by Granger causality tests, variance decompositions computations, and impulse response functions (IRF), which are standard tools for short-run dynamic analysis.

## 2.2. Data

We analyze return spillover effects between the Japanese and Chinese markets by focusing on pair-wise relations between Tokyo and Shanghai, using the Nikkei 225 Index and Shanghai Composite Index. Minute-by-minute observations of these two indexes were obtained from Tickdata.com for the period from January 7, 2008, to January 23, 2009. Similar to the Dow Jones 30 Industrials Index, Nikkei 225 is an arithmetic average of 225 representative stocks traded on Section I of the Tokyo Stock Exchange. Although the Shanghai Stock Exchange trade A shares for domestic investors (traded in local currency) and B shares for foreign investors (traded in US dollars), only the composite index of all shares was available to us.

Fig. 2

Daily Closing Stock Prices of Tokyo and Shanghai Markets



Note: The stock price index of Tokyo is the Nikkei 225 and that of Shanghai is the Shanghai Composite Index.

Daily closing prices for our sample period are plotted in Figure 2, showing downward trends in the Chinese market and reflecting adjustments following the bursting of a stock market bubble in China that started in November 2007. The Nikkei average hovered between 12,000 and 14,000 until September/October 2008 after which it plunged to around 8000.

Trading hours for the two stock exchanges are given in Figure 1. In Tokyo, opening prices are determined by batch trading (*itayose*). After opening at 09:00 JST, a continuous auction takes place until 11:00. After a 90-min lunch break, the afternoon session starts at 12:30 and ends at 15:00. In the Chinese market, pre-market call auctions between 09:15 and 09:25 (Chinese Standard Time, CST) determine the opening prices for the day at 9:25 CST. Continuous auction takes place between 09:30 and 11:30 for the morning session and between 13:00 and 15:00 for the afternoon session. Since there is a one-hour time difference between Japan and China, the only time windows during which the two stock exchanges are simultaneously open for trading are 10:30 to 11:00 and 14:00 to 15:00 (JST). We focus on these two windows of 30 minutes and 60 minutes in this study.

### 2.3. Data Selection

We carefully selected data to be used in our VAR model which utilizes many lags. In summary, the rules we use are characterized by the following four points: (a) we use minute-by-minute stock price returns when the stock exchanges are simultaneously open, i.e., 10:31 to 11:00 and 14:01 to 15:00 (JST); (b) we drop the first ten observations in each window. This deletes the opening prices in the Chinese market (both morning and afternoon sessions), resulting in slightly truncated windows, 10:41 to 11:00 and 14:11 to 15:00, each day. This rule has a merit that the prices at the opening (determined by a pre-market call auction by 9:25 CST) and immediately after the opening are excluded from the analysis. Otherwise, our calculations would include opening prices in China but not in Japan. Since stock prices at the opening of a stock market reflect information accumulated during night-time non-trading hours and are more volatile than prices during normal trading hours, it is appropriate to exclude opening prices of both markets to make a fair comparison.; (c) time series data is constructed by sequentially combining data from these windows over the estimation period; and (d) the basic dataset constructed under rules (a) through (c) above is further modified. In the traditional VAR estimation, the equation to explain a stock return at 10:41 has a one-period lag which is the last observation of the previous day at 15:00 and has a two-period lag observed at 14:59 on the previous day. However, true lags at 10:40, 10:39, 10:38, etc. are available in the deleted set of observations. Therefore, we re-use these values as lagged values in the regressions. Although

we delete first 10 observations from each time window, these values are used as true lagged values on the right-hand side of VAR equations.

Basic statistics on the levels and rates of change for the two indexes are provided in Table 1.

Table 1  
Stock Price Indexes of Tokyo and Shanghai

	Variable	Mean	St. Dev.	Maximum	Minimum	Skewness	Excess Kurtosis	JB	<i>p</i> -value
Logged Level	Tokyo	9.36388	0.21067	9.59177	8.8591	-0.84368	-1.0067	2721.75	0.0000
	Shanghai	7.9303	0.32603	8.61251	7.42791	0.3168	-1.08355	1110.74	0.0000
Minute-by-Minute Rate of Change	Tokyo	0.00074	0.08298	1.07348	-1.54325	-0.55788	22.52593	358607.17	0.0000
	Shanghai	0.00111	0.08803	0.49049	-0.47809	0.0726	1.53379	1673.37	0.0000

Note: The stock price indexes used for Tokyo and Shanghai are the Nikkei 225 and Shanghai Composite Index, which are observed at a minute-by-minute frequency. The sample period is from January 7, 2008, to January 23, 2009. Intraday data are for the 20-min period from 10:41 to 11:00 and the 50-min period from 14:11 to 15:00 (Japan Standard Time). The number of observations is 16,920. The rates of change are not log differences, but arithmetic rates of change from the previous minute. JB is the Jarque-Bera test of normality. The *p*-value is its significance.

The data are obtained for 20 minutes in the morning and 50 minutes in the afternoon window. For minute-by-minute rates of change, Tokyo's mean is smaller than that of Shanghai, but the standard deviations are about the same in the two markets. However, the maximum and minimum in Tokyo are two to three times larger (in absolute value) than those of Shanghai. The excess kurtosis of Tokyo returns is over 22.5 whereas it is only 1.5 in Shanghai, indicating much fatter tails in the distribution of returns in Tokyo. As with other stock price returns, the Jarque-Bera test of normality strongly rejects the null of normality, but the extent of this rejection is extreme in Tokyo, apparently due to its large kurtosis.

### 3. Results

#### 3.1. Unit Root Tests

The logged levels and rates of change of the three stock price indexes are tested for nonstationarity by the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (results are not shown to save space).<sup>4</sup> The result is typical of stock prices, namely, levels can be regarded as  $I(1)$  but rates of change are stationary, i.e.,  $I(0)$ .

#### 3.2. Engle-Granger Tests of Cointegration

Since the two stock price levels are  $I(1)$ , we next test for cointegration of logged stock prices in a bivariate system (results are not displayed to save space). According to critical values as given by MacKinnon (1991), the null of nonstationarity in the residuals cannot be rejected,

indicating absence of cointegration for the Tokyo-Shanghai bivariate system. Thus, we can safely proceed to estimating a conventional VAR model without error correction terms.

### 3.3. VAR Estimation and Granger Causality Tests

Since variables in VAR models must be stationary, we use minute-by-minute rates of change in the two stock indexes. The bivariate VAR system is estimated by ordinary least squares (OLS) with White's heteroscedasticity-consistent variance-covariance matrix. To determine the optimal lag order of the VAR model, we examine Ljung-Box Q statistics for the regression residuals. They indicate that ten lags are sufficient to eliminate serial correlation in the residuals. We thus adopt this lag order for all the following VAR models.<sup>5</sup>

After estimating VAR(10) for the Tokyo-Shanghai bivariate system, we conduct Granger causality tests for each set of lagged variables. The null hypothesis is that all ten coefficients on lagged values are zero, whose test statistic is distributed as Chi-squared. Results are presented in Table 2. Own lags are all highly significant. We, however, are interested in cross terms. Shanghai Granger causes Tokyo very significantly, but Tokyo Granger causes Shanghai with only 3.85% significance.

Table 2  
Granger Causality Tests for Tokyo-Shanghai System

From	To	Full Period		First Period		Second Period		Period after November 3, 2008		
		Chi Square	p-value	Chi Square	p-value	Chi Square	p-value	Chi Square	p-value	
Tokyo	→	Tokyo	65.63	0	52.16	0	49.39	0	22.42	0.0131
Shanghai	→	Tokyo	41.56	0	67.63	0	17.39	0.0661	18.96	0.0407
Tokyo	→	Shanghai	19.15	0.0385	13.47	0.1987	17.42	0.0656	9.52	0.4837
Shanghai	→	Shanghai	15,845.29	0	13,198.37	0	4106.34	0	2714.2	0

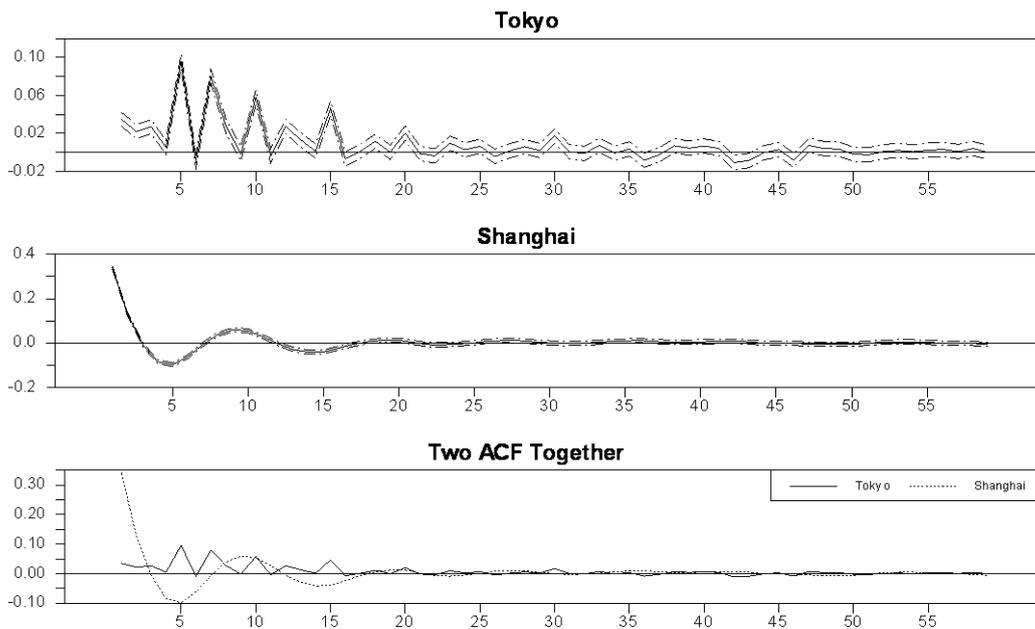
Note: Granger causality tests are conducted by testing the hypothesis that all ten coefficients of the lagged variables are zero. The test statistic is distributed as Chi-squared. The full period is from January 7, 2008, to January 23, 2009, and contains 16,920 observations. The first (pre-financial crisis) period is from January 7 to August 29, 2008, with 10,584 observations. The second (post-financial crisis) period is from September 1, 2008, to January 23, 2009, with 6336 observations. The period after November 3, 2008 (after the rapid fall of prices ceased) has 3672 observations. The p-value of the Chi-squared statistic testing for the explanatory power of Tokyo over Shanghai is 0.1987 for the first period, but 0.0656 in the second, indicating an increased influence of Tokyo after the global financial crises of September/October 2008 (shown in shaded cells).

While Tokyo responds to Shanghai in the sense of Granger causality, Shanghai's response to Tokyo is weak. This result is consistent with those of the studies on daily return spillovers between China and other countries (Huang, Yang, and Hu (2000), Groenewold, Tang, and Wu (2004), and Zhang (2008)).

### 3.4. Autocorrelation Functions

Another feature that characterizes the Chinese market is an extremely large test statistic for its own lags. Table 2 shows that while Tokyo's lags in the equation to explain Tokyo produce a Chi-squared test statistic of 66, those of Shanghai are 15,845. This apparently results from very strong serial correlation in Chinese stock returns, and may be a sign of relative inefficiency in the Chinese stock market.<sup>6</sup> An easy way to check this is to compute autocorrelation functions (ACF). Figure 3 shows that the magnitude of autocorrelation at one-minute lags is almost 10 times greater in Shanghai than in Tokyo, suggesting informational inefficiency in the Chinese market.

Figure 3  
Autocorrelation functions of Tokyo and Shanghai



Note: Minute-by-minute returns and 95% confidence levels shown. Horizontal axis measures time in minutes.

The ACF of Tokyo exhibit spikes at five-minute intervals. However, as Tsutsui et al. (2007) made clear, this merely reflects automatic updating of special quotes, and is not evidence of high autocorrelation of actual prices. On the other hand, ACF of Shanghai are cyclical, having significantly and numerically large peaks and troughs that may indicate overreaction in stock prices and subsequent adjustments. According to the overreaction hypothesis proposed by De Bondt and Thaler (1985), abnormal negative (positive) returns follow positive (negative) events.

Although they analyzed the predicted profitability of long-term winners and losers, the hypothesis also applies to the short-term reversal of stock prices, e.g., Ketcher and Jordan (1994). Thus, not only the magnitude of the ACF, but also their cycles may be evidence of informational inefficiency of the Chinese market.

We tested whether one can make unusually large profits by exploiting this inefficiency. We estimated an AR(10) model for the minute-by-minute returns on the Shanghai Composite Index and then generated dynamic forecasts for the next 10 minutes.<sup>7</sup> We utilized rolling-sample regressions, namely the initial regression used the first half of the sample (sample size was 30618) for estimation and dynamically forecast (i.e., out of sample) subsequent 10 minutes. We then added the next observation to increase the sample size by one and repeated the process of estimation and out-of-sample forecasting. Since this was repeated 30608 times, we obtained 30608 series of 10 forecast returns. Over each 10-min forecast horizon, we computed cumulative returns and tabulated the distribution of these returns. We then chose 1 percentile and 99 percentile values. Positive and negative returns exhibited maximum absolute values over the three-min horizon: 0.177% in the case of increasing stock prices and -0.181% in the case of declining prices.

To evaluate whether this represents a profitable trading strategy we need information on the transactions cost. In the case of Nikkei 225, Kohsaka (2010) carefully examines the buy/sell transactions cost in the Tokyo Stock Exchange and reports that it is around 0.002%. Therefore this cost is negligibly small. But, this constitutes only a part of the total transactions cost. We must also take into account a bid-ask spread and a possible market impact (effect on prices when a sizable order is placed). According to Kohsaka, the market impact is also negligible, unless the buy/sell order is substantially large. Kohsaka estimates the bid-ask spread to be between 0.1% and 0.2%. We conjecture that the costs in Shanghai are comparatively close to those in Tokyo, such that the estimated returns of around 0.18% would be barely sufficient to cover the transactions cost and thus we will not be able to make any excess profit. After all, the observed inefficiency in the Shanghai Stock Exchange does not seem to provide an exploitable profit opportunity.

### *3.5. Variance Decompositions*

A VAR model can be converted into a vector moving average representation (VMA) and the forecast error variance decomposed into factors explained by each disturbance. In Table 3, we compute such decomposition at 30-min horizons. In the Tokyo-Shanghai system, Shanghai accounts for only 0.361% of the forecast error variance of Tokyo's minute-by-minute returns,

while the remaining portion (99.639%) is explained by Tokyo's own shocks (the latter figure not shown in the table because it is trivial). In the decomposition of Shanghai, Tokyo explains an even smaller percent (0.231%) of Shanghai's variance and the rest is explained by Shanghai's own shocks. Although Granger causality tests indicate some causality from China to Japan, the proportion of forecast error variance explained by China is numerically quite small. And Tokyo's influence on Chinese market is even smaller. These results suggest that the linkage between Chinese and Japanese markets is quite weak. The same tendency can be found using daily data. Zhang (2008) reports that only 0.05% of China's 20-day ahead forecast error variance is accounted for by shocks to Japan and that 0.15% of Japan's forecast error variance is explained by events in China. Using a four-country VAR (U.S., U.K., Germany, and Japan) and daily data, Hirayama and Tsutsui (1998) found that 6.5% of a 20-day ahead forecast error variance of Japan is explained by the U.S. and that 2.0% of the U.S. variance is accounted for by Japan. These magnitudes are much larger than the ones we find between Japan and China in this paper.

Table 3  
Variance Decomposition for Tokyo-Shanghai System

Forecast Error		After			
Variance of:	Accounted for by:	Full Period	First Period	Second Period	November 3, 2008
Tokyo	Shanghai	0.361%	0.780%	0.366%	0.513%
Shanghai	Tokyo	0.231%	0.153%	0.507%	0.640%

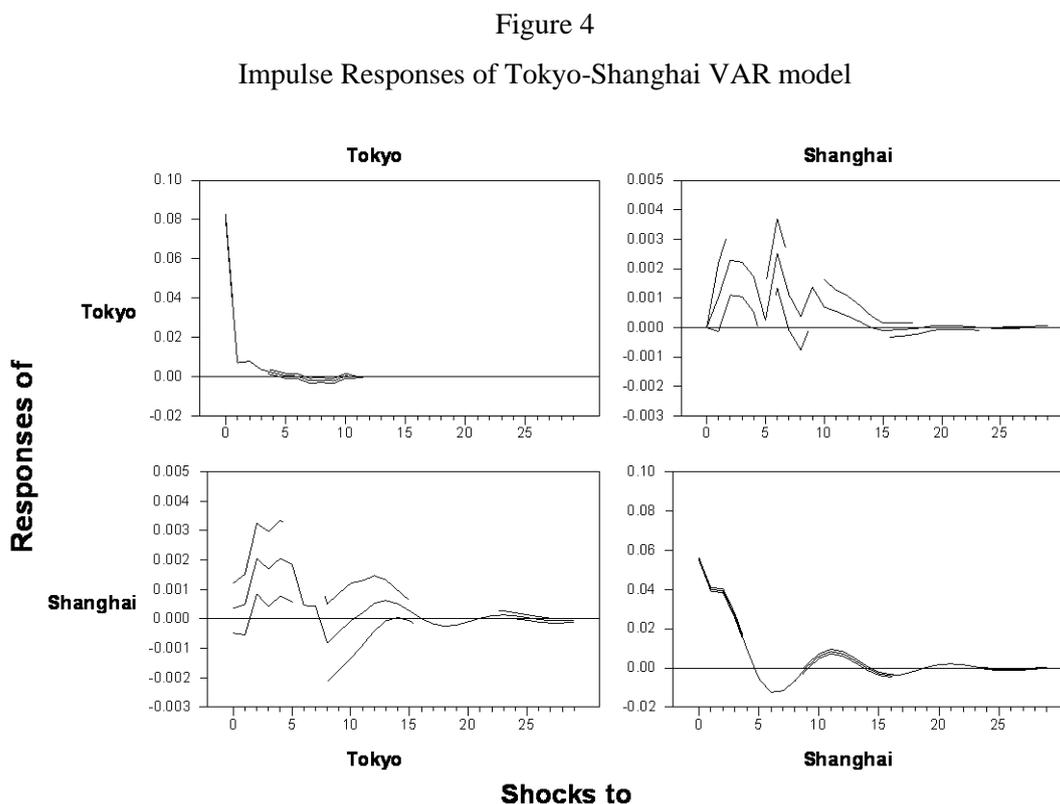
Note: Forecast error variance decomposition is computed for the Tokyo-Shanghai bivariate VAR system. Since the system is bivariate, only cross results are displayed. The remainder is accounted for by the other variable. The forecast horizon is 30 periods (minutes). When the causal ordering is reversed, the result is almost unchanged, because the correlation between the two residuals is very small. For definitions of the periods, see Table 2.

### 3.6. Impulse Response Functions

Our next tool to analyze short-run interactions is IRF, which are actually coefficients of the VMA model. They capture how a shock to one variable arising at a certain period affects endogenous variables in subsequent periods.

The IRF for the Tokyo-Shanghai system are plotted in Figure 4. Responses to own shocks are far greater in magnitude than responses to shocks on the other stock market. The maximum on the 'own' charts is 20 times greater than on the 'cross' charts, consistent with the results of variance decomposition. However, although the responses of Tokyo to its own shocks dissipate

very quickly (within some 10 min), Shanghai's responses to its own shocks oscillate and are statistically quite significant for about 30 min. This cyclical pattern may be a result of overreaction in one direction and subsequent adjustments in the reverse direction, which also caused strong serial correlation in Shanghai's stock returns.



Note: 95% Confidence bands are based on 10,000 random draws. Horizontal axis measures time in minutes.

In the 'cross' charts, more of Tokyo's responses are statistically significant than those of Shanghai up to 10 lags, in agreement with results of the Granger causality tests that indicate more significant response of Tokyo to Shanghai than of Shanghai to Tokyo. Shanghai's responses exhibit an oscillating pattern which may be a sign of overreaction of the Shanghai stock market to Tokyo, although negative responses at 8 and 9-min lags are not statistically significant.

#### **4. Was the Chinese Stock Market Transformed by the Global Financial Crisis of 2008?**

##### *4.1. The Global Financial Crisis and International Linkage of Stock Prices*

In the previous section we determined that the Chinese stock market is not much affected by Tokyo, i.e., international return spillover effects are unidirectional from China to Japan.

However, during our sample period, the New York stock market experienced a precipitous plunge that had far-reaching effects on other markets. Just as international stock price comovements were reinforced after Black Monday of 1987, the 2008 global financial crisis may have strengthened international return spillover effects so that, during our sample period, China may have undergone changes in its responsiveness to Tokyo. In this section we examine whether China became more responsive to Tokyo after the stock market crash of September/October 2008. To do so, we split the sample into two subperiods and recompute some of our tests. The first subperiod is January 7, 2008, to August 29, 2008; the second is September 1, 2008, to January 23, 2009.

#### *4.2. Granger Causality Tests: Causality from Tokyo to China Became Stronger*

The Granger causality results are presented in Table 2. Focusing on cross effects, we immediately notice that the Chinese market seems to have paid more attention to developments in Tokyo in the second, turbulent, post crisis period of 2008.<sup>8</sup> Namely, the  $p$ -value of the Chi-squared statistic testing the explanatory power of Tokyo over Shanghai is 0.1987 in the first period, but 0.0656 in the second, indicating increased significance of Tokyo (see shaded cells). According to the causality results in the second period, the relative independence of the Chinese stock price seems to have weakened.

