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Introduction to the Financial Macro-econometric Model

Atsushi Ishikawa*
atsushi.ishikawa@boj.or.jp

Koichiro Kamada*
kouichirou.kamada@boj.or.jp

Yoshiyuki Kurachi*
yoshiyuki.kurachi@boj.or.jp

Kentaro Nasu*
kentarou.nasu@boj.or.jp

Yuki Teranishi*
yuuki.teranishi@boj.or.jp

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Bank of Japan
2-1-1 Nihonbashi-Hongokucho, Chuo-ku, Tokyo 103-0021, Japan

* Financial System and Bank Examination Department

INTRODUCTION TO THE FINANCIAL MACRO-ECONOMETRIC MODEL*

Atsushi Ishikawa†; Koichiro Kamada‡; Yoshiyuki Kurachi§; Kentaro Nasu††; and Yuki Teranishi**

ABSTRACT

This paper introduces the Financial Macro-econometric Model (FMM) being developed by the Bank of Japan. The FMM is a medium-sized structural model comprising two sectors: a financial sector and a macroeconomic sector. It permits the quantitative analysis of various phenomena created by the feedback loop between the financial economy and the real economy. The model's most distinctive feature, which is rarely observed in this type of model, is seen in the financial sector, where we model the actual risk management behavior of banks. It facilitates macro stress testing and allows the robustness of the financial system and its effects on the macro economy to be consistently verified from various perspectives.

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† Email: atsushi.ishikawa@boj.or.jp

‡ Email: kouichirou.kamada@boj.or.jp

§ Email: yoshiyuki.kurachi@boj.or.jp

†† Email: kentarou.nasu@boj.or.jp

** Email: yuuki.teranishi@boj.or.jp

I. INTRODUCTION

The latest financial crisis, triggered by the subprime loan-related problems in the U.S., reaffirmed the significance of macro stress testing. The test here is meant the quantitative assessment of the robustness of individual financial institutions and entire financial systems to withstand severe changes in macroeconomic conditions. Financial supervisory bodies and central banks in the U.S. and European countries use macro stress testing as a tool to share information with market participants on financial systems' current situation, the need for policies to be implemented, and regulatory action to be taken, so as to prevent financial panic. The Bank of Japan has also conducted macro stress testing according to various scenarios and made public the results in its semiannual *Financial System Report*.[1]

However, conventional macro stress testing fails to capture explicitly the interaction between the financial system and the real economy, assessing only the impact of a slowdown in the real economy on the financial system without taking into account the negative feedback loop, whereby the destabilization of the financial system leads to the stagnation of the real economy and, in turn, to still further destabilization of the financial system.[2] In order to quantify the economic losses caused by a financial crisis or to evaluate the impact of financial regulations such as Basel III,[3] we need a macro-econometric model that incorporates the interrelation between the financial sector and the

[1] The *Financial System Report* uses a number of models to implement various stress tests. For example, the *Financial System Report* (Bank of Japan, 2010) evaluates the soundness of financial institutions by examining whether the capital adequacy ratio could be maintained at a sufficient level under intense negative stress for the GDP, stock prices, and etc.

[2] Mishkin (2008) emphasizes the importance of the feedback effects.

[3] For example, the Macroeconomic Assessment Group (MAG)—a joint working group of the Basel Committee on Banking Supervision, the Financial Stability Board (FSB) and the IMF—estimated the short-term economic impact of imposing stricter regulations on capital and liquidity. See Macroeconomic Assessment Group (2010). The long-term economic impact (LEI) working group estimated the advisable long-term levels for capital and liquidity. See Basel Committee on Banking Supervision (2010).

macroeconomic sector.

The Financial Macro-econometric Model (FMM) introduced in this paper is a two-sector model comprising the macroeconomic and financial sectors. The macroeconomic sector has a simple Keynesian framework, while in the financial sector we capture the actual risk management behavior of banks. That is, we use a financial sector model in which bank credits are influenced by credit costs, the capital adequacy ratio, and other considerations. Micro-data on individual banks are used to quantify such banking activity in estimated behavioral equations. This modeling strategy gives the FMM a feature that is rarely observed in this type of model. To the best of our knowledge, only a few financial supervisory authorities and central banks are equipped with similarly developed models.[4] The Bank of Japan has released a number of macro-econometric models, namely, the dynamic stochastic general equilibrium (DSGE) model by Sugo and Ueda (2008) as well as the hybrid models, such as the Quarterly Japanese Economic Model (Q-JEM), developed by Ichiue, et al. (2009) and Fukunaga, et al. (2011), all of which combine a theoretical model with a time-series model.[5] The primary purpose of these models is to measure the macroeconomic effects of exogenous shocks generated by overseas economies, monetary policies, and other considerations. In contrast, the FMM provides a quantitative analysis of the financial system, particularly its behavior

[4] In addition to the FMM, for example, the Bank of England tried a stress testing approach using combinations of several models. That is, it is examined how individual financial institutions' balance sheets established using micro-data react to a shock generated by the vector auto-regression model estimated based on macro-data. See Aikman, et al. (2009) for details.