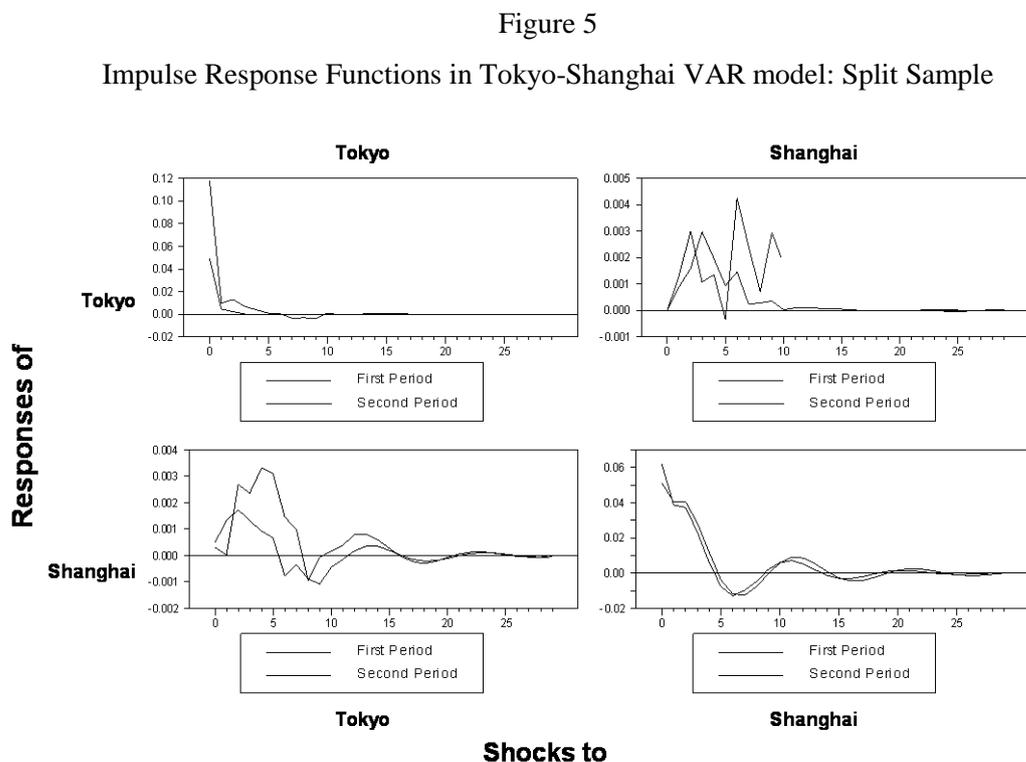
#### *4.3. Variance Decompositions: Sensitivity of Chinese Market Became Stronger*

Next, we re-estimate the forecast error variance decompositions for the two subperiods. Results are shown in Table 3. In agreement with the above, the explanatory power of Tokyo over Shanghai increased three to four times in the second period.<sup>9</sup> Tokyo's share is even greater than that of Shanghai in accounting for Tokyo's error variance in the second period. Again, this is evidence of increasing sensitivity of the Chinese market to Japan.

#### *4.4. Impulse Response Functions: Response of Chinese Market Became Stronger*

The IRF for the Tokyo-Shanghai system are estimated for the two subperiods and shown in Figure 5. Tokyo's responses to its own shocks are greater in the second period than in the first, probably because of much higher market volatility. Likewise, Tokyo's response to shocks in Shanghai are generally greater and more prolonged in the second period. Even starker are Shanghai's responses to Tokyo in the second period. In the first period, the IRF oscillated greatly with positive and negative values but, in the second period, the IRF tended to remain positive with a larger magnitude. Consistent with the findings of the Granger causality and

variance decompositions tests, the IRF also indicates a more significant response of the Chinese market to Tokyo in the second period.



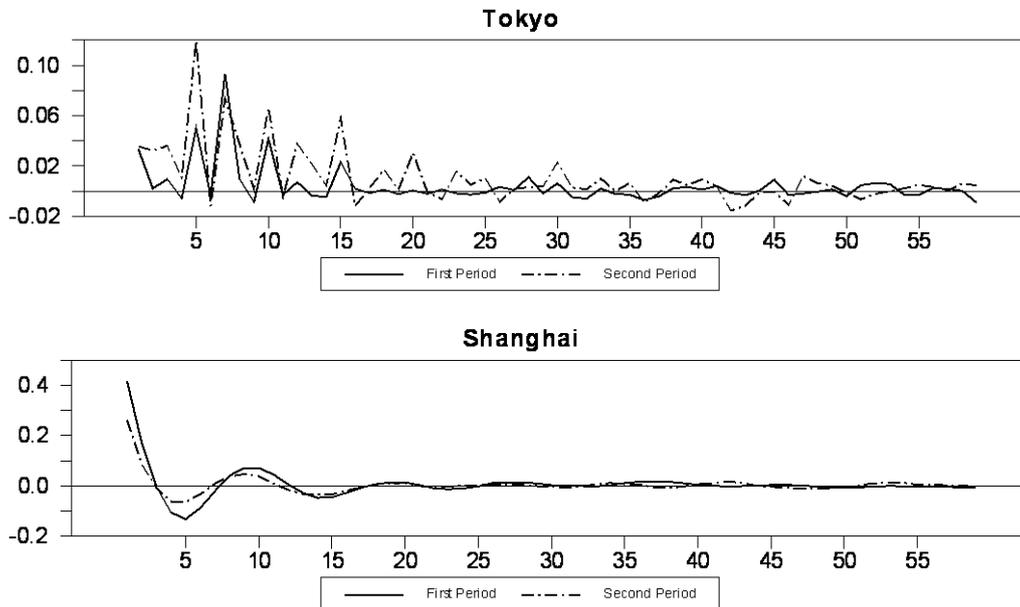
Note: Since the graphs are cluttered with so many lines, confidence bands are not depicted. Horizontal axis measures time in minutes. Note that the four graphs have different vertical scales.

#### 4.5. Nonetheless, Chinese Market Has Not Been Transformed

The question remains, did the Chinese stock market undergo a permanent change after the global financial crisis, or were they temporarily linked to Tokyo during this turbulent period?

To check whether the change in sensitivity of the Chinese market is permanent or temporary, we re-compute the above tests using data from November 3, 2008, onwards, i.e., after the rapid fall stopped. Results appear in Tables 2 and 3. The Granger causality tests reveal that Shanghai is not significantly explained by Tokyo in this period, suggesting that the increased influence of Tokyo was temporary and limited to September and October 2008. However, variance decomposition (Table 3) for the period after November 3, 2008, indicates otherwise; the proportions of forecast error variance explained by Tokyo remain rather high. However, the variance decomposition results were not tested for statistical significance. We tend to trust the Granger causality tests which test statistical significance and lead to the conclusion that the Chinese market remains isolated.

Figure 6  
Autocorrelation Functions of Two Stock Returns: Split Sample



Note: First period is from January 7 to August 29, 2008; the second period is from September 1, 2008, to January 23, 2009. Horizontal axis measures time in minutes

Since serial correlation at least partially reflects market inefficiency, we compare the magnitude and pattern of ACF before and after the financial crisis. Results are shown in Figure 6. The qualitative pattern remains the same in the second period, even though the amplitude is slightly smaller. The same is true for ACF after November 3, 2008. Thus, efficiency in the Chinese markets seems to be unchanged in the second period.

## 5. Discussion

After analyzing stock price spillover effects between Tokyo and Shanghai markets using a novel VAR estimation with correct lagged values, we check in this section whether our methodology produces more plausible results than those obtained from conventional VAR estimation. Next, we interpret the results, considering possible causes of the international interdependence of the stock prices.

### 5.1. Evaluation of Our Methodology

We use tick data from two stock exchanges and apply rules (a) through (d) in section 2.3 to select data for analysis. Let us see what happens if we do not follow these rules. Using the same

dataset for the dependent variable, we change the lag variable from the true lag to one that shifts the dependent variable just one period, as in conventional VAR estimations. Using these incorrect lag values, we may underestimate the true effects of the lags. Results of Granger causality tests carried out by conventional VAR estimation are shown in Table 4 (column 1). The Chi-squared statistics are generally smaller than in Table 2. Thus, using incorrect lag variables generally reduces statistical significance, as we conjectured.

Table 4  
Results of Granger Causality Tests, If Our Data Construction Rules are Disregarded

From	To	Conventional VAR Estimation		Chinese Data Including	
		(1)		Opening Prices	
		Chi Square	<i>p</i> -value	Chi Square	<i>p</i> -value
Tokyo	→ Tokyo	62.59	0.0000	59.32	0.0000
Shanghai	→ Tokyo	29.55	0.0010	24.12	0.0073
Tokyo	→ Shanghai	24.93	0.0055	20.75	0.0229
Shanghai	→ Shanghai	11,978.13	0.0000	266.03	0.0000

Note: This table indicates the results of the Granger causality tests if the dataset is formed disregarding our rules of construction. Column (1) shows the results if rule (d) of subsection 2.3 is violated, i.e., lags on the right-hand side of a regression are based on the usual method of referring to values from previous periods. Column (2) shows the results if, in addition to rule (d), we disregard rule (b), i.e., opening prices of the Chinese markets are included in the dataset, while those of the Tokyo market are not.

Next, we disregard rule (b) of subsection 2.3 and include the first ten observations following the opening of each trade session in China. We line up the data for the 30-min and 60-min windows contiguously. The windows include the opening prices of the Chinese markets, but not of the Tokyo market. Since opening prices respond to information accumulated during non-trading hours, their responsiveness is stronger than during normal trading hours. Since the data for Tokyo do not include opening prices, comparing the magnitude of responses is unfair. Results are given in Table 4 (column 2). Compared with Table 2, the significance of Tokyo on Shanghai increases, confirming our prediction that the inclusion of opening prices distorts causality results.

In sum, both rules of data selection, (b) and (d), are necessary to obtain undistorted results. In particular, symmetric treatment regarding exclusion of opening prices is critical to reach the conclusion that responses of the Chinese and Japanese markets to each other are asymmetric.

### *5.2. Possible Cause of Why the Shanghai Market Does Not Respond to the Tokyo Market*

A main result of our analysis is that while the Shanghai market seems to affect the Tokyo market, the effect of Japan's market on China seems to be much weaker. What causes this result?

Our sample period includes the bursting of a stock price bubble in China that can be interpreted as causing an asymmetric response in China.<sup>10</sup> It can be argued that during the burst, stock price volatility in China became so great that it affected Japan more than the other way round. However, Table 1 reveals that this is not the case. Indeed, the maximum and minimum Tokyo returns (rates of change) are roughly twice those of Shanghai, though the standard deviations are similar in the two markets. Therefore, if we extract Tokyo's minute-by-minute returns that fall within Shanghai's maximum/minimum range, they should have less significant impact on China. This would reinforce our results in Section 3 that the Shanghai market are not influenced by Tokyo.

To verify this statement, we divide Tokyo returns into those that fall within the maximum/minimum range of Chinese returns and those beyond this range. We then test the Granger causality of the two categories, large and small changes in Tokyo. We found that both large and small changes in Tokyo impact Shanghai at 5% but not 1% significance. These results are basically the same as in Table 4.<sup>11</sup>

Asymmetric causality between Tokyo and Shanghai can be attributed to different investor behavior. We claim that Japanese investors pay attention to Chinese stock prices in determining their portfolios, but that Chinese investors do not study Japanese prices. This implies that Chinese investors collect less information than their Japanese counterparts and is consistent with the long and persistent serial correlations amply shown by IRF and ACF (Figures 3, 4, and 5).

## **6. Conclusion**

Most studies of international stock price linkage has utilized daily data. However, as in the case of Japan and China which are located geographically close to each other and which share common trading hours, it is natural to use high-frequency data to examine mutual market interactions. In this paper we analyze intraday minute-by-minute data of the Tokyo and

Shanghai stock exchanges to investigate mutual interaction between Japanese and Chinese stock markets. Specifically, we focused on a 20-minute window (10:41-11:00 JST) in the morning and a 50-minute window (14:11-15:00 JST) in the afternoon during which the two stock exchanges are simultaneously trading shares. Our basic tool of empirical analysis was estimation of a Tokyo-Shanghai bivariate VAR model. Our methodology, we believe, correctly specifies the appropriate lagged variables in VAR equations. It also avoids using the volatile values that characterize the Chinese market after opening, thus treating the two markets symmetrically.

We then conduct Granger causality tests, variance decompositions, and computed IRF. Empirical analyses with the entire sample (from January 7, 2008, to January 23, 2009) confirmed findings from earlier studies using daily data that China is relatively isolated from other countries.<sup>12</sup> However, Tokyo seems to be statistically significantly impacted by Chinese stock price movements, implying that Japanese investors are more internationally oriented and alert to foreign markets than Chinese investors.

Another feature of the Chinese stock market is the fact that their minute-by-minute stock returns exhibit strong and persistent serial correlation. The IRF to their own shocks exhibit very significant and numerically large effects, with oscillating patterns of influence. This may reflect overreactions. Namely, stock prices overreact to new information, which is later reversed, indicating relative informational inefficiency.

Many studies show that after Black Monday, the world's stock markets became more cointegrated. Likewise, the global financial crisis of 2008 might have ushered in the internationalization of Chinese stock investors. To check, we split our sample into two subperiods at the end of August 2008. We found that while China did not respond to Tokyo in the first period, it did so in the second. However, it would be hasty to conclude that China became permanently attentive to Tokyo from September onwards. Indeed, if we exclude the September and October data points from the second period, the Granger causality tests qualitatively returned to the results of the first period. This implies that the Chinese market was subject to influences from Japan only during September/October 2008, and that it is still basically isolated from foreign countries.

## NOTES

1. Data source is: <http://data.worldbank.org/indicator/CM.MKT.LCAP.CD>.
2. Chen and Liu (2008) analyze volatility spillover effects between China and other markets. They found causality from China to other markets, but not vice versa.
3. A practical reason for adopting this test is that econometric packages cannot handle our particular method of selecting lags.

4. A constant term is included in the regression, but a linear time trend is not.
5. The lag order was altered from 1 to 20 and both Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBIC) were computed. The regressions to explain Tokyo exhibit minimal AIC and SBIC at nine lags. But, the regressions to explain Shanghai do not exhibit local minima between 1 and 20 lags. Stock prices of Shanghai seem to have a strong and persistent serial correlation, which might imply lack of efficiency in information processing. In any case, taking 20 lags is a bit excessive given that the morning window is only 30 minutes long.
6. We should be careful, however, that autocorrelation arises from various reasons such as bid-ask bounces and non-synchronized trading, which may not reflect efficiency.
7. An ARIMA model typically performs better than simple models as shown by Brand and Bessler (1983), but estimating a nonlinear model over 30,000 times unfortunately turned out to be too time-consuming. Thus a simple linear model was chosen in our study.
8. While Shanghai significantly Granger causes Tokyo in the first period, its significance declined substantially and Shanghai is barely statistically significant at a 10% confidence level in the second period. During the second period, variability was wider in Tokyo (see Figure 2), which probably underweighted the influence from China.
9. The explanatory power of Shanghai over Tokyo weakened in the second period.
10. Another factor accounting for the asymmetry between the countries is that China lists stocks of state enterprises, especially A shares whose liquidity is especially low. We hypothesize that these shares make the sensitivity of Chinese stock prices generally low.
11. This is because there are very few data points, only 47 (0.28%) of 16,920 observations, that belong to the 'large' category of changes and the 'small' changes are almost identical to the whole sample, making their explanatory power almost equal to that of the whole.
12. This result was obtained in a model that focuses only on Japan and China. If other important Asian markets such as Singapore and Korea are included in the analysis, the relative isolation of China may not hold. Bessler and Yang (2003) conduct an interesting analysis of causal relationships among multiple countries. Applying their novel methodology (Directed Acyclic Graphs) to a group of Asian countries may be an important next step.

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## **Japanese Banking Regulations and SME Finance under the Global**

### **Financial Crisis**

**Nobuyoshi Yamori**

Nagoya University

Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan

yamori@soec.nagoya-u.ac.jp

**Kazumine Kondo**

Aichi Gakuin University

12 Araiike, Iwasaki-cho, Nisshin, 490-0195, Japan

**Kei Tomimura**

Aichi University

4-60-6 Hiraike-cho, Nakamura-ku, Nagoya, 453-8777, Japan

**Yuko Shindo**

Yamaguchi Prefectural University

3-2-1 Sakurabata, Yamaguchi, 753-8502, Japan

**Kenya Takaku**

Nagoya University

Furo-cho, Chikusa-ku, Nagoya, 464-8601, Japan

### **ABSTRACT**

This paper discusses important policy actions in Japanese banking regulation under the global financial crisis, which seriously damaged the Japanese economy. First, the state of Japan's banking industry and an outline of Japan's banking regulations are discussed. Second, we explain the impacts of the global financial crisis on the Japanese economy and Japanese banks. Then we explain various responses of the small-and-medium-sized enterprise (SME) financing support program and banking regulations against the global financial crisis, including reintroduction of the public fund injection scheme, revision of capital adequacy regulation, and establishment of the Act to Facilitate Financing for SMEs. The measures taken by the Financial Services Agency (FSA) were effective in terms of preventing the shocks from resulting in "the greatest crisis of the century." However, these measures are temporary ways to avoid exacerbation of the problems; they are not remedies for the structural issues facing the Japanese economy, SMEs, and financial institutions.

**Keywords:** Banking Regulation, Global Financial Crisis, Japanese Banks, Bank Supervision.

**JEL Classification:** G21, G28.

## 1. Introduction

In the 1980s, Japanese financial institutions increased their presence in Western financial markets. Japanese financial institutions had close business relationships with large Japanese corporations (interlocking *keiretsu* business relationships) and suffered few non-performing loans because of the country's steady economic development, making them the soundest financial institutions in the world. Table 1 shows the transition in the credit ratings of major Japanese financial institutions and demonstrates that in 1988, many Japanese financial institutions were given a top credit rating.

However, in the 1990s, the financial condition of Japanese financial institutions deteriorated rapidly as a result of an increase in non-performing loans brought on by an economic slump. For example, Figure 1 shows the changes in the balance of non-performing loans that Japanese banks held. At its peak at March 2002 (i.e., the end of FY 2001), this level exceeded ¥40 trillion. Figure 2 clearly indicates the severity of the problem, and Figures 1 and 2 show that, despite disposing of non-performing loans exceeding ¥10 trillion several years in the late 1990s, the balance of non-performing loans still increased.

In 1997, the financial condition of major banks grew severe, as evidenced by the failure of institutions such as Hokkaido Takushoku Bank, which had a significant standing among major commercial banks, and Yamaichi Securities, one of the four major security corporations. Many financial institutions that survived with government assistance barely escaped bankruptcy.

In the past, Japanese banks were subjugated under extremely strict regulations implemented by the Ministry of Finance. In the 1980s, however, financial globalization progressed, increasing the concern that if the regulations did not change, they may promote the hollowing out of domestic markets. Beginning in 1996, the Japanese government advocated Japanese "Big Bang" financial reforms and fundamentally restructured the regulations. These reforms could have been viewed as a "constructive" approach to financial regulations for a new economic environment.

On the other hand, the deterioration of the business conditions of financial institutions progressed at a speed and scale greater than what was anticipated. Because the laws that

addressed such a situation were inadequate, financial regulators were forced to respond in an ad hoc manner, tackling each financial problem encountered by the major financial institutions as it occurred. After this trial-and-error approach of ten or more years, restructuring of the regulations was almost completed by around 2005.

The financial regulation reforms, aimed at dealing with the financial crises in Japan that took place after the bubble economy collapsed (the Post-Bubble Financial Crisis, for simplicity), initially were passive in nature. However, these reforms enhanced the crisis-response capabilities of Japan's financial system.

During the global financial crises that plagued the entire world from 2007 onward, Japan's financial system did not encounter major problems, and the distrust in the soundness of financial institutions did not intensify among the general public. Certainly, the Japanese economy was confronted with severe economic afflictions resulting from a major decline in exports. Nonetheless, unlike in the Post-Bubble Financial Crisis, the economic difficulties were not attributable to the financial system. In this sense, Japan's financial system had become equipped with crisis-response capabilities.

However, real economic damages due to the global financial crisis seemed unprecedented. As shown in Figure 3, real GDP growth rates were -3.2% for the fourth quarter of 2008 and -4.0% for the first quarter of 2009. The Japanese government and the Bank of Japan tried to protect the Japanese economy from failing into "the greatest crisis in the century." Regarding banking policy, several important measures, including reintroduction of the public capital injection scheme, were taken.

In this paper, we discuss details of and issues regarding these measures that evolved during the global financial crisis.<sup>1</sup> First, the state of Japan's banking industry is discussed in section 2. In section 3, an outline of Japan's banking regulations is provided. Then, in section 4, we explain actions regarding banking policy that responded to the global financial crisis. Finally, section 5 presents the conclusion.

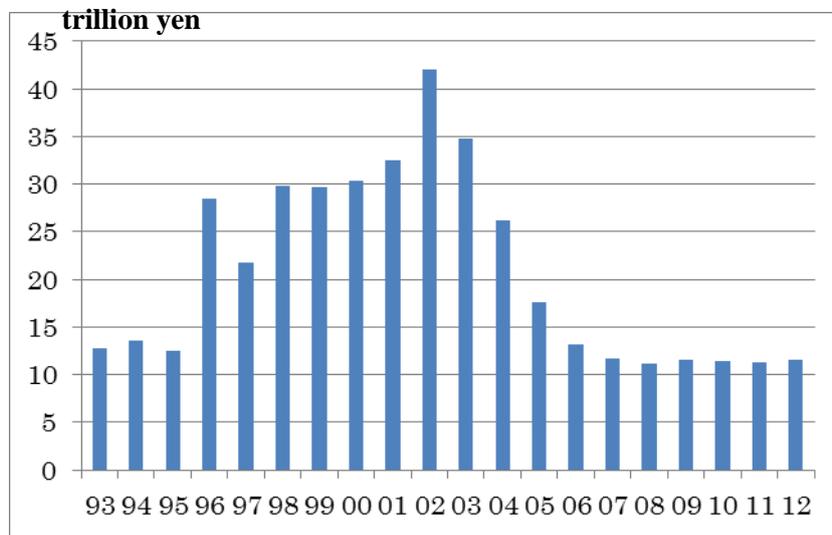
**Table 1**  
**Japanese Banks' Credit Ratings (Moody's Credit Rating)**

	1988	1993	1998	2006	2013
Aaa	Dai-Ichi Kangyo, Sumitomo, Fuji, Mitsubishi, IBJ, Norinchukin			Shoko Chukin	
Aa1	Sanwa, Mitsubishi Trust, Sumitomo Trust				
Aa2	Tokai, Tokyo, LTCB, Mitsui Trust				
Aa3	Yasuda Trust, Toyo Trust, Yokohama, Shizuoka	Mitsubishi, Sanwa, Tokyo, IBJ, Shoko Chukin, Shizuoka	Shizuoka, Shoko Chukin		Shizuoka, Shoko Chukin, Chugoku, Sumitomo Mitsui, Mitsubishi UFJ Trust, Tokyo-Mitsubishi UFJ
A1		Dai-Ichi Kangyo, Sumitomo, Fuji, Norinchukin	Sanwa, Tokyo Mitsubishi, Norinchukin	Norinchukin, Tokyo-Mitsubishi UFJ, Sumitomo Mitsui, Shizuoka, Mizuho Corporate, Chuo Trust	Shinkin Central, Chiba, Norinchukin, Higo, Mizuho Corporate, Mizuho, Mizuho Trust, Trust and Custody Services, Sumitomo Mitsui Trust, Japan Trustee Services, Yokohama
A2		Sakura, Tokai, Asahi	Sumitomo, Nippon Trust	Higo, Sumitomo Trust	Gunma, Joyo, Resona, Minato, Kinki Osaka, Saitama Resona
A3		Daiwa, LTCB, Yokohama	Dai-Ichi Kangyo, IBJ, Yokohama	Shinsei, Resona, Chuo Mitsui Trust, Mitsui Asset Trust, Yokohama	San-In Godo, Daishi, Hyakujushi, Kansai Urban
Baa1		Mitsubishi Trust, Sumitomo Trust, Toyo Trust	Sakura, Fuji, Toyo Trust, Sumitomo Trust, Asahi, Tokai	Aozora, Suruga, Hiroshima, San-In Godo	Ogaki Kyoritsu, Citibank, Suruga, Hiroshima, Fukuoka
Baa2		Hokkaido Takushoku (Takugin), Nippon Credit, Mitsui Trust, Yasuda Trust, Chuo Trust, Nippon Trust	Mitsui Credit	Nishi-Nippon City, Ogaki Kyoritsu, Kiyo, Hokuriku, Hokkaido, North Pacific	Aozora
Baa3			Nippon Credit, Hokkaido Takushoku, Chuo Trust, Yasuda Trust, Daiwa, LTCB	Ashikaga	
Ba1					Shinsei

(Source) Moody's.

**Figure 1**

**Changes in the Balance of Non-Performing Loans**



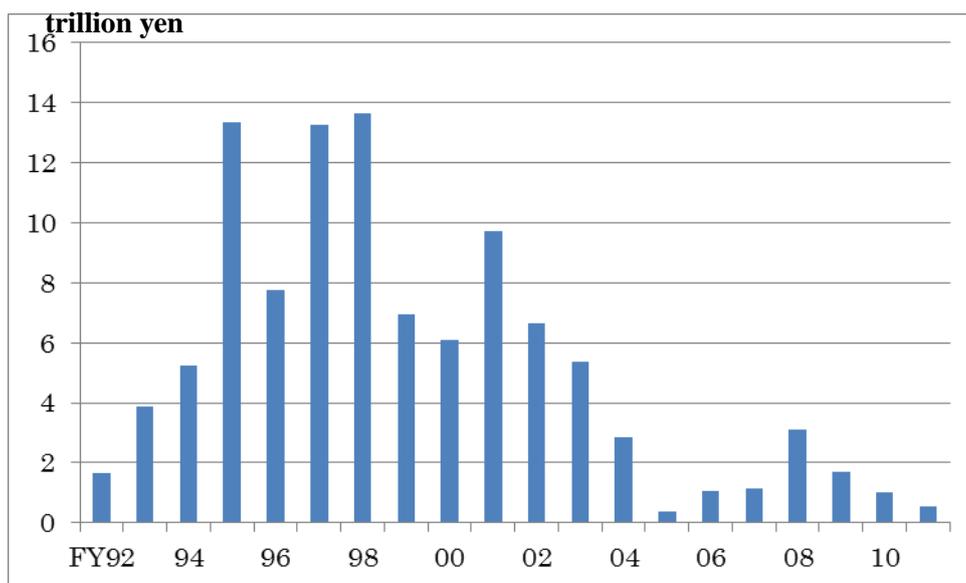
(Note) The figure shows the risk management loans of banks at the end of March of each year.

The statistics coverage has expanded in 1995 and 1997.

(Source) Financial Services Agency.

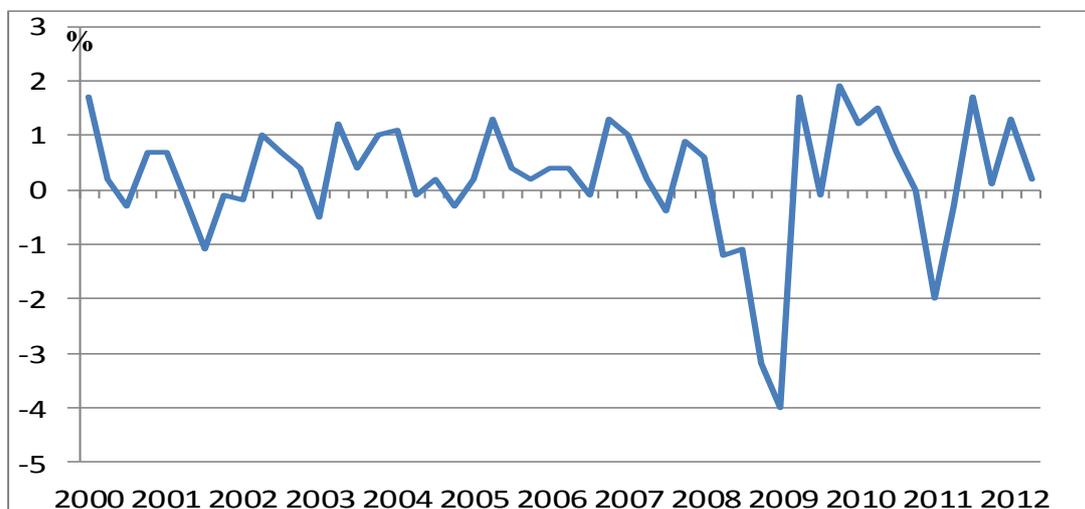
**Figure 2**

**Changes in the Total Losses on Disposal of Non-Performing Loans**



(Source) Financial Services Agency.

**Figure 3**  
**Real GDP Growth Rate**



(Source) Cabinet Office, Government of Japan.

## 2. Overview of the Banking Industry in Japan<sup>2</sup>

### 2.1. Industrial Structure of the Japanese Banking Industry

Figure 4 shows the basic structure of the banking industry in Japan.

Private banks can be divided into several categories based on such factors as business functions or historical background. The distinction among city banks, regional banks, and member banks of the Second Association of Regional Banks (regional banks II) is not a legal one but rather is a customary classification for the purposes of administration and statistics. City banks are large in size, with headquarters in major cities and branches in Tokyo, Osaka, other major cities, and their immediate suburbs. Regional banks are usually based in the principal city of a prefecture, conduct the majority of their operations within that prefecture, and have strong ties with local enterprises and local governments. Like traditional regional banks, regional banks II serve smaller companies and individuals within their home regions. Most of these banks converted the legal status from mutual savings banks into ordinary commercial banks in 1989.

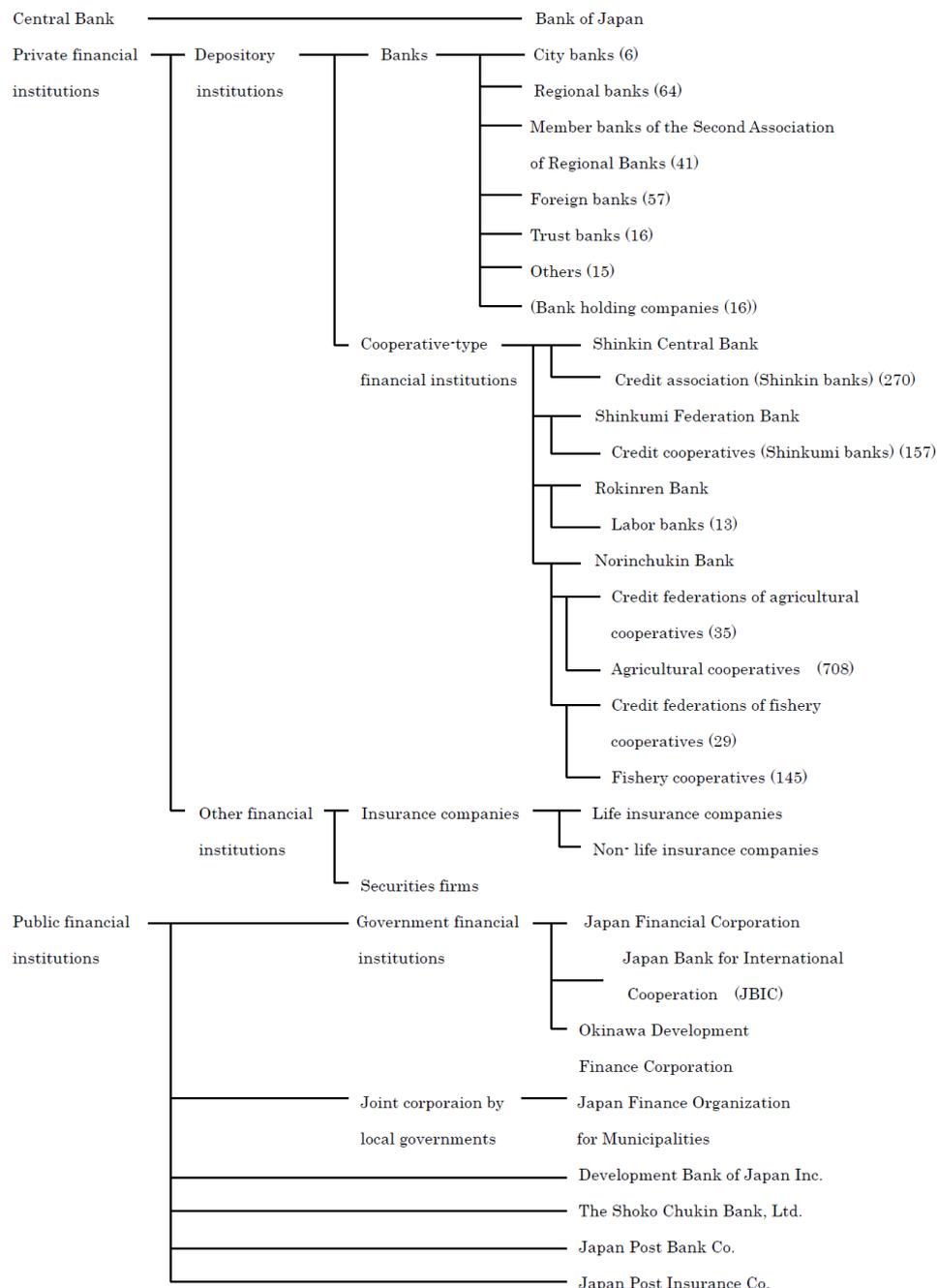
In addition to these commercial banks, there are cooperative financial institutions, including credit associations (Shinkin banks), credit cooperatives (Shinkumi banks), and agricultural

cooperatives (JA banks). These financial institutions are established to serve certain sectors. For example, Shinkin banks mainly engage in providing loans to small and medium-sized enterprises (SMEs), and agricultural cooperatives serve farmers.

Finally, Japan Post Bank is a unique financial institution. The government ran the postal savings system until 2007, when Japan Post Bank was established as a private stock company. However, the government still fully owns the stock of Japan Post Bank,<sup>3</sup> and most Japanese depositors regard Japan Post Bank as a publicly supported institution. Furthermore, because of the regulations, Japan Post Bank cannot extend SMEs and residential loans.

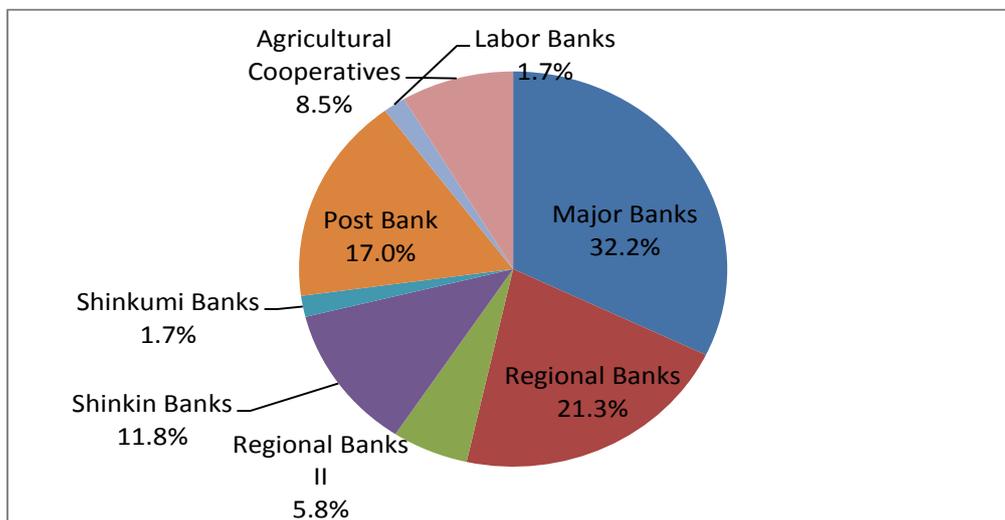
Figure 5 depicts the market shares of each of the categories of financial institutions in the Japanese deposit market. Major banks, including city banks and trust banks, have ¥332.8 trillion in deposits. Regional banks have the second largest shares, followed by Japan Post Bank and Shinkin banks.

**Figure 4**  
**Banking Industry Structure in Japan**



Note: Based on the Japanese Bankers Association’s homepage data, we updated the figures in parentheses, which represent the number of financial institutions in each category at various points in time from March 2011 to January 2013. The data sources are the FSA, Nikkin (a business journal publisher), and Fisheries Agency.

**Figure 5**  
**Deposits Markets in Japan**



(Note) Total deposits amount to ¥1,035 trillion at the end of March 2012.

(Source) Bank of Japan and business associations of these institutions.

## 2.2. Banking Regulation and Supervision Before the Global Financial Crisis

Japan's financial administration has gone through major changes since 1990. We discuss the transition of Japan's financial administration here by categorizing these changes into three stages.

The first stage occurred approximately between 1997 and 2002, when the administration was pressured to address difficulties in the financial system. In 1997, Hokkaido Takushoku Bank and Yamaichi Securities went bankrupt, followed by the collapse of Long-Term Credit Bank of Japan (LTCB) and Nippon Credit Bank (NCB) in 1998. Despite the government's ¥10 trillion capital injection and providing full protection on bank deposits, which was called the freeze on the "payoff system" in Japan, concerns regarding the soundness of major commercial banks spread in an unprecedented manner during this time.

Responding to these concerns, asset evaluation was tightened as the basis of the information disclosure system, and a system of prompt corrective action was introduced in order to accurately assess the state of financial institutions. In this sense, it was the period in which the

financial administration began to depart from its traditional form. Furthermore, financial legislation was being adjusted to process liquidation of insolvent financial institutions.

Until this period, the Ministry of Finance had been responsible for financial supervision in Japan. However, with growing financial turmoil in the wake of the collapse of the bubble economy, much criticism came regarding the fact that the Ministry of Finance held a dual function of financial administration and public financing. There was also an increasing criticism regarding the discretionary and obscure financial administration of the Ministry of Finance, which had led to the collapse of the bubble economy. Therefore, the function of financial supervision was removed from the Ministry of Finance. First, this function was transferred to the Financial Supervisory Agency. Later, in July 2000, the Financial Services Agency (FSA) was founded and given authority for overall financial administration. At that time, the FSA Commissioner, in a discourse on the commencement of the Financial Services Agency, promised to Japanese citizens “greater clarification of rules, prompt and stricter implementations of those rules, as well as improvements on the transparency of the policy formulation process and administrative procedures.” In other words, the implementation of a financial administration with a high transparency level, based on clarified rules, was a priority issue.

A turning point from the first stage to the second stage was the launch in October 2002 of the Financial Revitalization Program, under the Minister for Finance Services, Heizo Takenaka, as a response to an emergency of the Post-Bubble Financial Crisis. While the financial administration was severely criticized for its strong intervention in the operations of individual banks, under the Financial Revitalization Program, major banks were urged to accelerate their disposal of non-performing loans (with a balance reduction by half in three years).

The second stage, which began with the introduction of the Financial Revitalization Program, was the period approximately between 2003 and 2007. In May 2003, the financial problems of Resona Bank Group surfaced, and based on the discussions held by the Council on Financial Crisis Response, approximately ¥2 trillion of public funds were injected.<sup>4</sup>

In 2005, with the moderate revival of the economy, completely lifting the freeze on payoffs also

became possible. Repayments of public funds began as well. It was a period in which the stability of the financial system also began to be restored. The transition from emergency mode to ordinary mode progressed.

Simultaneously, the financial administration's focus shifted gradually from the revival of a stable financial system to user or consumer protection. Administrative measures against banks in this regard began to appear frequently.

The third stage was the period from 2007 to 2008. In December 2007, "Financial Reform Program—Challenges toward a Financial Services Nation" described the phase of the current financial system to be departing from emergency responses dealing with the non-performing loan problem and moving into a future-oriented phase aimed at creating a desirable financial system for the future. To borrow a slogan from the FSA, the system was entering a phase that saw "qualitative progress in financial regulation (better regulation)."

However, the third stage was suddenly terminated. In reality, the global financial crises directly triggered by the bankruptcy of Lehman Brothers occurred, and financial regulations to respond to the crisis had to be implemented again.

### **3. Japanese Economy and Financial Institutions under the Global Financial Crisis**

#### *3.1. Macroeconomic Impacts of the Global Financial Crisis*

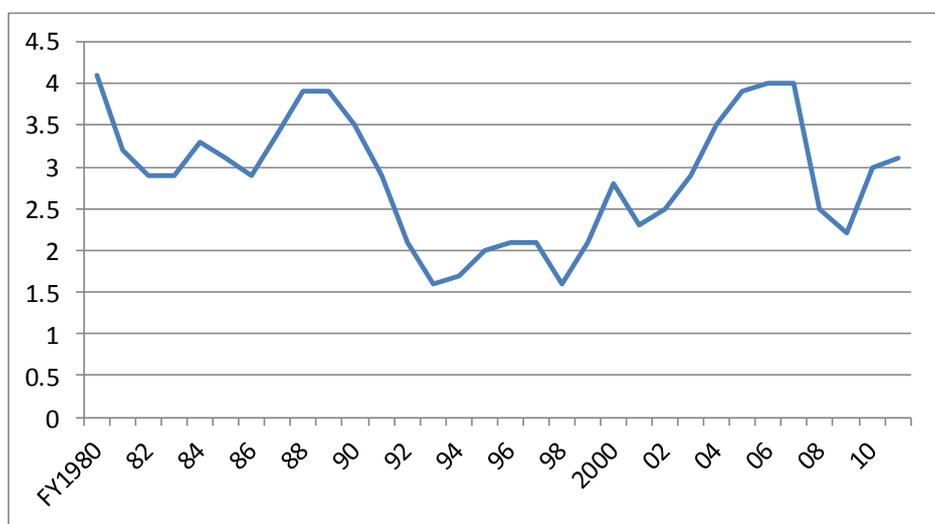
As shown in Figure 3, real GDP growth rate for the fourth quarter of 2008 was negative. Naturally, Japanese corporate performance deteriorated. As shown in Figure 6, the average return on assets (ROA) sharply declined by 1.5%, from 4.0% for 2007 to 2.5% for 2008.

It is natural to expect that these sharp declines in economic activity would lead to a substantial increase in corporate bankruptcies. The number of corporate bankruptcies is shown in Figure 7. Although the number increased by 1,500 in 2008 from the previous year, it is considerably smaller than it was around 2001, when the figure reached over 19,000. That is, measured in corporate bankruptcies, the effect of the global financial crisis was not unprecedented.

A direct reason for this unexpected result is that firms could borrow new money and obtain

various supports from financial institutions, including an exemption from the interest rate payment, a grace period for payment of the interest, a grace period for reimbursement of the principal, and a waiver of the claim. Therefore, in spite of the sharp deterioration in business conditions, funding difficulties for average firms only moderately worsened (See Figure 8).

**Figure 6**  
**Return on Assets (ROA) of Japanese Corporations (%)**



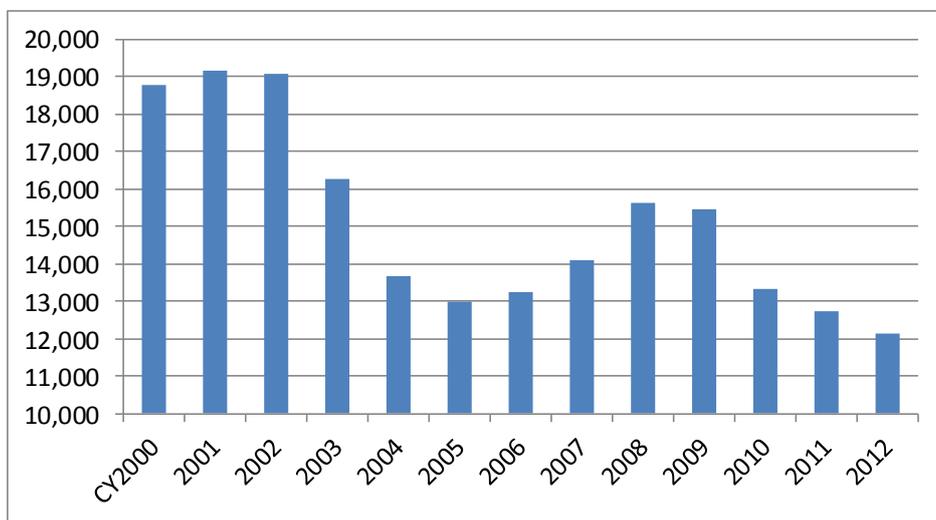
(Note 1) Here the ratio is defined as ordinary profit / total assets.

(Note 2) This figure is based on the whole sample, including small and large firms, and both manufacturing and non-manufacturing firms.

(Source) Ministry of Finance, Statistics of Financial Statements of Incorporated Businesses.

Figure 7

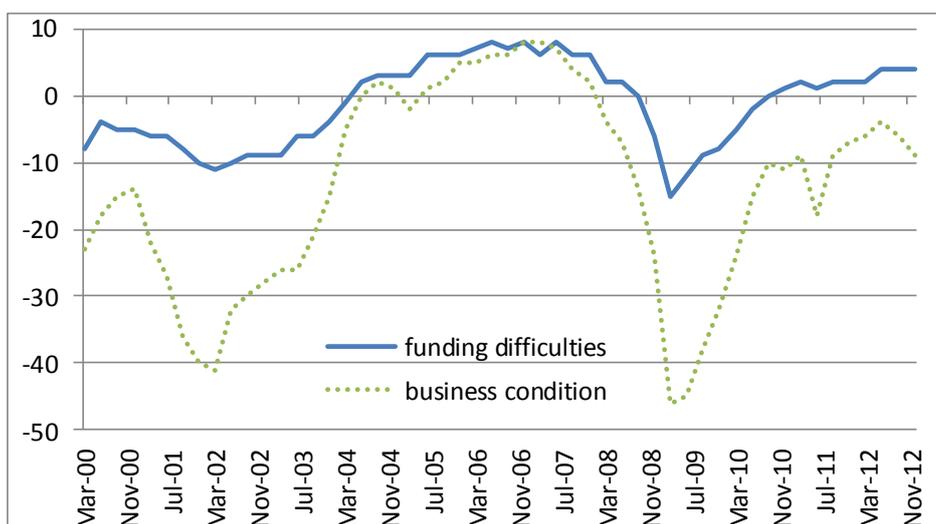
Number of Corporate Bankruptcies



(Source) Tokyo Shoko Research.