[5] The DSGE model is used broadly as a tool for monetary policy analysis. At the Bank of Japan, based on the view of a suite of models, various DSGE models are created to address economic issues, including those by Sugo and Ueda (2008), Hirose and Kurozumi (2010), Fueki, et al. (2010), and others. In addition to Ichiue, et al. (2009) and Fukunaga, et al. (2011), the Board of Governors of the Federal Reserve System developed a well-known hybrid model called the FRB/US (see Brayton and Tinsley, 1996; Brayton, et al., 1997).

under major stresses.[6]

The rest of the paper is organized as follows: Section II outlines the structure of the FMM by comparing it with other models and picking up the model's key behavioral equations. Also presented are results of the tests to evaluate the FMM's performance. Section III provides a number of examples to show the viability of the FMM for simulation purposes. Following the conclusion in Section IV, Appendices I and II contain, respectively, a detailed list of model variables and an explanation of estimated behavioral equations.

II. STRUCTURE OF THE FINANCIAL MACRO-ECONOMETRIC MODEL

(1) Model overview

The FMM is a medium-sized structural model comprising the financial sector and the macroeconomic sector. The FMM's most distinctive feature is in its financial sector, which models the actual risk management behavior of banks. That is, the financial sector is so designed that banks' credit supply is affected by credit costs, the capital adequacy ratio, and other factors (Figure 1). Macroeconomic conditions influence the amount of bank lending and the credit ratings which, in turn, impact credit costs and bank capital. Further, these financial sector changes are passed on to the macroeconomic sector, affecting household expenditures and business fixed investments. These macroeconomic fluctuations are then fed back into the financial sector.

The FMM provide compactly the complex interdependence between financial activities and the macro economy, with a particular focus on financial variables (Figure 2). The FMM is a medium-sized model with a total of 77

[6] As pointed out by the Basel Committee (2011), the financial sector has not been addressed sufficiently by the macro model, except for the financial accelerator models by Kiyotaki and Moore (1997) and Bernanke, et al. (1999). However, triggered by the latest financial crisis, the development of a macro model focusing on financial activities has started to gather momentum finally.

variables (41 endogenous, 36 exogenous) as macro variables, one third as many as the Q-JEM (with 242) and 1.5 times as many as Sugo and Ueda's (2008) model (with 47). The FMM emphasizes the importance of financial activities, 60 variables (32 endogenous, 28 exogenous) being included in the financial sector, while only 17 variables (9 endogenous, 8 exogenous) being included in the macroeconomic sector. With few exceptions, the FMM variables are in nominal terms.

The FMM's 41 endogenous variables are calculated using 18 behavioral equations and 23 definitional identities. Unlike the DSGE model, the behavioral equations are not derived from a particular theoretical model, but specified on the basis of empirical rules and data.[7] The behavioral equations are estimated separately by least squares, based on data since the 1980s.[8] Thus, when interpreting the results of simulations, one should bear in mind the possibility of simultaneous equation bias.

(2) Specifications

We explain four core behavioral equations in the financial sector, namely, functions for credit costs, corporate lending volume, lending interest rates, and business fixed investments (see Appendices I and II for the variables and equations employed in the FMM).

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[7] The FMM can be interpreted as a large structural vector auto-regression model, as pointed by Dungey and Pagan (2000).

[8] The frequency of the FMM is quarterly. Annual/semiannual data is converted into quarterly data by equitable distribution or linear interpolation. Some figures are shown on a fiscal year basis to enhance visual effects.

Credit Cost Function (Micro-based)

Bank *i*'s credit cost

= $\Sigma_m\Sigma_n$ (transition probability of Bank *i*'s self-assessment from *m* to *n*)

× (loss ratio at time of downgrading of Bank *i*'s self-assessment from *m* to *n*)

× (exposure of Bank *i*'s self-assessment from *m* to *n*),

where the transition probability of Bank *i*'s self-assessment from *m* to *n* is given using the following formula:

Transition probability of Bank *i*'s self-assessment from *m* to *n* (after logit transformation)

= (coefficient specific to Bank *i*)

+ (coefficient common to all banks) × two-period mean of semiannual growth rate of nominal GDP

+ (coefficient common to all banks) × two-period mean of (borrower's financial indicator × semiannual growth rate of nominal GDP)

Note: See Figure 3 for details of the estimation results.

The core of the credit cost function is the transition probability of self-assessment employed by banks.[9] The Bank of Japan conducts a semiannual survey, in which it asks its account-holders about their self-assessment. Each bank's transition probability is calculated on the basis of this information. The transition probability is estimated, based on the panel data characterizing each bank (such as financial indicators for each bank's borrower companies) as well as data common to all banks (such as the nominal GDP growth rate).