Figure 8

Business Sentiments



(Note) Results for all industries and all firms except the financial industry.

(Source) Bank of Japan's quarterly short-term economic survey (Tankan).

### *3.2. Bank Loans*

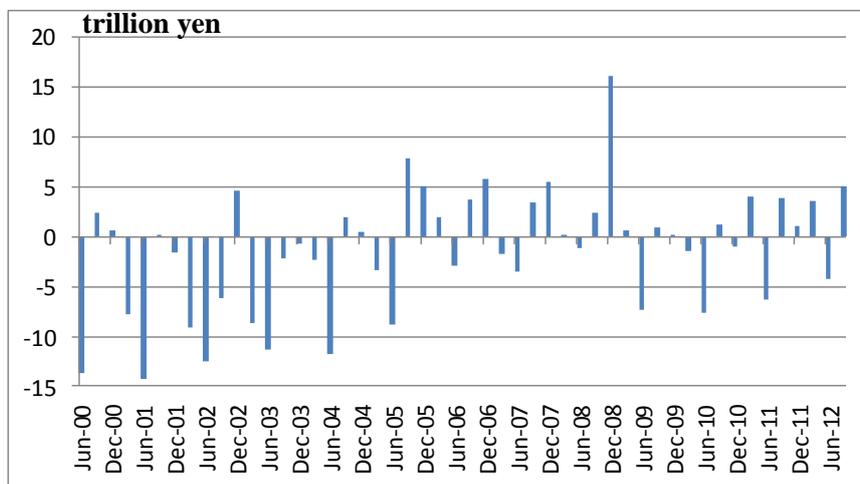
Figure 9 shows changes in loans extended by Japanese domestic banks and Shinkin banks. The fourth quarter of 2008, when the Lehman shock hit Japan, saw the largest increase in bank loans. Without this increase, the financing difficulties of Japanese firms might have been severer than what Figure 8 shows.

Figure 10 shows borrowers' side data. This figure shows that large firms borrowed substantial money from banks during the peak of the global financial crisis, but small- and medium-sized firms (SMEs) did not increase borrowing at the same time. However, it is notable that SMEs paid back lower amounts than before the crisis. Banks might support SMEs by giving SMEs a period of grace.

Why did banks extend more loans to borrowers who had become riskier due to the global financial crisis? When banks conduct a business model, called transaction banking, banks evaluate credit risks of borrowers on a timely manner. It was natural that banks downgraded credit evaluation of most borrowers during the global financial crisis. If so, bank loans might have decreased. In reality, bank loans increased. Most of Japanese banks perform the relationship banking business model, where banks and borrowers have long-term relationship, which mitigates information asymmetry. Banks can support firms who face temporal difficulties because the banks believe that firms will become profitable after the crisis ends. Therefore, it is natural that banks performing relationship banking tend to increase loans to long-term customer during the crisis. This might be the case for Japan.

However, the government was worried about whether voluntary supports provided by banks were enough to keep SMEs afloat. Rather, the government was afraid that banks might overestimate borrowers' risks and hesitate to extend supportive loans. The Japanese economy experienced such situations during the financial system crisis in the late 1990s and early 2000s. Therefore, the government decided to introduce various measures to protect the shocks from resulting in the greatest crisis in the century. We discuss these measures in the following parts of this paper.

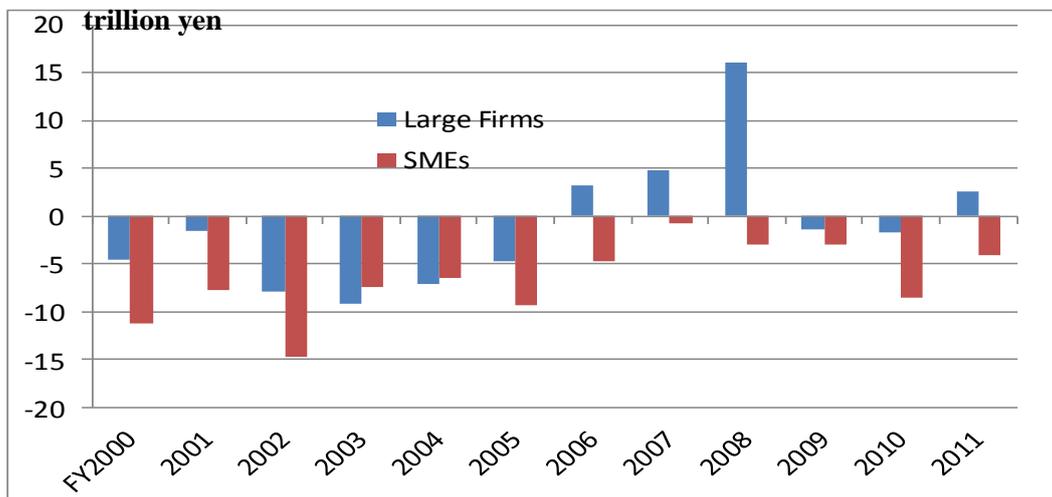
**Figure 9**  
**Bank Loan Changes (from the previous quarter)**



(Note) This graph shows the changes in loans of domestic banks and Shinkin banks, including trust accounts.

(Source) Bank of Japan.

**Figure 10**  
**Corporate Borrowing from Financial Institutions**



(Note) This graph shows sums of long-term and short-term fund-raising from financial institutions for each fiscal year. Here large firms are defined as firms with ¥1 billion or more in capital. SMEs are firms except for large firms.

(Source) Ministry of Finance, Statistics of Financial Statements of Incorporated Businesses.

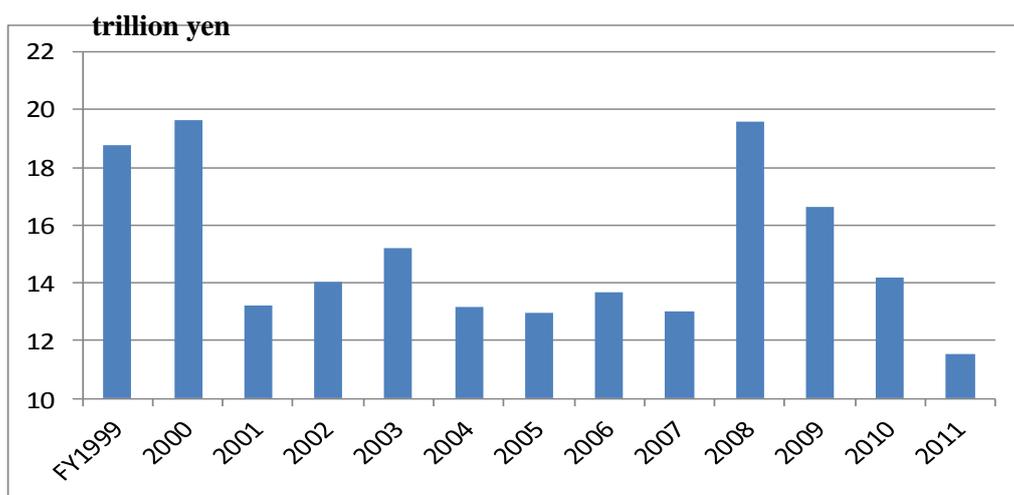
### 3.3. Public Guarantee Scheme

Japanese government, which was not sure the relationship banking response was substantial enough, decided to establish a new loan guarantee scheme, called “emergency guarantee” in 2008.

In Japan, there are loan guarantee schemes in which public corporations (Shinyo Hosho Kyoukai) guarantee bank loans. Under the general guarantee schemes, when borrowers fail to pay back loans, banks that extended loans to the bankrupt borrowers absorb 20% of the losses, and public guarantee corporations absorb the remaining 80%. However, under the emergency guarantee scheme, banks shoulder no burden of the losses, and the public guarantee corporations absorb all losses. Furthermore, the rates of guarantee charges that firms should pay to public guarantee corporations were set at a level that did not reflect the actual riskiness of the borrowers. Namely, implicit subsidy was provided to risky borrowers.

Figure 11 shows that approval amounts of new loan guarantees sharply increased in fiscal year (FY) 2008, reaching approximately ¥20 trillion. At the end of FY 2008, the total balance of loan guarantees amounted to ¥34 trillion<sup>5</sup>.

**Figure 11**  
**Approval Amounts of New Loan Guarantees**



(Source) National Federation of Credit Guarantee Corporations.

### *3.4. Loans from Public Financial Institutions*

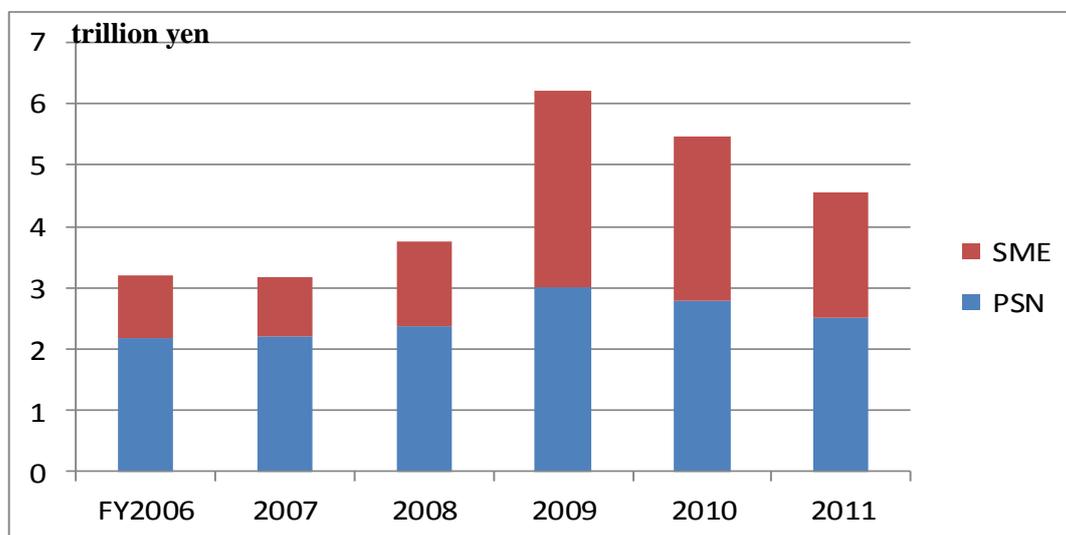
Public financial institutions had played an important role in Japanese financial markets before the Koizumi Cabinet's reform. The Koizumi Cabinet started privatization of public financial institutions because they believed that public financial institutions were inefficient and that private financial institutions were able to play the same role more efficiently.

The new laws were passed in 2007, and Development Bank of Japan (DBJ) and Shoko Chukin Bank (Central Bank for Commercial and Industrial Associations) were converted to stock companies in October 2008. At the same time, four public financial institutions, such as National Life Finance Corporation and Small Business Finance Corporation, were merged into one public institution, Japan Finance Corporation (JFC).

Ironically, just as these reforms began, the global financial crisis emerged, and the government had to use public financial institutions to tackle the crisis. The government urged JFC to provide special loans to corporate sectors. JFC provided more than ¥6 trillion to individuals and firms in 2009, which was almost twice the amount loaned in 2007, as shown in Figure 12. Furthermore, JFC started a new insurance scheme, the so-called "emergency operations." Under this scheme, DBJ and Shoko Chukin Bank could transfer loan losses to JFC. Actually, DBJ and Shoko Chukin Bank, using this scheme, provided ¥1.4 trillion in credits to private corporations for the latter half of FY 2008 and ¥3.9 trillion in credits for FY 2009.<sup>6</sup>

**Figure 12**

**Loans Provided by JFC**



(Note) PSN is new loans by National Life Finance Corporation and its incoming business department of JFC. SME is new loans by Small Business Finance Corporation and its incoming business department of JFC.

(Source) Japan Finance Corporation.

#### **4. Regulatory Measures to Encourage Banks to Make Loans**

Financial markets throughout the world became dysfunctional after the Lehman shock. The Japanese financial market was also exposed to a difficult situation, although not as difficult as those in Europe and the United States.<sup>7</sup> A critical problem in Japan was the possible deterioration in financing for SMEs. In this section, we discuss the regulatory measures taken by the government to ensure a smooth supply of funds to SMEs during that period.<sup>8</sup>

##### *4.1. Public Capital Injection*

###### *4.1.1. Brief Description of Capital Injections*

Observers recognized that many Japanese banks suffered from insufficient capitals because of huge losses caused by non-performing loans and declines of assets prices. However, there were

strong political criticisms that the government intended to save guilty banks by the sacrifice of taxpayers. The government experienced bitter negotiation to provide 700 billion yen and rescue almost bankrupt housing loan companies (Jyusen) in 1996. So, although the government recognized that a scheme to inject public funds into weak but still solvent banks was necessary to protect the financial system, it hesitated to propose the scheme to the congress.

To respond to the financial crisis that was aggravated by the failure of banks such as Hokkaido Takushoku Bank in November 1997, the Financial Functions Stabilization Act was finally established. Based on the Act, the first injection of public funds into banks in Japan to increase capital occurred in March 1998. Total public funds of ¥1.8 trillion were injected into 21 banks, including large city banks. However, because the injection was small, the weak management of banks such as LTCB that received the injection remained unresolved. The reason why the injection was so small was that the government was still concerning the political criticism and that banks were afraid of the reputation risk that capital injection would be a signal of weak banks and trigger depositors' bank runs.

In summer 1998, the world financial crisis that originated in Japan was feared due to the increase in Japan premiums while international financial crises, including Asian currency crises, were expanding. Thus, the Japanese public recognized that a large-scale capital injection was necessary, and the Act on Emergency Measures for Early Strengthening of Financial Functions was enacted in October 1998. A total capital injection of ¥25 trillion was prepared based on the Act. Beginning with an injection of ¥7.5 trillion for 15 banks in March 1999, by March 2002, a total of ¥8.6 trillion was injected based on the Act.

After the bank recapitalization bill lapsed, the Financial Crisis Response ordained in the Deposit Insurance Law was the only possible scheme for further injection of public funds into banks. An amount of ¥2 trillion public funds was injected into Resona Bank in May 2003 based on this scheme. Because the scheme was supposed to be exercised only in a state of emergency, this measure is taken only after a problem has occurred.

Therefore, the Financial Function Strengthening Act was approved in 2004, which enabled the government to inject capital prophylactically into financial institutions that are solvent but that

cannot perform adequate financial functions due to insufficient capital.

#### *4.1.2. Revised Act on Special Measures for Strengthening Financial Functions*

Because banks in Japan are subject to the capital adequacy rule, they are required to hold additional equity capital to increase lending. Therefore, after the Lehman shock, the concern was that a credit crunch or credit withdrawal would be triggered regarding SMEs given this capital adequacy rule. Moreover, if many banks had weak capital adequacy ratios, the financial system would become unstable.

The Financial Function Strengthening Act, which enabled the government to inject public funds for prevention purposes based on applications from financial institutions, was implemented to strengthen the financial condition of regional financial institutions in Japan. The Act was in effect from the end of August 2004 to the end of March 2008. Unfortunately, when the Lehman shock hit Japan, the Act was not in effect. Given the seriousness of the global financial crisis, the government decided to implement a new Financial Function Strengthening Act (hereafter, the revised Act) in December 2008. The revised Act was scheduled to be in effect until March 2012.<sup>9</sup>

Because the old Act placed significant responsibility on the directors at banks that received public funds, bank managers hesitated to apply for such assistance. Only two banks, Kiyo Holdings, Inc. (Kiyo Bank) and Howa Bank, received public funds. Unlike the old Act, the revised Act does not impose heavy penalties on bank executives when the bank applies for a capital injection.

Table 2 lists the banks that received an injection of public funds under the revised Act.<sup>10</sup> The table indicates that the number of banks that applied for an injection was much higher than under the old Act. On the other hand, because penalties imposed on management and shareholders were not significant under the revised Act, there was concern that a serious problem of moral hazard may occur.<sup>11</sup> Namely, the government assigned the highest priority to making banks to continue to provide loans to SMEs.

**Table 2**  
**Banks That Received a Capital Injection under the Revised Financial Function**  
**Strengthening Act**

Name of financial institutions	Date of capital injection	Amount (¥100 million)
Hokuyo Bank	March 2009	1,000
Fukuho Bank	March 2009	60
Minami Nihon Bank	March 2009	150
Michinoku Bank	September 2009	200
Kirayaka Bank	September 2009	200
Daisan Bank	September 2009	300
Shinkumi Federation Bank (Yamanashi Prefecture Shinkumi)	September 2009	450
Towa Bank	December 2009	350
Kouchi Bank	December 2009	150
Fidea Holdings (Hokuto Bank)	March 2010	100
Miyazaki Taiyo Bank	March 2010	130

(Note) The capital injection into Shinkumi Federation Bank was made through purchasing trust beneficiary rights. Other injections were made by purchasing preferred shares.

(Source) Deposit Insurance Corporation of Japan.

#### *4.2. Redefinition of Non-Performing Loans*

In November 2008, the FSA revised several rules that defined non-performing loans. Before the revision, the regulatory rule generally classified loans to borrowers whose loan conditions, such as payment schedule and interest rates, were changed as non-performing loans. It is difficult for banks to provide new loans to such downgraded borrowers. Therefore, firms hesitated to ask banks to change loan conditions. Banks also hesitated to change loan conditions because they had to write down these condition-changed loans, resulting in lower capital ratio.

The new rules introduced wider exceptional instances under which banks were allowed not to

classify condition-changed loans as non-performing loans. For example, under the new rule, if the borrowers have a credible restructuring plan and are confidently expected to attain the normal status of borrower classification within approximately five years (within 10 years if appropriate), the borrowers whose loan's condition is changed are allowed to be classified as normal status.<sup>12</sup>

This revised rule had significant impacts. Figure 1 in section 1 shows that the balance of non-performing loans increased only slightly in 2008, despite the fact that the economic slowdown was significant. Regarding the FSA's report on factors in changes of non-performing loans, ¥1.4 trillion in loans originally classified as non-performing loans (i.e., loans that require monitoring) were upgraded to normal status in 2008 because a credible restructuring plan was drawn up, while the figure for 2007 (before the rules changed) was only ¥0.2 trillion. Also, the amount of loans downgraded from normal status to non-performing status in 2008 was ¥0.9 trillion, which was less than before the crisis. Namely, the figures in 2006 and 2007 were ¥1.0 trillion and ¥1.2 trillion, respectively. This suggests that many borrowers maintained normal status by drawing up credible restructuring plans amid the global financial crisis.

This regulatory measure is controversial. Downgrading likely damages borrowers and decreases the chance for them to recover. It is also reasonable that loans to borrowers with truly credible restructuring plans are classified as normal status. Owing to this measure, banks can support borrowers without worrying about loss due to the write-off. This measure enables the financial system to continue functioning smoothly.

However, this measure has a downside. Speaking in the extreme, it is always possible to draw up a 10-year plan for a borrower to revitalize. By sweeping real issues under the rug, both banks and firms might not be forced to perform painful reforms. Harada, Hoshi, Hosono, Koibuchi, and Sakuragawa (2011), among others, pointed out that this measure damages the trustworthiness of Japanese banks' disclosure because it is subjective to judge whether a restructuring plan is credible.<sup>13</sup>

#### *4.3. Temporal Loosening of Capital Adequacy Ratio Regulation*

The government released an Economic Policy Measure Package, named “Seikatsu Taisaku,” on October 30, 2008. As a part of this measure, the government decided to loosen the capital adequacy ratio regulation to tackle the global financial crisis. This measure was scheduled to end by March 31, 2012.<sup>14</sup>

Before the measure, banks following the domestic capital adequacy rule were forced to deduct 60% of valuation losses of “other available-for-sale securities” from capital. However, after this measure, banks were allowed not to deduct any valuation losses of “other available-for-sale securities” from the capital. As securities prices sharply decreased during the crisis, many banks suffered huge valuation losses of securities in their portfolio.<sup>15</sup> Therefore, without this measure, the regulatory capital ratio of these banks would have fallen substantially.

The securities market did not function well during the crisis, and thus market prices of securities seemed to temporarily differ from fundamental values. In this sense, this temporal loosening may be reasonable. However, this measure also makes bank disclosure opaque.

#### *4.4. New Measures for Financial Facilitation*

“New measures for financial facilitation” were announced in March 2009 to facilitate firms’ borrowing because business conditions, not only of SMEs but also of middle-size and large firms, deteriorated remarkably during the recession after the Lehman shock. There are three main measures.

First, special off-site interviews were conducted at the end of FY 2008 to investigate whether banks were eager to supply funds to firms. Based on the results of the interviews, the operations from April to June 2009 of major banks as well as regional financial institutions that were swamped with complaints were examined.<sup>16</sup>

Second, the FSA changed the risk weight given to emergency guaranteed loans for calculating regulatory capital asset ratios. As emergency guaranteed loans were fully guaranteed by public credit guarantee corporations and banks hold no credit risk for them, the FSA decreased their risk weight from 10% to an exceptional 0%. This measure intended to decrease amounts of risk

assets, which is the denominator of the capital ratio.

Adding to the temporal loosening of capital adequacy ratio regulation discussed in 4.3, regulatory capital ratio of regional banks actually increased for FY 2008 when they recorded negative profits. Namely, average capital ratio of regional banks (including regional banks II) rose from 10.5 % (at the end of March 2008) to 10.7% (at the end of March 2009).

Third, capital injections based on the revised Act, discussed in section 4.1 in this paper, were promoted during open hearings to financial institutions by requesting that they consider a more positive use of the Act.

#### *4.5. Act to Facilitate Financing for SMEs (Kinyu Enkatsuka Act)*

An “Act on temporary measures to facilitate financing for SMEs” (hereafter, the SMEs Finance Act) was implemented in December 2009 to assist SMEs that had difficulty with management and finance as a result of the recession after the Lehman shock. The SMEs Finance Act imposes obligations on financial institutions to make efforts to respond to requests as best as they can when SMEs and mortgage borrowers apply for a softening of borrowing conditions, such as extensions of repayment deadlines.

The SMEs Finance Act could cause an increase in non-performing loans. Therefore, banks might hesitate to respond to borrowers’ requests. Thus, some additional measures were taken to promote the implementation of the Act. If a financial institution admits softening loan conditions, it does not have to classify them as non-performing loans in most cases under the Act.<sup>17</sup> Moreover, although banks must make an effort to respond to borrower requests, a legal penalty on banks is not specified if they fail to do so. However, banks must organize their implementation system, report their implementation results to the authorities, and disclose them to the public. A legal penalty is imposed for false disclosures or reports.

Table 3 summarizes the implementation of the Act from the beginning of its enforcement to the end of September 2012. The implementation ratio is at a relatively higher level because of the supportive measures discussed above. However, from the point of view of financial stability, we are concerned that banks hold many unreported non-performing loans because substantial loans

with extended repayment periods may be classified as normal loans.

We can admit that the SMEs Finance Act has directly contributed to a decrease in the number of corporate bankruptcies. If the difficulties borrowers face are cyclical, the costs of this measure seem moderate. However, if borrowers face structural difficulties, procrastination will make issues harder to resolve. Procrastination often disinclines banks and borrowers to conduct painful restructurings. Unfortunately, Teikoku Data Bank, a Japanese major industry information provider, reports that failures of firms that obtained a softening of loan conditions under the Act are increasing.<sup>18</sup> It suggests that the costs of procrastination will be larger.

**Table 3**  
**Implementation Rate of the Act to Facilitate SME Finance (in cases where debtors are SMEs) (until September 2012)**

	1 (%)	2 (%)
Major banks (10)	97.3	92.2
Regional banks (106)	97.3	92.8
Other banks (26)	90.7	86.9
Credit associations (272)	97.6	93.5
Credit cooperatives (159)	98.1	94.3
Labor credit associations (14)	100.0	100.0
Credit federation of agricultural cooperatives and credit federation of fisheries cooperatives (67)	98.8	95.8
Total (654)	97.4	92.9

(Note 1) Column 1 displays the implementation ratio that equals the implementation number divided by both the implementation number and the rejection number.

(Note 2) Column 2 displays the implementation ratio that equals the implementation number divided by the total application number. The discrepancy between Columns 1 and 2 is due to the numbers of applications under review.

(Note 3) Saitama Resona Bank is included in the regional banks.

(Source) Financial Services Agency.

## 5. Concluding Remarks

This study explains how Japanese banks and banking regulations have responded to the global financial crisis. Although the Japanese financial system weakened significantly after the collapse of the economic bubble in the early 1990s, it had recovered stability and soundness before this global crisis occurred. Japanese financial institutions did not hold a large amount of securitized assets related to subprime loans, thus direct losses related to these assets were not large during the global financial crisis of 2008. Therefore, unlike in Europe and the United

States, there was little need for the FSA to assist damaged financial institutions. However, bank supervision regulations had to be changed in response to the financial crisis in Japan. Namely, as SMEs' business conditions deteriorated sharply, the government had to encourage banks to assist SMEs.

Historically, the main purpose of bank regulation is to keep the banking system stable and sound, but the FSA had to shift the emphasis from prudential consideration to economic activity consideration.<sup>19</sup> Although there are some measures, such as the public capital injection scheme, that actually increase bank soundness, most measures are regarded as financial window-dressing, including the change of the definition of non-performing loans and the exclusion of valuation losses of securities from capital ratio calculations.

How should we evaluate these window-dressing measures? These measures mitigated negative shocks, limiting corporate bankruptcies. We may understand that the FSA implicitly modified pro-cyclicality, which the Basel II capital adequacy regulation is criticized as having done. During the crisis, the FSA reduced effective capital ratio while the nominal ratio of 8% remained unchanged. Without these measures, bad economic conditions might have reduced banks' capital ratios, and banks with lower capital ratios would have been forced to cut lending, deteriorating the economy further. After the crisis, many observers criticized the capital adequacy regulation for its pro-cyclical nature. In this sense, the FSA was a pioneer.

However, as pointed out before, these measures make reported figures, such as bad-loan ratios and capital ratios, opaque. It is now hard for depositors to know how much banks hold in real capital and bad loans based on the disclosure report. The true financial condition of Japanese banks may be worse than what is disclosed. Fortunately, so far, this ambiguity has not created public distrust of banks. Additionally, procrastination of problems often damages motivations of banks and borrowers to tackle difficulties, and therefore, the possibility to resolve problems likely becomes smaller.

We also note that the FSA utilized the double standard, under which different rules are applied for internationally active banks (i.e., banks having overseas subsidiaries and branches) and for domestically operating banks. For example, it is hard for the FSA to modify capital adequacy

rules for international banks, which are subject to the Basel international agreement. However, rules for domestic banks are not subject to the international agreement and the FSA can modify the rules. When crisis hit Japan, the FSA had relatively high degree of freedom for modifying regulatory rules that were only applied for domestic banks. Responding to the crisis, the FSA could flexibly modify several regulatory rules. Furthermore, domestic banks are major lenders to SMEs. Therefore, regulatory measures that mainly affected domestic banks were effective for protecting SMEs.

Recently, IMF (2012) pointed out; “for domestic and internationally active banks, different minimum capital levels and a different definition of capital are used, although a similar capital adequacy framework applies. Triggers for early intervention measures due to a shortfall in minimum capital levels are set at a too low level especially for domestic banks.” Then, IMF insisted “The authorities should seek to enhance the standards for capital adequacy, and to streamline the rules applicable for domestically and internationally operating banks.” Implicitly, IMF criticizes the double standard approach taken by the FSA. In the future, we are not sure whether the FSA’s approach is accepted by other countries<sup>20</sup>.

In Sum, we have a big challenge. We have to search for a policy that has flexibility or a counter-cyclical nature to stabilize the short-term economic fluctuation but that does not hurt the credibility of bank disclosure, which is necessary condition for long-term economic stability. Furthermore, the Japanese economy has to cope with recurring crises after the collapse of the bubble economy. The Japanese economy is still stagnant, and it is more and more necessary to stimulate the economy from the financial side. We need to search for new policy measures that encourage banks to take more risk to stimulate the economy and yet also effectively prevent banks from taking excess risk.

#### **ACKNOWLEDGEMENTS**

This research was financially supported by the Japan Society for the Promotion of Science (JSPS), Grant-in-Aid for Scientific Research (A). This paper was presented at the conference

held by Daejeon & Chungnam Branch, the Bank of Korea, in March 2013. We thank Professor Yutaka Kurihara for encouraging us to submit this paper to this journal.

## NOTES

1. More technical analyses are conducted in Ogura and Yamori (2010), Yamori and Harimaya (2009, 2010a, 2010b), Yamori, Harimaya, and Asai (2006), Yamori and Okada (2007), Yamori, Tomimura, and Harimaya (2011). Also, many studies analyze Japanese banking (e.g., Hall, 1999, 2003, 2007; Honda, 2002; Uchida & Udell, 2010).
2. See Yamori and Nishigaki (2008), which describes the large changes that have occurred in the financial system since the 1990s, as well as the impacts of those changes on banks, and discusses the new challenges for Japanese banks.
3. To be more exact, the government holds 100% of the shares of the holding company, Japan Post, and the holding company holds 100% of the shares of Japan Post Bank. A part of Japan Post shares that the government holds is scheduled to be sold.
4. A detailed analysis was conducted by Yamori and Kobayashi (2007). According to the results, the market recognized that this capital infusion was a “too big to fail” type policy.
5. Japanese fiscal year starts on April 1 of each year and ends on March 31 of the following year.
6. Therefore, the government recognized the necessary role of public financial institutions. Initially, stocks of DBJ and Shoko Chukin Bank were scheduled to be sold in the market by 2015. However, while tackling the global crisis, the government changed the schedule. New laws, which put off complete privatization of DBJ to around 2022, were enacted in 2011.
7. The FSA reported that the total amount of subprime-loan-related products Japanese depository institutions held as of September 30, 2008, was ¥797 billion, while the Tier 1 capital of these institutions amounted to ¥50.1 trillion.
8. A detailed discussion of the BOJ’s policies can be found in Yamori and Kondo (2011).
9. The Act was revised in 2011 after the East-Japan Great Earthquake. The public capital injection scheme will be in effect until March 2017.
10. Under the 2011 revised Act, many banks that were seriously damaged by the East-Japan Great Earthquake obtained public funds.
11. Based on the Act, an Examination Board has been established to review the applications and monitor the performance of banks. Currently, Nobuyoshi Yamori, an author of this paper, serves as a member of this Examination Board.
12. Strictly speaking, these assets are generally classified as “other performing loans with some concerns for the future.”
13. Spiegel and Yamori (2006) find that banks with larger bad loans tended not to disclose figures of bad loan ratios when the disclosure was not compulsory. Furthermore, Kondo (2010) also showed that financial institutions with more bad loans tended to be passive

- regarding disclosure, especially if they were rated by foreign rating agencies.
14. In June 2012, the FSA decided to extend this measure until March 30, 2014. It exemplifies the difficulty in ending a “temporal” measure.
  15. According to the Japanese Bankers Association, total valuation losses of “other available-for-sale securities” amounted to ¥1.9 trillion at the end of March 2009, while banks held ¥2.5 trillion valuation profits at the end of March 2008. As Tier 1 capital of regional banks, most of which followed the domestic capital adequacy rule, was around ¥13 trillion yen at the end of March 2009, this measure had substantial impacts on their capital ratios.
  16. “One Year of the Financial Services Agency (Fiscal Year 2008)” indicates that there were no regional financial institutions that were swamped with complaints.
  17. Under the Act, the definition of non-performing loans was revised. Now, borrowers who have no restructuring plan when they request a softening of borrowing conditions but who will surely make a credible restructuring plan within one year are classified as normal status.
  18. See Teikoku Data Bank HP at <http://www.tdb.co.jp/report/watching/press/p120805.html>.
  19. Of course, in the sense that a prosperous economy reduces the possibility of corporate failures, these measures indirectly contribute to the soundness of the banking system.
  20. The FSA has already implemented Basel III regarding internationally active banks. The FSA plans to implement different capital adequacy rules for domestic banks. Regarding to IMF (2012), “The FSA expects the IMF to understand that non-internationally active banks engage in community based businesses and thus their minimum capital ratios should be set to balance the two objectives of facilitating their financial intermediary function in respective regions and ensuring safety and soundness of those banks.”

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## **Required Return on Investment and Its Financing**

**Yukitami Tsuji**

Keio University

2-15-45 Mita, Minato-ku, Tokyo, 108-8345, Japan

tsuji@fbc.keio.ac.jp

Received: December 24, 2012   Revised: April 4, 2013   Accepted: April 24, 2013

### **ABSTRACT**

It is widely accepted that the required return on investment is regarded as the weighted average cost of capital. This method for deciding whether an investment should be executed is theoretically appropriate in only a few models, such as the Modigliani and Miller (1963) hypothesis. In a capital structure model that includes bankruptcy costs and agency costs, this study calculates the required return from the model. We examine difference between the WACC computed from data and the required return estimated from the model. This study also shows that the pecking order hypothesis holds for investment financing in optimal capital structure.

**Keywords:** WACC, Required Return, Optimal Capital Structure, Pecking Order

**JEL Classification:** G31, G32

## 1. Introduction

This study calculates the required return on investment in a corporate capital structure model. The required return on investment is a cut-off rate or a hurdle rate when deciding whether an investment is executed or not. If a firm employs the IRR method for its decision-making, it adopts investment opportunities for which their internal rates of return are above their required return. When a firm uses the NPV method, the required return determines a discount rate to compute its net present value.

For brevity we begin by summarizing an investment decision that depends on the IRR method. In the explanation that uses the NPV method, some details must change, but the same basic argument holds. In the IRR method, a rate of return on investment is expected. A simple example is useful to clarify the matter. Suppose that immediately after executing an investment of \$100, a firm predicts the increase in earnings before interest and tax (EBIT) at \$20. Then the expected rate of return is 20%, and the after-tax return is expressed as  $(1 - \tau) \times 20\%$ , where  $\tau$  is a corporate tax rate. It is now common sense among business and academic circles that the required return to be compared with this return is the weighted average cost of capital (WACC), defined as

$$CC_{tax} = \frac{S_L}{V_L} \rho_S + \frac{B}{V_L} (1 - \tau) \rho_B, \quad (1)$$

where  $S_L$  is an equity value,  $B$  is a debt value, and  $V_L$  is a firm value.  $\rho_S$  is the cost of capital on equity, which is usually computed through the CAPM.  $\rho_B$  is the cost of capital on debt. Instead of the required return on debt-holders, an average borrowing rate the firm incurs is substituted into  $\rho_B$ .<sup>1</sup>

If a firm is listed on a stock exchange, the value of the required return through Equation (1) is calculated from data on firm's stock prices and financial reports. We can get it with minimal difficulty, as if it were decided exogenously outside the firm. Whether this method preserves theoretical consistency, however, depends on a particular model. Intuitively speaking, this is the Modigliani and Miller (1963) model, which assumes corporate income tax.<sup>2</sup> When you extend your model to consider a factor that Modigliani and Miller (1963) did not assume, its logic fails. The dominant evolving theories discredit the hypothesis that Modigliani and Miller (1963) derived. Several factors that the MM hypothesis did not include --- for example, the financial distress costs, the bankruptcy costs, and the agency costs --- are widely recognized among business and academic circles. If you extend Modigliani and Miller (1963) to adding the bankruptcy costs and the agency costs in order to explain actual capital structure, then the required return that should be compared with  $(1 - \tau) \times 20\%$  is no longer an exogenous value given by  $CC_{tax}$  in Equation (1). It is necessary to endogenously calculate the required return

through a capital structure model. If you adhere to using  $CC_{tax}$ , your investment decision can be suboptimal. The purpose of this paper is to compare  $CC_{tax}$  and the required return from the model.

Unless they are different,  $CC_{tax}$  approximates the required return. We can say that the WACC, which is popular in practice, is a convenient method to get the true value of the required return. But if they differ distinctly, there is no validity of regarding  $CC_{tax}$  as the required return. In this paper, the capital structure model on which the required return depends extends a bankruptcy cost model to including agency costs. Under this model, we calibrate a value of the required return as a rate of return below which existing shareholders have a loss on firm's investment. This computation shows how different the required return is from  $CC_{tax}$  for numerical examples and actual firms.

The sample we employ in this paper consists of more than 500 firms, which are listed on the Tokyo Stock Exchange among manufacturing industries. Although  $CC_{tax}$  and the required return from the model move together to some extent, their co-movement is not very strong. There is a period when  $CC_{tax}$  is 20% larger than the estimated required return in terms of sample averages. Since  $CC_{tax}$  overestimates the required return on investment for some firms, using the WACC is not always adequate.

The method for computing the required return from the model reveals an interesting characteristic of investment financing; compatibility of the optimal capital structure theory and the pecking order hypothesis.<sup>3</sup> Although these are considered as conflicting opinions, the model of this paper shows that a firm has an optimum in corporate capital structure. When adding an investment to the firm, the pecking order hypothesis appears in financing the investment. We can say that the pecking order hypothesis can be derived in the optimal capital structure model. This is another characteristic of this paper. The reason is as follows.

If a capital structure model has homogeneity of degree one with respect to firm's size, the investment strategy that maintains constant return to scale seems to be optimal. In this case, the required return is equal to firm's earnings ratio. However, when a firm maximizes the wealth of shareholders, this strategy is not always optimal, depending upon how it finances the investment. We assume that cash to execute the investment is raised from outside investors. The investment that makes a firm purely scaled up must issue a mix of new debt and new equity, the proportion of which is the same as the corporate capital structure. As long as old debt-holders do not make a loss, this pure scaling-up strategy is optimal. On the contrary, the firm can give old shareholders greater gains at the sacrifice of the old debt-holders, issuing more debt in financing the investment. New debt exceeding the pure scaling-up case dilutes the value of old debt and

increases the wealth transfer from old debt-holders to shareholders. As a result, the required return on investment becomes smaller than the firm's earnings ratio. Therefore, even if a capital structure model has constant return to scale, the pure scaling-up investment strategy is not necessarily optimal when a firm can issue securities without any restriction.

How to finance an investment changes the required return. An investment opportunity, which otherwise would be rejected, might be executed because shareholders are compensated with the wealth transfer from old debt-holders. The required return on investment decreases by the wealth transfer. Maximizing the wealth transfer through all debt financing minimizes the required return. When financing an investment, all debt is preferred to the mix of debt and equity. Even if the firm has the optimal capital structure, the pecking order hypothesis can hold for investment financing.

However, there is a financing pattern other than the pecking order hypothesis in this model. Unless the probability of firm's bankruptcy increases for all debt financing, no wealth is transferred from old debt-holders to shareholders. Then the mixed issuance of debt and equity which reflects the optimal capital structure might be preferable to all debt. Strictly speaking, whether the pecking order hypothesis holds or not depends on parameters a firm faces. Although both of them exist for actual firms, the pecking order hypothesis outnumbers the mixed issue.

This paper clarifies two aspects about the investment decision. One is to investigate whether the WACC is valid for the required return on investment. The other is that investment financing results in the pecking order hypothesis under the optimal capital structure model. There are many studies in economics that focus on investment. Hayashi (1982) is the most comprehensive among traditional theories. In the meantime, introducing uncertainty, continuous time models, which began with Dixit and Pindyck (1994), develop dynamic strategy to make an investment decision. The efforts of integrating these streams are completed in Bolton, Chen, and Wang (2011), where issues of corporate finance have not yet been included sufficiently. Continuous time modeling about various kinds of agency costs as well as investment has now become very popular through tentative studies of Leland (1998) and Morellec (2004). Models that deal with investment explicitly and discuss effects of financing on it in terms of agency costs are Giat, Hackman, and Subramanian (2010), DeMarzo, Fishman, He, and Wang (2012), and Hackbarth and Mauer (2012).

These studies in recent years depend on sophisticated frameworks and provide us with refined analyses. But it cannot be denied that due to their features they might be difficult to come in contact with firm's decision-making. As to the method of the investment decision, which is taught in common in American universities and prevails in practice, implication of these studies

is not obvious. It is not evident that these studies interpret consistently traditional corporate finance viewpoints. On the contrary, since this paper uses a simple one-period model, what it means is straightforward, and we can reply to problems mentioned above.

This study explains a model of capital structure in Section 2, where we do not consider firm's investment explicitly. In Section 3, adding investment to the model, we provide the method for calculating the required return, and investigate how a firm should finance investments. We show some simulation results in Section 4 and apply the method to actual firms in Section 5. Section 6 presents the conclusion.

## 2. A Model of Capital Structure

### 2.1. Valuation of Equity and Debt

We begin with a basic model, the purpose of which is to derive optimal capital structure at the outset.<sup>4</sup> This is a one-period model. At the beginning of a period, a firm is founded and issues debt and shares of stock. The firm purchases assets and starts up in business. Investors are debt-holders and shareholders. The person who makes the decisions for the firm is a manager who works on behalf of the shareholders. At the end of the period when the firm is liquidated, EBIT over the period and proceeds from the sale of assets are distributed among the investors. The values of equity and debt issued at the beginning are denoted as  $S_L$  and  $B$ . The sum of  $S_L$  and  $B$  is a firm value  $V_L$ .  $V_L$  also represents the value of assets the firm holds at the beginning, because we assume that the firm purchases them with all the funds it raises.

In this study, the debt, which is a senior claim, promises a payment  $L$  to debt-holders at the end of the period.  $L$  consists of the principal and interest of the debt. The sum of the EBIT and the liquidation value is  $\tilde{Z}$ , which is firm's cash flow distributed to debt-holders and shareholders at the end of the period.  $\tilde{Z}$  is a random variable that follows a normal distribution  $N(\mu_Z, \sigma_Z)$ .<sup>5</sup>  $\mu_Z$  is an expected value and  $\sigma_Z$  is standard deviation. If a realized value  $Z$  of  $\tilde{Z}$  is greater than  $L$ , the firm pays  $L$  to the debt-holders first, then corporate income taxes, and finally the residual is paid to the shareholders as dividends. However, if  $Z$  is less than  $L$ , the firm is in default and goes bankrupt. Then bankruptcy costs that amount to  $K$  are incurred. This study assumes bankruptcy costs to be proportional to the firm value,  $K = kV_L$ .

Suppose that the corporate income tax is an asymmetric type of tax loss offset provisions. Asymmetric income tax is such that taxable income is charged at the rate of  $\tau$  if and only if it is positive. If taxable income is negative, the tax payment is zero. Taxable income is calculated as  $Z - V_L - (L - B)$ , where  $Z - V_L$  is earnings from business activities, and  $L - B$  is a deductible interest expense. When  $Z$  is greater than  $V_L + L - B$ , the tax payment amounts to

$\tau[Z - V_L - (L - B)]$ . When  $Z$  is less than  $V_L + L - B$ , the tax payment becomes zero since the taxable income is negative.

Shareholders' cash flow at the end of the period,  $\tilde{Q}_{LS}$ , is formulated as

$$\tilde{Q}_{LS} = \begin{cases} \tilde{Z} - L - \tau(\tilde{Z} - V_L - [L - B]) & \text{for } Z \geq V_L + L - B, \\ \tilde{Z} - L & \text{for } V_L + L - B > Z \geq L, \\ 0 & \text{for } L > Z. \end{cases} \quad (2)$$

Since shareholders have limited liability,  $S_L = V_L - B > 0$ , this means that  $V_L + L - B$  is always greater than  $L$ . There are three equations for  $\tilde{Q}_{LS}$ , depending on whether  $\tilde{Z}$  is greater than  $V_L + L - B$  or  $L$ . The first of Equation (2) is the case where the taxable income is positive; there is no bankruptcy. In the second of Equation (2), the taxable income is negative, but the firm does not go bankrupt. The third describes the case where the firm goes bankrupt. Then  $\tilde{Z}$  belongs to the debt-holders, and the shareholders get nothing.

Debt-holders' cash flows are represented as  $\tilde{Q}_{LB}$ , the formula for which depends on whether the promised payment to debt,  $L$ , is greater than the bankruptcy costs,  $K$ . In the case where  $L > K$ ,  $\tilde{Q}_{LB}$  is

$$\tilde{Q}_{LB}^{(L>K)} = \begin{cases} L & \text{for } Z \geq L, \\ \tilde{Z} - K & \text{for } L > Z \geq K, \\ 0 & \text{for } K > Z. \end{cases} \quad (3)$$

The superscript shows  $L > K$ . When  $Z \geq L$ , debt-holders receive the promised payment  $L$ . When  $Z$  is less than  $L$ , the firm goes bankrupt, and  $\tilde{Z}$  belongs to the debt-holders who incur the bankruptcy costs  $K$ . If  $Z$  is less than  $K$ , debt-holders' cash flow from the firm becomes zero because of their limited liability.

In the case of  $K \geq L$ , the formula for  $\tilde{Q}_{LB}$  becomes

$$\tilde{Q}_{LB}^{(K \geq L)} = \begin{cases} L & \text{for } Z \geq L, \\ 0 & \text{for } L > Z. \end{cases} \quad (4)$$

This second equation represents the bankruptcy case where there is no cash flow because of the bankruptcy costs and the limited liability.

The equity value  $S_L$  and the debt value  $B$  at the beginning of the period are derived from their cash flows at the end of the period. This study employs the CAPM in pricing securities. The certainty equivalent approach of the CAPM can be applied to their valuation:

$$S_L = \frac{E(\tilde{Q}_{LS}) - \lambda_{cov}(\tilde{R}_M, \tilde{Q}_{LS})}{1 + R_F}, \quad (5)$$

$$B = \begin{cases} \left[ E\left(\tilde{Q}_{LB}^{(L>K)}\right) - \lambda \text{cov}\left(\tilde{R}_M, \tilde{Q}_{LB}^{(L>K)}\right) \right] / (1 + R_F) & \text{for } L > K, \\ \left[ E\left(\tilde{Q}_{LB}^{(K \geq L)}\right) - \lambda \text{cov}\left(\tilde{R}_M, \tilde{Q}_{LB}^{(K \geq L)}\right) \right] / (1 + R_F) & \text{for } K \geq L, \end{cases} \quad (6)$$

where  $R_F$  is a riskless interest rate,  $\tilde{R}_M$  is the rate of return on the market portfolio, and

$$\lambda = \frac{E(\tilde{R}_M) - R_F}{\sigma(\tilde{R}_M)^2}.$$

The means and covariance in Equations (5) and (6) are computed through partial moment formulas for the normal distribution  $N(\mu_Z, \sigma_Z)$ . Their expressions appear in Tsuji (2012).

## 2.2. Modeling the Agency Costs of Debt

The valuation of equity and debt in Section 2.1 is premised on the CAPM, which depends on the assumption that investors have perfect information in capital markets. The agency costs are caused by managerial discretion or investment distortion after a firm issues its security. Thus, we assume that capital markets are perfect, at least when securities are issued. Other studies about agency costs also assume that investors have perfect information in capital markets at the beginning of a period. For example, Leland (1998) and Morellec (2004) employ continuous time pricing models for security valuation, taking agency costs into account. This model adopts the CAPM instead of continuous time models.

At the beginning of a period, a manager and all investors equally expect a correct probability distribution of  $\tilde{Z}$ , which means perfect information. Their expectation is reflected in the parameters:  $\mu_Z$ ,  $\sigma_Z$ , and  $\text{cov}(\tilde{R}_M, \tilde{Z})$ . We know from the means and covariance of Equations (5) and (6) that  $S_L$  and  $B$  are functions of several parameters:  $L$ ,  $\mu_Z$ ,  $\sigma_Z$ ,  $k$ ,  $\tau$ ,  $\lambda$ ,  $R_F$ , and  $\text{cov}(\tilde{R}_M, \tilde{Z})$ . What the manager is able to control directly in his/her decision making is assumed to be  $L$ ,  $\mu_Z$ , and  $\sigma_Z$ . We focus on them in this model.<sup>6</sup> The equity and debt values are denoted as

$$\begin{aligned} S_L &= S_L(L, \mu_Z, \sigma_Z), \\ B &= B(L, \mu_Z, \sigma_Z). \end{aligned}$$

The firm value is the sum of these values and is defined as

$$V_L(L, \mu_Z, \sigma_Z) = S_L(L, \mu_Z, \sigma_Z) + B(L, \mu_Z, \sigma_Z).$$

How does this model account for managerial discretion, which causes the agency costs? The model reflects what the manager does in the probability distribution parameters,  $\mu_Z$  and  $\sigma_Z$ . Needless to say,  $\mu_Z$  and  $\sigma_Z$  might be observable, but cannot be verified even if a realized

value  $Z$  is verifiable. After issuing securities, he/she can operate the firm aligned with his/her own target, so that  $\mu_Z$  and  $\sigma_Z$  attain the most advantageous value. These are not the best for investors. On the other hand, anticipating the manager's decision after issuing securities, the investors correctly forecast the values of  $\mu_Z$  and  $\sigma_Z$  that he/she will select. This is the meaning of "perfect information" in this model. While the manager might guarantee these values, his/her promises are not enforceable and not trusted by the investors because they are not verifiable.<sup>7</sup> Investors evaluate securities, predicting the values of  $\mu_Z$  and  $\sigma_Z$  that he/she will choose in line with his/her objective.

The model in this study explicitly considers agency costs between debt-holders and shareholders. Hereafter, we designate them as the agency costs of debt. When discussing the agency costs of debt, a manager is assumed to be a faithful agent for shareholders. This model assumes that his/her objective is to maximize the wealth of shareholders. Then the incentives of asset substitution and debt overhang give rise to the agency costs. With regard to asset substitution, even if it reduces EBIT, the manager can use a business strategy that increases firm's risk enough to increase the equity value. Debt overhang makes the manager abandon a business strategy that improves the EBIT but that might decrease the equity value owing to leakage into debt.

If a firm is unleveraged, asset substitution and debt overhang do not arise, and all the strategies that increase the EBIT are used. The result of this decision making by the unleveraged firm is the expected value of its cash flow,  $\omega_Z$ . On the other hand, if the firm is leveraged and has to pay  $L$  at the end of a period,  $L$  makes  $\mu_Z$  lower than  $\omega_Z$  due to these incentives. Hence  $\mu_Z$  is regarded as a function of  $\omega_Z$  and  $L$ . For the brevity of this model, we assume that  $\mu_Z$  is a linear function of  $L$  through the incentives that cause the agency costs:

$$\mu_Z = \omega_Z - \alpha L, \quad \alpha > 0, \quad (7)$$

where  $\alpha$  means the decline in  $\mu_Z$  from  $\omega_Z$  with a unit increase of a debt burden. So  $\alpha$  is the marginal effect of the agency costs of debt.<sup>8</sup>

At the beginning of a period, the manager chooses firm's capital structure to maximize the firm's value. The capital structure is derived from  $L$ , under which he/she decides to maximize cash the firm raises from capital markets:

$$L^* = \arg \max_L \{S_L(L, \mu_Z, \sigma_Z) + B(L, \mu_Z, \sigma_Z)\}. \quad (8)$$

Next, during the period just after the beginning, the manager behaves so as to maximize the equity value. With the firm taking more risk in managements, the equity value increases to the detriment of the debt value. Through the incentive of this asset substitution, he/she chooses  $\sigma_Z$ , the value of which leads to the maximization of  $S_L$ .<sup>9</sup>

$$\sigma_Z^* = \operatorname{argmax}_{\sigma_Z} S_L(L^*, \mu_Z^*, \sigma_Z^*) \quad (9)$$

In sum, the optimal decision making strategy for the manager is to decide the values of these three parameters,  $L$ ,  $\mu_Z$ , and  $\sigma_Z$ , which satisfy Equations (7), (8), and (9). We denote these solutions as  $L^*$ ,  $\mu_Z^*$ , and  $\sigma_Z^*$ . The manager favors their values the most, carrying out his/her objective. Then investors can price the securities, perfectly knowing them. Rewrite the simultaneous equations, thus:

$$\frac{\partial}{\partial \sigma_Z} S_L(L^*, \mu_Z^*, \sigma_Z^*) = 0, \quad (10)$$

$$\frac{\partial}{\partial L} V_L(L^*, \mu_Z^*, \sigma_Z^*) = 0, \quad (11)$$

$$\mu_Z^* = \omega_Z - \alpha L^*. \quad (12)$$

Although  $L^*$ ,  $\mu_Z^*$ , and  $\sigma_Z^*$  are endogenously decided with the equations, new exogenous parameters,  $\omega_Z$  and  $\alpha$ , have appeared. Thus, by formulating the agency costs, the equity, debt, and firm valuations become functions of  $\omega_Z$  and  $\alpha$ ;

$$\begin{aligned} S_L &= S_L(\omega_Z, \alpha; L^*, \mu_Z^*, \sigma_Z^*), \\ B &= B(\omega_Z, \alpha; L^*, \mu_Z^*, \sigma_Z^*), \\ V_L &= V_L(\omega_Z, \alpha; L^*, \mu_Z^*, \sigma_Z^*). \end{aligned}$$

### 2.3. A Numerical Example

This model cannot be solved analytically. In order to know features of the model, we have to depend on a numerical solution method. Here we explain a numerical example on which the model is to be solved.

We assume a one-period model where one period is a long term (for example, 10 years). A cash flow at the end of a period,  $\tilde{Z}$ , is the sum of EBIT for 10 years and the liquidation value of assets. One of the basic parameters to which we give a numerical value is  $\omega_Z$ , which is the cash flow at the end of the period when the firm is unleveraged and when there are no agency costs. Another parameter is  $\alpha$ , which is the marginal effect of the agency costs. We assume that  $\omega_Z$  is 50 and that  $\alpha$  is 0.2.

For other parameters, the bankruptcy cost parameter  $k$  is 0.4, and the corporate income tax rate  $\tau$  is 0.45. Parameters related with capital markets are  $E(\tilde{R}_M) = 0.11$ ,  $\sigma(\tilde{R}_M) = 0.18$ , and  $R_F = 0.06$  if they are denoted as a one-year standard, and  $\operatorname{corr}(\tilde{R}_M, \tilde{Z})$  is 0.2. The value of 11% for  $E(\tilde{R}_M)$  is the condition under which one period equals one year. Since this model assumes one period to be 10 years, this value must be converted to  $(1.11)^{10} - 1$ , which is equal to 1.839. That is,  $E(\tilde{R}_M) = 1.839$  in the case of one period equals 10 years. For evaluating the expected rate of return and the riskless rate, the numerical value obtained after the conversion is

employed. For standard deviation,  $\sqrt{10}$  is multiplied by a one-year value. After these conversions,  $\lambda$  becomes 3.236.

The numerical example is summarized in Table 1. With the exogenous variables given, endogenous variables are computed from this model.  $\mu_Z^* = 47.41$ ,  $\sigma_Z^* = 23.66$ , and  $L^* = 12.93$  are solutions of the simultaneous equation system, Equations (10), (11), and (12). Values of  $S_L$ ,  $B$ , and  $V_L$  under these solutions are also written.  $DR$  is the debt ratio  $B/V_L$ .  $ROA$  is a firm's earnings ratio calculated from

$$R_{ROA} = \frac{\mu_Z^* - V_L}{V_L}, \tag{13}$$

where  $\mu_Z^*$  includes total earnings during 10 years.  $ROA$  in the table is converted from  $R_{ROA}$  into the case of a one-period equals one year standard.<sup>10</sup> In the numerical example the earnings ratio is 11.44%, which is the before-tax value.

**Table 1**  
**A Numerical Example**

Exogenous Variables									
$\omega_Z$	$\alpha$	$k$	$\tau$	$E(\tilde{R}_M)$	$\sigma(\tilde{R}_M)$	$R_F$	$\lambda$	$corr(\tilde{R}_M, \tilde{Z})$	
50.0	0.2	0.4	0.45	0.11	0.18	0.06	3.236	0.2	
Endogenous Variables									
$\mu_Z^*$	$\sigma_Z^*$	$L^*$	$S_L$	$B$	$V_L$	$DR$	$ROA$		
47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144		

(Note) An optimal triad,  $\mu_Z^*$ ,  $\sigma_Z^*$ , and  $L^*$ , which maximizes  $S_L$  and  $V_L$  and which makes Equation (12) hold, is provided for exogenous variables in the table. The equity value  $S_L$ , the debt value  $B$ , and the firm value  $V_L$  are computed under the optimal triad.  $E(\tilde{R}_M)$ ,  $\sigma(\tilde{R}_M)$ , and  $R_F$  are numbers in the case of one period equals one year.  $\lambda$  is computed after these are converted to the case of one period equals 10 years.  $\omega_Z$ ,  $\mu_Z^*$ ,  $\sigma_Z^*$ , and  $L^*$  are numbers in the case of one period equals 10 years.  $DR$  is the debt ratio  $B/V_L$ .  $ROA$  is the earnings ratio, which is the before-tax value.  $ROA$  converts  $R_{ROA}$  computed by Equation (13) to the case of one period equals one year.

**Table 2**  
**Changes in  $\omega_Z$**

$\omega_Z$	$\mu_Z^*$	$\sigma_Z^*$	$L^*$	$S_L$	$B$	$V_L$	$DR$	$ROA$	
40.0	37.93	18.92	10.35	8.41	5.13	13.54	0.379	0.1144	
45.0	42.67	21.28	11.64	9.46	5.78	15.23	0.379	0.1144	
50.0	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	
55.0	52.15	26.02	14.23	11.56	7.06	18.62	0.379	0.1144	
60.0	56.90	28.38	15.52	12.61	7.70	20.31	0.379	0.1144	

(Note) This table presents simulation results when  $\omega_Z$  is changed from 40.0 to 60.0. Parameters other than  $\omega_Z$  are the values of Exogenous Variables in Table 1. See the footnote of Table 1.

The numerical example exhibits a feature of this model, scale homogeneity. Table 2 confirms that a firm is homogeneous of degree one with respect to  $\omega_Z$ . For example, if  $\omega_Z$  increases

from 50 to 60, where new  $\omega_Z$  is 1.2 times as large as the old one, then all variables such as  $\mu_Z^*$ ,  $\sigma_Z^*$ ,  $L^*$ ,  $S_L$ ,  $B$ , and  $V_L$  increase by 1.2 times. Ratios like  $DR$  and  $ROA$  keep the same values. The scale homogeneity depends on assuming that Equation (12) is linear. It is unknown whether  $\mu_Z^*$  is linearly related to  $\omega_Z$  and  $L^*$ . If the relation is quadratic, the homogeneity disappears. Although this is not necessary in the model, the assumption of homogeneity provides us with a special case that is useful in modeling firm's investment.

### 3. Modeling Corporate Investment

#### 3.1. Required Return on Investment: A Basic Form

In this section, corporate investment is added onto the basis of the model described in Section 2. It is assumed that new investment opportunities appear suddenly just after a firm has begun doing business. Should the firm realize these opportunities? In order to decide whether or not to execute investment, the firm has to know the required return on investment. How is this computed? We offer it through calculation, relying upon the model.

Now, it is necessary to assume that an investment opportunity appears suddenly and that investors and the firm do not know about it when the firm issues securities for the foundation. Since capital markets are perfect at the beginning of a period, the opportunity must be reflected in security valuation, and the investment must be included in the firm's decisions for starting up business. If so, however, we cannot study corporate investment explicitly because it is impossible to separate one investment decision from others. Although a dynamic model might overcome this problem, it makes calculation too complicated to be workable. In order to account for corporate investment in the framework of this simple one-period model, we must depend on this assumption, which may be unusual.<sup>11</sup>

All the cash obtained through the issues at the beginning has already been used for the purchase of assets, and the firm has no money for the investment. The amount of investment that must be newly raised from investors is  $I$ .  $I_B$  of this  $I$  is debt issuance and remaining  $I_S$  is equity issuance. So  $I = I_S + I_B$ .  $I$  is assumed to be exogenously given. This model is able to optimally decide the proportion of debt to equity with the amount of investment  $I$  given. For a while, in order to simplify our discussion, we also assume  $I_S$  and  $I_B$  to be exogenous.

The model in Section 2 represents the case where the firm has no investment. Superscript <sup>(0)</sup> is added to variables to indicate explicitly the no-investment case. The expected cash flow at the end of a period for an unleveraged firm is  $\omega_Z^{(0)}$ . The parameter that represents the effect of the agency costs is  $\alpha$ . Both of them are exogenous for the leveraged firm. Simultaneous equations to be solved are:

$$\frac{\partial}{\partial \sigma_Z} S_L(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}) = 0, \quad (10)$$

$$\frac{\partial}{\partial L} V_L(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}) = 0, \quad (11)$$

$$\mu_Z^{*(0)} = \omega_Z^{(0)} - \alpha L^{*(0)}, \quad (12)$$

where  $L^{*(0)}$ ,  $\mu_Z^{*(0)}$ , and  $\sigma_Z^{*(0)}$  are solutions of the equations. Then, firm's business is such that a cash flow at the end is randomly distributed on  $N(\mu_Z^{*(0)}, \sigma_Z^{*(0)})$ . In addition, the firm promises  $L^{*(0)}$  to debt-holders. As a result, the values of equity and debt are  $S_L^{(0)}$  and  $B^{(0)}$ :

$$\begin{aligned} S_L^{(0)} &= S_L(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}), \\ B^{(0)} &= B(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}). \end{aligned}$$

An investment opportunity suddenly appears just after the firm has started up business. If the firm implements the investment, the distribution of the cash flow is changed to  $N(\mu_Z^{*(1)}, \sigma_Z^{*(1)})$ . Superscript <sup>(1)</sup> indicates that investment is executed. Since the firm issues new debt, the promised payment to debt-holders at the end is also altered to  $L^{*(1)}$ . The perfect information in capital markets informs investors of these changes immediately. Hence new values of equity and debt are  $S_L^{(1)}$  and  $B^{(1)}$ .

The parameters in the case of investment are  $\mu_Z^{*(1)}$ ,  $\sigma_Z^{*(1)}$ , and  $L^{*(1)}$ . They are constrained by the agency costs of debt. First, the incentive of the asset substitution requires  $\sigma_Z$  to maximize  $S_L$ .

$$\sigma_Z^{*(1)} = \arg \max_{\sigma_Z} S_L(L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z) \quad (14)$$

Next, through the linear relationship caused by the agency costs of debt,  $\mu_Z^{*(1)}$  is related to  $\omega_Z^{(1)}$ , which is the expected cash flow when the unleveraged firm executes the same investment. The relationship shown in Equation (12) is rewritten as

$$\mu_Z^{*(1)} = \omega_Z^{(1)} - \alpha L^{*(1)}. \quad (15)$$

There is no guarantee that this  $\alpha$  remains unchanged after the investment is implemented. We assume that the  $\alpha$  is the same regardless of investment.<sup>12</sup> Lastly,  $L^{*(1)}$  is concerned with financing the investment. Under these constraints, the values of equity and debt,  $S_L^{(1)}$  and  $B^{(1)}$ , are functions in this manner:

$$\begin{aligned} S_L^{(1)} &= S_L(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}), \\ B^{(1)} &= B(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}). \end{aligned}$$

Since the investment needs to finance  $I_B$  with debt, the debt valuation is

$$B^{(1)} - \frac{L^{*(0)}}{L^{*(1)}} B^{(1)} = I_B. \quad (16)$$

The second term on the left side is the value that belongs to old debt-holders just after the new debt  $I_B$  is issued. New debt-holders have the same priority as the old ones, and both of them claim  $L^{*(1)}$  in sum.  $L^{*(1)}$  is evaluated as  $B^{(1)}$ , which is divided between the new debt-holders and the old ones with proportions of  $\left(1 - \frac{L^{*(0)}}{L^{*(1)}}\right)$  and  $\frac{L^{*(0)}}{L^{*(1)}}$ . Since rational investors pay  $I_B$  for the value of  $\left(1 - \frac{L^{*(0)}}{L^{*(1)}}\right) B^{(1)}$ , Equation (16) holds. The value of old debt  $\frac{L^{*(0)}}{L^{*(1)}} B^{(1)}$  does not always maintain the original  $B^{(0)}$ . When the former is smaller than the latter, the old debt-holders lose their money.

The amount of the equity issue is  $I_S$  when the investment is implemented. What is the relation of equity values concerning the investment? If the investment is profitable, the wealth of old shareholders must increase because of capital gain. When the investment is not executed, the price of a share of stock is  $P_S^{(0)}$ , and the outstanding number of shares is  $n_S^{(0)}$ . Then, the equity value is  $S_L^{(0)} = n_S^{(0)} P_S^{(0)}$ . When the investment is executed, the share price is  $P_S^{(1)}$  and the outstanding number is  $n_S^{(1)}$ . Since the issued price of new equity is  $P_S^{(1)}$ , the number of new shares is  $I_S/P_S^{(1)}$ . The next equation is developed.

$$\begin{aligned} S_L^{(1)} &= n_S^{(1)} P_S^{(1)} = \left( n_S^{(0)} + \frac{I_S}{P_S^{(1)}} \right) P_S^{(1)} \\ &= S_L^{(0)} + I_S + n_S^{(0)} (P_S^{(1)} - P_S^{(0)}) \end{aligned} \quad (17)$$

That is, the equity value under the investment,  $S_L^{(1)}$ , is decomposed into three parts: 1) the original equity value without the investment,  $S_L^{(0)}$ ; 2) the value of the newly issued shares owned by new shareholders,  $I_S$ ; and 3) the benefit to old shareholders owing to capital gain of the original shares,  $n_S^{(0)} (P_S^{(1)} - P_S^{(0)})$ . When the firm is operated in the interest of old shareholders, the investment is executed if and only if  $P_S^{(1)}$  is larger than or equal to  $P_S^{(0)}$ .

From Equation (17), the relationship between equity values is summarized into

$$P_S^{(1)} \geq P_S^{(0)} \Leftrightarrow S_L^{(1)} \geq S_L^{(0)} + I_S.$$

Consider an investment plan where  $P_S^{(1)} = P_S^{(0)}$  holds. This investment is marginal in terms of whether or not old shareholders profit from executing it. Then equity values satisfy

$$S_L^{(1)} = S_L^{(0)} + I_S. \quad (18)$$

We focus on the following simultaneous equations.

$$\sigma_Z^{*(1)} = \arg \max_{\sigma_Z} S_L(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z) \quad (14)$$

$$\mu_Z^{*(1)} = \omega_Z^{(1)} - \alpha L^{*(1)} \quad (15)$$

$$\left(1 - \frac{L^{*(0)}}{L^{*(1)}}\right) B(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}) = I_B \quad (16)$$

$$S_L(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}) - S_L(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}) = I_S \quad (18)$$

Equations (16) and (18) simply rewrite the preceding two as functions. Equation (16) is concerned with the debt financing. Equation (18) is the issue of new equity when the investment is marginal. In Equation (14),  $\sigma_Z$  is decided according to the asset substitution. Equation (15) is the constraint due to the agency costs of debt. The system of these four equations is denoted as a basic form. We know the values of the variables with superscript <sup>(0)</sup>. If  $I_B$  and  $I_S$  are given, then four variables ( $\omega_Z^{(1)}$ ,  $\mu_Z^{*(1)}$ ,  $\sigma_Z^{*(1)}$ , and  $L^{*(1)}$ ) can be solved from the four equations. Intuitively, using Equation (14) for  $\sigma_Z^{*(1)}$  and Equation (15) for  $\mu_Z^{*(1)}$ , the solutions of this system are reduced to searching for two unknowns,  $L^{*(1)}$  and  $\omega_Z^{(1)}$ , that satisfy Equations (16) and (18).

The solutions  $\omega_Z^{(1)}$ ,  $\mu_Z^{*(1)}$ ,  $\sigma_Z^{*(1)}$ , and  $L^{*(1)}$  illustrate the case where the firm has implemented an investment with a minimum return, below which old shareholders would make a loss. Hence,

$$R_q \equiv \frac{\omega_Z^{(1)} - \omega_Z^{(0)} - I}{I} \quad (19)$$

is the required return on the investment. If return on an investment plan is above this value, executing it increases shareholders' wealth. Otherwise, shareholders' wealth decreases. The required return computed by this method plays a role on a cut-off or hurdle rate on investment.

The above discussion supposes that values of  $I_B$  and  $I_S$  are exogenously given. This means that we know how the investment is financed. Even if the amount of investment  $I$  is known in advance, however,  $R_q$  is never computed without specifying  $I_B$  and  $I_S$ . If  $I_B$  changes  $R_q$ , minimizing  $R_q$  is best for maximizing the shareholders' wealth. If  $R_q$  decreases, an investment plan that forces the share price to decline might be changed to a profitable one that increases the share price. Therefore, the optimal method of financing investment is to decide the value of  $I_B$  through solving

$$\min_{I_B} R_q \quad \text{for } 0 \leq I_B \leq I. \quad (20)$$

### 3.2. Proportional Scaling-up Investment

We begin with the simplest case, where investment scales up a firm proportionally. In this model, a firm is homogeneous of degree one with respect to its size. If the investment enlarges the firm

in proportion, the required return on investment must be equal to the earnings ratio of the firm,  $ROA$ . In fact, it is easy to confirm that  $R_q$  defined in Equation (19) is equal to  $R$  defined in Equation (13), when the firm is homogeneous of degree one.

There are two conditions for the investment that maintains a firm's constant return to scale. One is that a debt ratio after the investment is the same as before:

$$\frac{I_S}{I_B} = \frac{S_L^{(0)}}{B^{(0)}} = \frac{S_L^{(1)}}{B^{(1)}}.$$

Here, the proportion of debt financing over the amount of investment,  $I_B/I$ , is equal to the debt ratio of the capital structure. Since  $S_L^{(1)} - S_L^{(0)} = I_S$  holds for the marginal investment, a simple calculation leads to  $B^{(1)} - B^{(0)} = I_B$ . Comparing this with Equation (16), we obtain

$$\frac{L^{*(0)}}{L^{*(1)}} B^{(1)} = B^{(0)}, \quad (21)$$

which means that old debt-holders do not make a loss from the investment.

In the basic form presented above, the incentive of the asset substitution makes old debt-holders lose and makes old shareholders gain from investment. Since the transfer of wealth arises among investors, this investment does not proportion a firm to its size. For the investment that scales up a firm proportionally, it is necessary that old debt-holders do not lose money from it. New debt  $I_B$  associated with the investment has the same priority for the firm as old debt  $B^{(0)}$ . Although the new debt issue might dilute them, Equation (21) shows that the old debt-holders keep the same value  $B^{(0)}$  as long as the investment purely proportions a firm.

The other condition is constraint on  $\sigma_Z^{*(1)}$ , which represents business risk. It is possible that asset substitution arises whenever a manager chooses  $\sigma_Z^{*(1)}$  as he/she likes. This possibility must be ruled out for the proportional scaling-up investment. When  $\omega_Z$  increases by  $c$  times, the standard deviation also increases by  $c$  times.

$$\omega_Z^{(1)} = c\omega_Z^{(0)} \Rightarrow \sigma_Z^{*(1)} = c\sigma_Z^{*(0)}$$

In other words, the next relation is obtained:

$$\sigma_Z^{*(1)} = \frac{\omega_Z^{(1)}}{\omega_Z^{(0)}} \sigma_Z^{*(0)}. \quad (22)$$

These two conditions enable us to formulate the required return on the investment that maintains firm's constant return to scale. First, in order to finance the investment  $I$ , the amount of which is exogenously given, raise cash  $I_B$  with new debt and  $I_S$  with new shares so that  $I_B/I$  is equal to the original debt ratio,  $B^{(0)}/V_L^{(0)}$ . Next, with the values of  $I_B$  and  $I_S$  given, we solve the following simultaneous equations.

$$\sigma_Z^{*(1)} = \frac{\omega_Z^{(1)}}{\omega_Z^{(0)}} \sigma_Z^{*(0)} \quad (22)$$

$$\mu_Z^{*(1)} = \omega_Z^{(1)} - \alpha L^{*(1)} \quad (15)$$

$$B(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}) - B(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}) = I_B \quad (23)$$

$$S_L(\omega_Z^{(1)}, \alpha; L^{*(1)}, \mu_Z^{*(1)}, \sigma_Z^{*(1)}) - S_L(\omega_Z^{(0)}, \alpha; L^{*(0)}, \mu_Z^{*(0)}, \sigma_Z^{*(0)}) = I_S \quad (18)$$

Equation (18) expresses the issue of new shares for the marginal investment, and Equation (15) describes the relation concerning the agency costs of debt. Both of them are the same as those in the basic form. Equations (22) and (23) are the ones different from those in the basic form. Equation (22) shows that the business risk  $\sigma_Z^{*(1)}$  is proportional to firm's size. Equation (23) is the condition that the old debt-holders do not make a loss. As in the basic form, four variables  $\omega_Z^{(1)}$ ,  $\mu_Z^{*(1)}$ ,  $\sigma_Z^{*(1)}$ , and  $L^{*(1)}$  are solved with these four equations. Lastly, from  $\omega_Z^{(1)}$  and  $\omega_Z^{(0)}$ , we calculate the required return on the proportional scaling-up investment through Equation (19).

Solutions of the simultaneous equations are summarized in Table 3 for the case of proportional scaling-up investment when the firm in the previous example faces an investment opportunity of  $I = 2$ . In order to finance  $I = 2$ , the amount of new debt,  $I_B$ , is calculated so that the proportion of new debt is the same as the original debt ratio 0.379. The value of  $I_B$  is 0.758. The remaining 1.242 is  $I_S$ , which is the amount of the new share issue. The values of equity and debt change from 10.51 and 6.42 to 11.75 and 7.18 for  $I_S$  and  $I_B$ . This marginal investment requires the firm to pay  $L^{*(1)} = 14.46$  to all debt-holders and to expect earnings of  $\mu_Z^{*(1)} = 53.02$ . These values give 55.91 to  $\omega_Z^{(1)}$ . Since earnings must be changed from  $\omega_Z^{(0)} = 50$  to  $\omega_Z^{(1)} = 55.91$  for  $I = 2$ , the required return on the investment  $R_q$  is 11.44% on the one-period equals one-year standard. See the *RRI* on Table 3, which is the value converted from  $R_q$  in Equation (19) into the standard. *RRI* for the proportional scaling-up investment is exactly equal to *ROA* in the case of no investment.

There is another method to determine  $I_B$  and  $I_S$ . Figure 1 plots the required return  $R_q$  with  $I_B$  changed from 0 to 2. The computation is the same in that  $I = 2$  is given and the simultaneous equations, (15), (18), (22), and (23), are solved. The increase in debt makes  $R_q$  down at first but then makes  $R_q$  up.  $R_q$  depends on the method of financing the investment, and there is an optimal value of  $I_B$  that minimizes  $R_q$ .

Homogeneity of degree one guarantees that the proportion of  $I_B$  and  $I_S$  that minimizes  $R_q$  is always equal to the ratio of  $B^{(0)}$  and  $S_L^{(0)}$ . Its proof is the same as the firm theory of

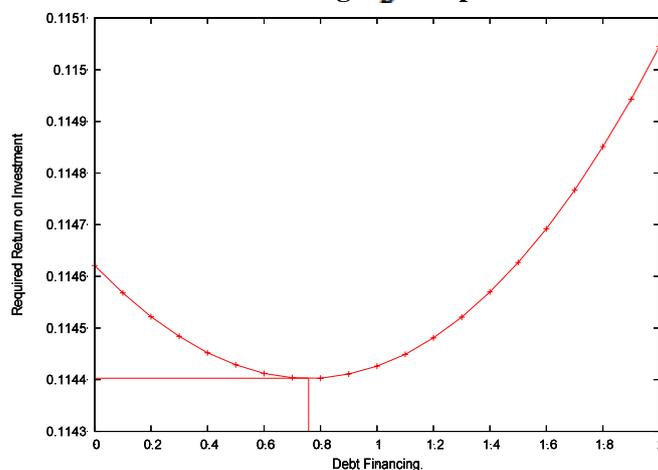
microeconomics, which says that the ratio of inputs under the cost minimization does not depend on the quantity of production whenever there is constant return to scale. This numerical example shows that there exists the value of  $I_B$  that minimizes  $R_q$ . It is optimal that debt is issued with the value of  $I_B$  and that the remaining  $I - I_B$  is financed with new shares.

**Table 3**  
**The Required Return: Proportional Scaling-up Investment**

No Investment									
$\omega_z^{(0)}$	$\mu_z^{*(0)}$	$\sigma_z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR$	$ROA$	
50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	
Marginal Investment									
$\omega_z^{(1)}$	$\mu_z^{*(1)}$	$\sigma_z^{*(1)}$	$L^{*(1)}$	$S_L^{(1)}$	$B^{(1)}$	$V_L^{(1)}$	$I_B$	$I_B/I$	$RRI$
55.91	53.02	26.45	14.46	11.75	7.18	18.93	0.758	0.379	0.1144

(Note) This table shows the case of proportional scaling-up investment.  $\omega_z$ ,  $\mu_z^*$ ,  $\sigma_z^*$ , and  $L^*$  are values in the case of one period equals 10 years. Superscript <sup>(0)</sup> represents no investment and superscript <sup>(1)</sup> represents the case that marginal investment is implemented.  $DR$  is the debt ratio  $B/V_L$ .  $ROA$  is the before tax earnings ratio, which is converted to the case of one period equals one year from  $R_{ROA}$  computed by Equation (13).  $RRI$  is the before-tax required rate of return on investment and is converted to the one year case from  $R_q$  in Equation (19).

**Figure 1**  
**The Required Return and Debt Financing  $I_B$ : Proportional Scaling-up Investment**



In sum, as long as we consider the proportional scaling-up investment, there are two methods for deciding its finance. The first is to divide  $I$  between  $I_B$  and  $I_S$  by the firm's debt ratio. The second is to search  $I_B$ , which is to minimize  $R_q$ . Only in the investment that maintains the homogeneity, both the methods reach the same solutions. In the basic form under which investment does not necessarily scale up a firm proportionally, however, the former method is inappropriate because constant return to scale no longer holds. It is evident that only the second

method preserves consistency in calculating the basic form.

### 3.3. Calibration of the Basic Form of Investment

If we are not restricted to the proportional scaling-up case, investment financing can bring about wealth transfer to shareholders to the detriment of debt-holders, which enables a firm to decrease the required return. Using calibration of the numerical example, we show that investment is executed in the interest of old shareholders.

The system of equations to be solved is the basic form mentioned above. The investment financing,  $I_B$ , is decided so that  $R_q$  is minimized from Equation (20). The result of this computation is summarized in Table 4.  $I_B = 2$  in the table means that all debt finance minimizes  $R_q$  over the investment of  $I = 2$ . Figure 2 confirms this fact. The figure plots  $R_q$  when  $I_B$  is between 0 and 2.  $R_q$  declines monotonically with  $I_B$ .

The reason for this result is obvious. Compared to the proportional scaling-up investment, the more debt issued in financing, the more the old debt-holders are diluted. In the example, the old debt-holders had the value of 6.42. When the new debt of 2 is issued, their value declines to 6.28, which is obtained by subtracting  $I_B = 2$  from  $B^{(1)} = 8.28$ . Since the loss of the old debt-holders becomes old shareholders' gain, the required return on investment could decrease. In other words, old shareholders do not always take a loss from low return on investment if the wealth transfer from old debt-holders is large.

There is a comment about the computation of  $\sigma_Z^{*(1)}$ . In all the cases of no investment,  $\sigma_Z^{*(0)}$  can be calibrated as an inner solution to maximize an equity value  $S_L^{(0)}$ . When the investment is implemented, however,  $\sigma_Z^{*(1)}$  does not converge at all. Simulation results show that  $S_L^{(1)}$  becomes a decreasing function of  $\sigma_Z^{*(1)}$  in most cases, which means that  $\sigma_Z^{*(1)} = 0$  is optimum to maximize  $S_L^{(1)}$ . This is unrealistic and inappropriate. Thus, we assume the domain,  $[\underline{\sigma}_Z, \overline{\sigma}_Z]$ , over which  $\sigma_Z^{*(1)}$  is to be searched. The lower limit,  $\underline{\sigma}_Z$ , is set as

$$\underline{\sigma}_Z = \frac{\omega_Z^{(1)}}{\omega_Z^{(0)}} \sigma_Z^{*(0)},$$

which is the value for the proportional scaling-up investment. The upper limit,  $\overline{\sigma}_Z$ , is assumed to be  $\sigma_Z^{*(0)}$  times 1.3.

The domain of  $\sigma_Z^{*(1)}$  implies how much distorted the investment is without the constraint of proportional scaling-up. When  $\omega_Z$  is enlarged by investment,  $\sigma_Z$  is always larger. In the case of the proportional scaling-up investment, they are perfectly proportional. This is the lower limit

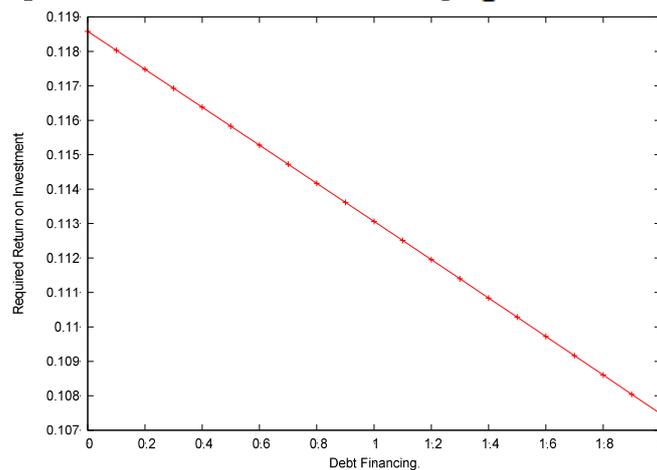
of the domain. On the other hand, the incentive of asset substitution might increase  $\sigma_Z$  to infinity, where the computation becomes impossible. Intuitively, we regard as the upper limit the increase in an original  $\sigma_Z^{*(0)}$  by 30%.

**Table 4**  
**The Required Return: Basic Form Investment**

No Investment								
$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR$	$ROA$
50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144
Marginal Investment								
$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$S_L^{(1)}$	$B^{(1)}$	$V_L^{(1)}$	$I_B$	$RRI$
55.55	52.14	26.28	17.05	10.51	8.28	18.79	2.0	0.1075

(Note) This table shows the result of calculating the basic form of investment. See the footnote of Table 3.

**Figure 2**  
**The Required Return and Debt Financing  $I_B$ : Basic Form Investment**



The result of Table 4 confirms that the lower limit  $\underline{\sigma_Z}$  is chosen as an optimal value of  $\sigma_Z^{*(1)}$ , which maximizes an equity value. In other words, it is optimal that the standard deviation of earnings is proportional to firm's size. This means that no incentive that further distorts investment exists as a real factor. The reason for an incentive that deviates from the proportional scaling-up investment lies in a financial factor, which leads to all debt financing.

In subsequent sections, we see several examples for simulation and application to real firms. In many cases, as well as Table 4, the above-mentioned optimal behaviors are observed: First, investment should be financed by all debt issuance. Second, the choice of  $\sigma_Z^{*(1)}$  should be the lower limit of the domain. The results of this numerical example are not extreme; in fact, they are very standard.

In this capital structure model, a firm has constant return to scale. The investment policy that maintains homogeneity is not optimal for this firm. If it issues the same proportion of debt as its debt ratio to finance the investment, and if it employs the required return equal to its original earnings ratio  $R_{ROA}$ , then the firm is proportionally scaled up by investment. The firm can gain more by breaking the homogeneity than by keeping it, however, in the case of investment through acquiring additional assets. By transferring wealth from old debt-holders to old shareholders when issuing more debt, the firm can decrease the required return  $R_q$  and raise equity value more, increasing investment opportunity. As a result of the optimal behavior of investment, homogeneity disappears from the firm that has constant return to scale.

A firm should finance the entire amount of investment by debt, which means that the pecking order exists for investment financing. Although this model has optimal capital structure, all debt financing is preferred to the mix of debt and equity when a firm exercises investment. The discussion implies that investment financing is different from the firm's capital structure and that optimal capital structure is compatible with the pecking order hypothesis.

#### 4. Simulation

In this section, simulation shows how endogenous variables change when one of exogenous parameters changes. Exogenous parameters are  $\omega_Z^{(0)}$ ,  $I$ ,  $\alpha$ ,  $k$ ,  $\tau$ ,  $\lambda$ , and  $corr(\tilde{R}_M, \tilde{Z})$ . We investigate the effect of their change on endogenous variables.

A numerical example used in this simulation is the same as Table 1. The results of the simulation are summarized in Tables 5 through 11. The computation is convergent for almost all cases, but there are a few which fail. We make a comment later about cases where the computation does not succeed.

There are two features for successful cases. One is that financing investment with all debt is optimal. The ratio  $I_B/I$  in the tables is 1.0 for every case. In that situation, old debt-holders take a loss through the decrease in their debt value. We confirm this fact, comparing  $B^{(0)}$  and  $OldB$  of the tables.  $OldB$  represents the debt value belonging to the old debt-holders at the time the investment is executed.  $OldB$  is smaller than  $B^{(0)}$ . As the result of all debt finance, the debt ratio with investment increases from that without it;  $DR^{(1)}$  is larger than  $DR^{(0)}$ .

The other feature for success is the value of  $\sigma_Z^{*(1)}$ . For every case this is the lower limit of the domain  $[\underline{\sigma}_Z, \overline{\sigma}_Z]$  for its optimal search. Optimum  $\sigma_Z^{*(1)}$  is completely proportional to  $\omega_Z^{(1)}$ , which means that there is no incentive for which a firm takes more risk than proportionality. However, there is wealth transfer associated with issuing more debt than proportional. Because

of the wealth transfer from the old debt-holders to old shareholders, the required return on investment,  $RRI$ , is smaller than the original earnings ratio,  $ROA$ .

We describe other results of the simulation as well. Table 5 demonstrates the effect of a change in  $\omega_Z^{(0)}$ . In the case of no investment where superscript  $(0)$  is attached on a variable, the same numbers as those in Table 2 are shown.  $DR^{(0)}$  and  $ROA$  are unchanged regardless of  $\omega_Z^{(0)}$  owing to the homogeneity of this model. Reflecting the investment finance, which forfeits it,  $DR^{(1)}$  rises and  $RRI$  is smaller than  $ROA$ .  $RRI$  decreases slightly when  $\omega_Z^{(0)}$  is up.

**Table 5**  
The Change in  $\omega_Z^{(0)}$

$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	$OldB$	$I_B/I$	$RRI$	$RRI_{tax}$
40.00	37.93	18.92	10.35	8.41	5.13	13.54	0.379	0.1144	0.0659
45.56	42.67	21.56	14.48	7.00	0.454	5.00	1.000	0.1077	0.0592
50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
60.00	56.90	28.38	15.52	12.61	7.70	20.31	0.379	0.1144	0.0659
65.54	61.62	31.00	19.62	9.57	0.431	7.57	1.000	0.1073	0.0590

(Note) This table presents simulation results when  $\omega_Z^{(0)}$  is changed from 40.0 to 60.0.  $DR^{(0)}$  and  $DR^{(1)}$  are debt ratios computed from  $B^{(0)}/V_L^{(0)}$  and  $B^{(1)}/V_L^{(1)}$ .  $ROA$  is the value of the one-year basis converted from  $R_{ROA}$  of Equation (13).  $RRI$  is the value of the one-year basis converted from  $R_q$  of Equation (19).  $CC_{tax}$  is the weighted average cost of capital given by Equation (1).  $OldB$  is the debt value which belongs to old debt-holders, and is calculated from  $B^{(1)} - I_B$ .  $I_B/I$  is the ratio of debt finance over the amount of investment.  $I_B/I = 1.0$  means that the investment is financed with all debt.  $RRI_{tax}$  is an after-tax earnings ratio and is calculated from  $(1 - \tau)RRI$ . Other parameters are  $\alpha = 0.2$ ,  $k = 0.4$ ,  $\tau = 0.45$ ,  $I = 2.0$ ,  $\lambda = 3.24$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ .

**Table 6**  
The Change in  $I$

$I$	$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	$OldB$	$I_B/I$	$RRI$	$RRI_{tax}$
1.0	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	52.76	49.77	24.96	14.97	7.35	0.412	6.35	1.000	0.1070	0.0589
2.0	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
5.0	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	64.04	59.33	30.30	23.52	11.11	0.514	6.11	1.000	0.1087	0.0598

(Note) This table presents simulation results when  $I$  is changed from 1.0 to 5.0. Other parameters are  $\alpha = 0.2$ ,  $k = 0.4$ ,  $\tau = 0.45$ ,  $\lambda = 3.24$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ . See the footnote of Table 5.

**Table 7**  
**The Change in  $\alpha$**

$\alpha$	$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	$OldB$	$I_B/I$	$RRI$	$RRI_{tax}$
0.16	50.00	47.00	20.89	18.73	8.49	9.27	17.76	0.522	0.1091	0.0599
	55.20	51.54	23.07	22.84	11.11	0.567	9.11	1.000	0.1002	0.0551
0.20	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
0.24	50.00	48.41	24.84	6.62	13.16	3.39	16.55	0.205	0.1169	0.0717
	55.83	53.29	27.74	10.62	5.31	0.288	3.31	1.000	0.1130	0.0622

(Note) This table presents simulation results when  $\alpha$  is changed from 0.16 to 0.24. Other parameters are  $k = 0.4$ ,  $\tau = 0.45$ ,  $I = 2$ ,  $\lambda = 3.24$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ . See the footnote of Table 5.

**Table 8**  
**The Change in  $k$**

$k$	$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	$OldB$	$I_B/I$	$RRI$	$RRI_{tax}$
0.2	50.00	45.78	19.18	21.12	7.33	10.68	18.01	0.593	0.1075	0.0565
	55.15	50.12	21.15	25.13	12.53	0.631	10.53	1.000	0.0992	0.0546
0.4	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
0.5	50.00	48.02	25.69	9.89	11.67	4.88	16.55	0.295	0.1169	0.0698
	55.70	52.89	28.62	14.06	6.75	0.367	4.75	1.000	0.1105	0.0608

(Note) This table presents simulation results when  $k$  is changed from 0.2 to 0.5. Other parameters are  $\alpha = 0.2$ ,  $\tau = 0.45$ ,  $I = 2$ ,  $\lambda = 3.24$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ . See the footnote of Table 5.

**Table 9**  
**The Change in  $\tau$**

$\tau$	$\omega_Z^{(0)}$	$\mu_Z^{*(0)}$	$\sigma_Z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_Z^{(1)}$	$\mu_Z^{*(1)}$	$\sigma_Z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	$OldB$	$I_B/I$	$RRI$	$RRI_{tax}$
0.40	50.00	48.79	23.84	6.03	14.45	3.15	17.59	0.179	0.1101	0.0726
	55.55	53.56	26.48	9.95	5.08	0.260	3.08	1.000	0.1074	0.0644
0.45	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
0.50	50.00	46.04	19.63	19.81	7.35	9.84	17.20	0.572	0.1126	0.0553
	55.34	50.56	21.73	23.91	11.67	0.613	9.67	1.000	0.1032	0.0516

(Note) This table presents simulation results when  $\tau$  is changed from 0.4 to 0.5. Other parameters are  $\alpha = 0.2$ ,  $k = 0.4$ ,  $I = 2$ ,  $\lambda = 3.24$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ . See the footnote of Table 5.

Table 6 presents the effect of a change in  $I$  with  $\omega_Z^{(0)} = 50$  fixed.  $RRI$  increases when  $I$

risers. As demonstrated in Tables 5 and 6, the amount of investment relative to firm size has a positive relationship with the required return.

The effect of the agency cost parameter  $\alpha$  is shown in Table 7. The debt ratio,  $DR^{(0)}$ , changes sensitively to  $\alpha$ . Comparing  $\alpha = 0.16$  and  $\alpha = 0.24$ , a debt ratio declines from more than 50% to less than 20%. Conventional wisdom tells us that the increase in the agency cost pushes up the cost of capital on investment. Table 7 supports this wisdom; the increase in  $\alpha$  raises  $RRI$ .

**Table 10**  
The Change in  $\lambda$

$\lambda$	$\omega_z^{(0)}$	$\mu_z^{*(0)}$	$\sigma_z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_z^{(1)}$	$\mu_z^{*(1)}$	$\sigma_z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	OldB	$I_B/I$	RRI	$RRI_{tax}$
1.62	50.00	47.29	26.82	13.53	11.81	6.60	18.41	0.358	0.1051	0.0592
	55.01	51.39	38.37	18.13	7.88	0.400	5.88	1.000	0.0963	0.0529
3.24	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
4.85	50.00	47.38	21.14	13.12	9.20	6.61	15.81	0.418	0.1221	0.0707
	55.96	52.52	23.66	17.16	8.48	0.480	6.48	1.000	0.1153	0.0634
-1.62	50.00	46.34	41.61	18.28	15.15	8.39	23.55	0.356	0.0782	0.0393
	N.A.									

(Note) This table presents simulation results when  $\lambda$  is changed. Other parameters are  $\alpha = 0.2$ ,  $k = 0.4$ ,  $\tau = 0.45$ ,  $I = 2$ , and  $corr(\tilde{R}_M, \tilde{Z}) = 0.2$ . "N.A." denotes that the computation is not convergent. See the footnote of Table 5.

**Table 11**  
The Change in  $corr(\tilde{R}_M, \tilde{Z})$

$corr(\tilde{R}_M, \tilde{Z})$	$\omega_z^{(0)}$	$\mu_z^{*(0)}$	$\sigma_z^{*(0)}$	$L^{*(0)}$	$S_L^{(0)}$	$B^{(0)}$	$V_L^{(0)}$	$DR^{(0)}$	$ROA$	$CC_{tax}$
	$\omega_z^{(1)}$	$\mu_z^{*(1)}$	$\sigma_z^{*(1)}$	$L^{*(1)}$	$B^{(1)}$	$DR^{(1)}$	OldB	$I_B/I$	RRI	$RRI_{tax}$
0.2	50.00	47.41	23.66	12.93	10.51	6.42	16.93	0.379	0.1144	0.0659
	55.55	52.14	26.28	17.05	8.29	0.441	6.29	1.000	0.1075	0.0591
0.4	50.00	47.22	18.95	13.90	7.89	7.11	15.00	0.474	0.1279	0.0735
	56.29	52.72	21.34	17.87	8.99	0.533	6.99	1.000	0.1214	0.0668
0.8	50.00	45.87	11.36	20.67	3.47	11.18	14.65	0.763	0.1306	0.0644
	56.60	51.72	12.86	24.39	13.11	0.791	11.11	1.000	0.1268	0.0697
-0.1	50.00	46.34	41.61	18.28	15.15	8.39	23.55	0.356	0.0782	0.0393
	N.A.									

(Note) This table presents simulation results when  $corr(\tilde{R}_M, \tilde{Z})$  is changed. Other parameters are  $\alpha = 0.2$ ,  $k = 0.4$ ,  $\tau = 0.45$ ,  $I = 2$ , and  $\lambda = 3.24$ . "N.A." denotes that the computation is not convergent. See the footnote of Table 5.

The effect of the bankruptcy cost parameter  $k$  is summarized in Table 8, and the effect of tax rate  $\tau$  in Table 9. When  $k$  increases, or when  $\tau$  decreases, the debt ratio,  $DR^{(0)}$ , declines. Table 8 shows that the increase in  $k$  raises  $RRI$ ; however, we do not know the effect of  $\tau$  on  $RRI$  in Table 9.

Tables 10 and 11 illustrate the effects of parameters associated with capital markets. Table 10 is the case of  $\lambda$ . Table 11 is about  $corr(\tilde{R}_M, \tilde{Z})$ . It is intuitively said that the increases in  $\lambda$  or  $corr(\tilde{R}_M, \tilde{Z})$  raise the required return on investment because investors in capital markets require more. The results of these computations support that supposition. However, the computation always fails when  $\lambda$  or  $corr(\tilde{R}_M, \tilde{Z})$  is negative. Since the negative values of  $\lambda$  or  $corr(\tilde{R}_M, \tilde{Z})$  are sometimes observed in actual data, this fact might prove a defect in this model.

Here, we make a comment on the weighted average cost of capital (WACC) defined in Equation (1). To use the WACC as the required return on investment lacks consistency with assumptions on which this model depends. The required return on investment should be calculated endogenously as the  $RRI$ . How different are the WACC and  $RRI$ ? Values of the WACC are displayed in  $CC_{tax}$  in Tables 5 through 11. To be compared with them,  $RRI_{tax}$  is converted into an after-tax value from  $RRI$ . For almost all cases,  $CC_{tax}$  is larger than  $RRI_{tax}$  by 10-20 percent, significant difference.<sup>13</sup>

## 5. Application to Actual Firms

This section applies the method of this study to actual firms. We compare the required return computed from the model,  $RRI_{tax}$ , with the weighted average cost of capital,  $CC_{tax}$ .

In the case of no investment, this model evaluates equity and debt, solving an optimal triad,  $L^{*(0)}$ ,  $\mu_Z^{*(0)}$ , and  $\sigma_Z^{*(0)}$ , when two variables,  $\omega_Z^{(0)}$  and  $\alpha$ , are set. Since equity and debt are evaluated as functions of  $\omega_Z^{(0)}$  and  $\alpha$ , these estimates can be solved from equity and debt as their inverses. Data concerning equity and debt are available. We get an equity value by multiplying the share price by the outstanding number of shares. The proxy variable for a debt value is interest-bearing debt on the balance sheet. We can compute  $\omega_Z^{(0)}$ ,  $\alpha$ ,  $L^{*(0)}$ ,  $\mu_Z^{*(0)}$ , and  $\sigma_Z^{*(0)}$  for an actual firm from data. Then, based on the calibration, we derive the required return on investment for the firm.

This study computes the required return for actual firms on the supposition that they invest an outlay amounting to 15% of the firm's value. We selected firms listed on the Tokyo Stock Exchange (TSE) 1st section in manufacturing sectors. Our experiment covers two periods. The

first is the 10 fiscal years from 1974 to 1983, and the second is the 10 fiscal years from 1984 to 1993. These sets of 10 years are each regarded as one period. We call the former “period[1]” and the latter “period[2].” For each variable, an average over the period is employed.  $S_L^{(0)}$  is the average market value of stock, and  $B^{(0)}$  is the average interest-bearing debt. Data on capital market variables,  $E(\tilde{R}_M)$ ,  $\sigma(\tilde{R}_M)$ ,  $R_F$ , and  $\lambda$ , about these periods are converted into a one period equals 10 years standard.  $corr(\tilde{R}_M, \tilde{Z})$  is calibrated from a beta coefficient for the firm's equity return. A bankruptcy cost parameter,  $k$ , is assumed to be 0.3 for all the firms since we do not know what is valid. We assume that corporate tax rate,  $\tau$ , is 0.45.

**Table 12**  
**Summary of Computation Results**

	number of firms	
	period[1]	period[2]
manufacturing firms listed on TSE 1-st section (A)	515	592
firms which succeed in the pre-investment computation (B)	471	578
rate of success (B)/(A)	91.5%	97.6%
firms which succeed in computing their required return (C)	442	576
rate of success (C)/(B)	93.8%	99.7%
firms whose standard deviation converges to its upper bound	158	4
firms whose standard deviation converges to its lower bound	284	572
firms which finance their investment with debt only	253	455
firms which finance their investment with the mix of debt and equity	31	117

(Note) Period[1] is ten years from 1974 fiscal year to 1983. Period[2] is ten years from 1984 fiscal year to 1993. “pre-investment computation” means that we can estimate  $\omega_z^{(0)}$ ,  $\alpha$ ,  $L^{*(0)}$ ,  $\mu_z^{*(0)}$ , and  $\sigma_z^{*(0)}$ . “computing required return” means that we can estimate parameters of the basic form in Section 3.1.

Table 12 summarizes the results of the computation. We calculated 515 firms for period[1] and 592 firms for period[2]. For period[1] and period[2], 471 and 578 firms, respectively, succeeded in computing the parameters of  $\omega_z^{(0)}$  and  $\alpha$ . This proves that the model in this study applies remarkably well to actual firms. Next we had 442 firms for period[1] and 576 firms for period[2] that succeeded with the basic form in Section 3.1. The number of firms for which the standard deviation converged on its lower bounds are 284 and 572, for period[1] and period[2], respectively. The rest of firms were convergent to the upper bound of the standard deviation. While almost all firms for period[2] chose the lowest standard deviation as an optimum, more than 30% for period[1] tried to increase it. Although they intended to take more business risk for period[1], this incentive disappeared in period[2]. Furthermore, among those with the lowest standard deviation, there were 253 firms for period[1] and 455 firms for period[2] that financed investment with only debt issuance. At most 25% of the firms were willing to issue a mix of debt and equity; 31 firms for period[1] and 117 firms for period[2].

The upper bound of the standard deviation,  $\overline{\sigma_Z}$ , is set to a tentative value. When the standard deviation is convergent on it, other estimated parameters that depend on it are arbitrary. Firms' computations in this group are excluded, and we selected firms whose standard deviations are convergent on their lower bound. Table 13 compares the required return estimated from the model,  $RRI_{tax}$ , with the WACC from data,  $CC_{tax}$ .<sup>14</sup> For these averages,  $CC_{tax}$  is larger than  $RRI_{tax}$  over both the periods.  $CC_{tax}$  has twice as large a standard deviation (s.d.) as  $RRI_{tax}$ .  $diff$  designates the rate of difference between  $CC_{tax}$  and  $RRI_{tax}$ , and its positive value means that  $CC_{tax}$  is larger than  $RRI_{tax}$ .  $diff$  varies between period[1] and period[2]. Its sample average is 0.78% over period[1] and 18.54% over period[2]. While only 130 firms, less than half, have a positive value of  $diff$  for period[1], almost all firms have positive  $diff$  for period[2]. Which is larger between  $CC_{tax}$  and  $RRI_{tax}$  is obscure for period[1], but in period[2]  $CC_{tax}$  tend to be larger.

Table 13 shows three test statistics related to the difference between  $RRI_{tax}$  and  $CC_{tax}$ . "t-test" is the result of the ordinary t-value on the difference in averages. " $diff \cdot Z$ " is the Z-value computed from the hypothesis that  $diff$  is zero. "Wilcoxon" is the non-parametric statistics for their significant difference. All of the results exhibit the fact that  $RRI_{tax}$  is not different from  $CC_{tax}$  over period[1], but that there is a significant difference between them during period[2].

Table 13 calculates three correlation statistics between  $RRI_{tax}$  and  $CC_{tax}$ . The ordinary correlation coefficient, "Pearson," is 0.816 for period[1] and 0.727 for period[2]. In light of non-parametric statistics, "Spearman" has almost the same values and "Kendall" has lower ones. These three coefficients for period[2] are lower than those for period[1]. All of them are significantly different from zero.

Table 14 reveals transition as to whether  $RRI_{tax}$  and  $CC_{tax}$  decrease together from period[1] to period[2]. 278 firms can compute  $RRI_{tax}$  for both the periods. For all the firms,  $RRI_{tax}$  declines from period[1] to period[2], and  $CC_{tax}$  of 183 firms, more than 65%, comes down together.

In summary, the correlation and the transition find that  $RRI_{tax}$  estimated from the model in this study suits to some extent with  $CC_{tax}$  computed from data, and that they are not irrelevant. These facts prove that the value of required return we compute is not meaningless. However, correlation coefficients are not very high, and  $CC_{tax}$  and  $RRI_{tax}$  are significantly different for a period. The average of their difference is about 18%, and it is highly probable that  $CC_{tax}$  is much larger than  $RRI_{tax}$  for some firms. For these firms, considering their required return as the WACC leads to investment distortion.

**Table 13**  
**Comparisons between  $CC_{tax}$  and  $RRI_{tax}$**

	$CC_{tax}$		$RRI_{tax}$		$diff$	
	period[1]	period[2]	period[1]	period[2]	period[1]	period[2]
mean	0.0832	0.0763	0.0822	0.0648	0.0078	0.1774
s.d.	0.0151	0.0091	0.0085	0.0046	0.1140	0.0982
min	0.0549	0.0557	0.0615	0.0550	-0.1988	-0.1049
max	0.1236	0.1092	0.1069	0.0791	0.3625	0.5874

	firms	$diff > 0$	difference: test statistics			Correlation		
			t-test	$diff \cdot Z$	Wilcoxon	Pearson	Spearman	Kendall
period[1]	284	130	1.832	1.155	0.856	0.816**	0.809**	0.624**
period[2]	572	566	41.71**	43.22**	20.68**	0.727**	0.732**	0.541**

(Note)  $CC_{tax}$  is the weighted average cost of capital computed from the data, and  $RRI_{tax}$  is the after-tax required return on investment estimated from the basic form of this study.  $diff$  is the rate of their difference;  $diff = (CC_{tax} - RRI_{tax})/RRI_{tax}$ . “t-test” is the t-statistics under the hypothesis that  $RRI_{tax}$  and  $CC_{tax}$  have the same mean. “ $diff \cdot Z$ ” denotes a Z-value under the hypothesis of  $diff = 0$ . “Wilcoxon” is non-parametric statistics  $Z$  of the Wilcoxon test. “Pearson” is an ordinary correlation coefficient, and “Spearman” and “Kendall” are non-parametric rank correlations. \*\* represents 1% significance level.

**Table 14**  
**Transition of  $CC_{tax}$  and  $RRI_{tax}$**

total	278
same movement	183**
(percentage)	(65.8%)

(Note) The number of firms whose  $RRI_{tax}$  can be calculated for both the periods is “total.” For all the firms,  $RRI_{tax}$  declines from period[1] to period[2]. The number of firms whose  $RRI_{tax}$  and  $CC_{tax}$  move together is “same movement.” From the large sample sign test, \*\* indicates that they move the same way with 1% significance.

## 6. Conclusion

This study calculates the required return on investment through an extended capital structure model that includes the agency costs of debt. The WACC, which is standard in an investment decision, is obscure in that it lacks theoretical foundation beyond the Modigliani and Miller (1963) hypothesis. Although the WACC approximates true required return, it is necessary to compare the WACC with the required return calculated from the model for actual firms in order to investigate how precise the approximation is. Since the WACC overestimates the required return for some firms, using the WACC is not always adequate.

Even if a firm has constant return to scale in a capital structure model, the investment strategy that maintains the homogeneity is not necessarily optimal. When the firm depends on outside cash to finance the investment, the wealth transfer to old shareholders at the sacrifice of old debt-holders enables the required return on investment to decrease from a value of the proportional scaling-up investment case. As the result of the transfer, the constant return to scale

disappears for the investment.

The finance which makes old debt-holders lose as much as possible is to issue new debt of all the amount of investment. This means that the pecking order hypothesis holds for investment financing. It is true that the optimal capital structure exists over a firm itself in this model. Nevertheless, all debt financing is preferable to the mixed issuance of debt and equity for the investment. It has become popular to discuss which explains actual firms better, the pecking order hypothesis or the optimal capital structure theory. The more important is to construct a model that attempts to embrace both of them consistently, and this study is an example of this trial.

It is evident that the model of this paper has a limit to its analysis. The pecking order hypothesis is just one of investment financing patterns. The other is that the mix of debt and equity can be more preferable. Without explicit modeling of the mechanism on which agency costs occur, we are not able to investigate further which case is valid. The one-period model is so simple that it has a limitation in dealing with investment, which is a dynamic problem. Its logical defect lies in the assumption of Equation (7) and constant  $\alpha$  in Equation (15). In order to overcome these difficulties, it is inevitable to model the mechanism generating agency costs. Then keeping it applicable to actual firm's decision is research in the future.

#### ACKNOWLEDGEMENTS

We thank Shigeru Tamura, Takashi Kaneko, Kenji Wada. We received many helpful comments when presenting the paper at seminars of the Graduate School of Business at Keio University. We greatly appreciate useful advice of an anonymous referee and an editor, Yutaka Kurihara.

#### NOTES

1. Many textbooks published in the United States explain how to use the WACC as the required return in making an investment decision. The most standard are Brealey, Myers and Allen (2011) and Ross, Westerfield and Jaffe (2011).
2. Extending Modigliani and Miller (1958), which proves the debt irrelevancy theorem, Modigliani and Miller (1963) argues the effect of corporate income tax on capital structure. Discussion among Arditti and Levy (1977), BenHorim (1979) and Boudreaux and Long (1979) confirms the argument about an investment decision under the assumptions of Modigliani and Miller (1963). Levy and Sarnat (1990) stands in the same viewpoint.
3. The pecking order hypothesis is pioneered by Myers (1984) and Myers and Majluf (1984). They derived the hypothesis from the information asymmetry. This study depends on a quite different view of the matter. These years there are several empirical studies that investigate which is more applicable to actual firms, the optimal capital structure theory and the pecking order hypothesis. See ShyamSunder and Myers (1999), Fama and French (2002), and Frank and Goyal (2003).

4. For detailed explanation, see Tsuji (2012).
5. In this study, unlike an ordinary notation such as  $N(\mu_Z, \sigma_Z^2)$ , the second variable of  $N(;\cdot)$  denotes standard deviation, not variance.
6. There are other parameters which the manager influences indirectly; for example,  $k$  and  $cov(\tilde{R}_M, \tilde{Z})$ . We assume that the parameters other than  $L$ ,  $\mu_Z$ , and  $\sigma_Z$  are given and constant.
7. The concept of verifiability in this paper depends on Hart (1995).
8. Pathbreaking studies about the agency costs are Jensen and Meckling (1976) and Myers (1977). Their arguments are intuitive, not operational. In recent years making efforts to model the mechanism on which agency costs occur is becoming popular and remains to be developed. The more refined the research is, it is losing simplicity and lucidity. The model of this study is so simple that what it means is obvious. For example, using the simple one-period model, numerical examples in Tsuji (2012) examine the effects on the EBIT through the incentives which bring about the agency costs of debt. They derive negative relations between the expected EBIT and debt without Equation (7). The simulation results of the numerical examples are reduced to a function like Equation (7). The function is not always linear. But the author finds that whether it is quadratic or exponential is not essential.
9. Note that the optimal value of  $\sigma_Z$  can exist as an inner solution because  $\tilde{Q}_{LS}$  has both convex and concave regions in the function of  $\tilde{Z}$ .
10. The value of  $ROA$  in Table 1 is converted from  $R_{ROA}$  in Equation (13) through  $(1 + R_{ROA})^{\frac{1}{10}} - 1$ .
11. This study considers that one period is a very long term like 10 years. For example, a firm recognizes an investment opportunity one month after its foundation. Immediately it finances and executes the investment. This one month of ten years is regarded as the beginning of the period.
12. The most important defect of this model is that  $\alpha$  is constant in Equation (15).  $\alpha$  is endogenous as the result of the investment decision from which agency costs are generated. Equation (15) is, so to speak, a reduced form of the structure that describes agency costs. Without the generation mechanism, it is not so useful to discuss how the value of  $\alpha$  is changed. If a model included the mechanism, arguments would be complicated. For brevity, we avoid confusing investment decision-making, assuming constant  $\alpha$  in this paper.
13.  $RRI$  is the before-tax value. Its after-tax number  $RRI_{tax}$  is calculated from  $RRI_{tax} = (1 - \tau)RRI$ . Earnings in this study are the lump-sum of ten years. The results of numerical examples and simulation show what is distributed to each year from the lump-sum. These kinds of conversion have several alternatives. This study produces results under the method which minimizes the difference between  $CC_{tax}$  and  $RRI_{tax}$ . Under an alternative the difference can expand dramatically.
14.  $CC_{tax}$  in Section 4 is estimated from the model's value in simulation. In Section 5, where we focus on comparing the model with an actual firm,  $CC_{tax}$  is computed from data.

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