We use the panel data of 117 banks (major, regional and second-tier regional banks) and employ quantile regression to estimate the transition

[9] This credit cost function is also used in the *Financial System Report*. For details of the credit cost function, see the *Financial System Report* (Bank of Japan, 2009). There are five self-assessment categories: Normal, Needs Attention, Special Attention, In Danger of Bankruptcy, and Bankruptcy/de facto Bankruptcy. The loans in categories other than Bankruptcy/de facto Bankruptcy can be transitioned to other categories, but those in the Bankruptcy/de facto Bankruptcy category cannot be transitioned to any others.

functions of self-assessment.[10] The quantile can be changed according to simulation purpose. The parameters estimated by the 50% quantile regression are used to describe a standard scenario, in which no excessive stress is assumed in the economy. In contrast, the parameters estimated by the 90% quantile regression are used to perform stress testing, which assumes that the economy is under excessive stress. Quantile regression makes it possible to describe a nonlinear relationship: That is, a decline in the nominal GDP, if substantial, will have more than equiproportional effects on the soundness of banks. The estimated transition probability is combined with the loss ratio and the loan exposure at the time of downgrading, to obtain the credit costs of individual banks. Finally, the credit costs of all banks are aggregated into the macro credit cost.

We also prepare a macro-based credit cost function to approximate the above micro-based credit cost functions by several aggregate variables (see Appendix II for details). Approximation is achieved to a considerable degree, as seen in Figures 6 and 7. We find the macro-based credit cost function useful particularly when calculations must be repeated many times, as in stochastic simulations.

[10] The number of banks is as of the end of FY2010. See the *Financial System Report* (Bank of Japan, 2010) for the definition of the term major banks.

Corporate Lending Volume Function

Year-on-year growth rate of corporate lending volume

= 0.43 × expected growth rate <0.07>

− 2.00 × year-on-year change in (lending interest rate − eight-quarter mean of year-on-year growth rate of consumer prices) <0.00>

+ 0.18 × capital adequacy ratio gap (excluding public funds) <0.13>

− 0.06 × ten-quarter mean of year-on-year growth rate of amount of outstanding corporate bonds (- 4) <0.29>

+ 0.45 × year-on-year growth rate of land prices <0.00>

− 2.85 × off-balancing dummy <0.00>

− 1.90 × financial revitalization program dummy <0.01>

+ 1.38 × independent administrative institution dummy <0.12>

+ 2.52 × company-specific factor (2006) dummy <0.14>

Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.82

The corporate lending volume depends on both macroeconomic sector variables (expected growth rate and land prices) and financial sector variables (the lending interest rate, capital adequacy ratio, and outstanding corporate bonds).[11] When the expected growth rate rises, companies increase their fixed investments and their demand for loans. When land prices rise, the lending volume also increases, due to the greater ease with which money can be borrowed from banks as the collateral value of land grows. However, when the lending interest rate rises, companies reduce their demand for funds to avoid higher funding costs. Furthermore, since issuing corporate bonds is a substitute for bank loans, the lending volume declines when the amount of outstanding corporate bonds increases. When its capital adequacy ratio falls below the regulatory capital ratio, a bank either needs to increase its capital or reduce its risk assets by trimming its lending volume. Note, in this model, the corporate

[11] The term expected growth rate, as used in this paper, refers to the growth outlook (over the coming three years) for real economic growth in Japan based on the *Annual Survey of Corporate Behavior* (see Appendix I).

lending function does not distinguish between supply and demand factors. Four dummy variables have been added as explanatory variables (see Appendix II for an explanation of those dummies). Finally, the estimated parameters are mostly significant, except for the amount of outstanding corporate bonds (figures in angle brackets < > are *p*-values).

Lending Interest Rate Function

Year-on-year change in lending interest rate

= 0.60 × year-on-year change in call rate (- 1) <0.00>

+ 0.01 × four-quarter mean of year-on-year change in lending volume gap <0.06>

− 0.02 × capital adequacy ratio gap <0.01>

Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.94

The lending interest rate depends on financial sector variables, such as the call rate, the lending volume, and the capital adequacy ratio. When the call rate rises, a bank passes on the higher funding costs to its lending interest rate. The lending interest rate increases, as does the lending volume gap,[12] reflecting the tighter supply–demand balance. A bank with a low capital adequacy ratio raises its interest rate, since it can make a profit and boost its capital if the interest rate elasticity of the lending volume is low. Otherwise, the bank has to decrease its lending volume. Further, when credit cost increases, a bank raises its lending interest rate to compensate a reduction in capital.

[12] The lending volume gap refers to the deviation of the actual corporate lending volume from the potential that meets the potential GDP (see Appendix I for details).

Business Fixed Investment Function

Year-on-year growth rate of business fixed investments

= 10.2 × four-quarter mean of year-on-year growth of corporate profit margin <0.00>

+ 0.72 × expected growth rate <0.01>

− 2.12 × year-on-year change in (lending interest rate − eight-quarter mean of year-on-year growth rate of consumer prices) <0.01>

+ 0.67 × year-on-year growth rate of corporate lending volume <0.00>

Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.57

The business fixed investments of firms vary according to macroeconomic sector variables (the expected growth rate and corporate profit margin) in addition to financial sector variables (the lending interest rate and corporate lending volume). When the expected growth rate increases, the business fixed investments are expanded. A rise in the corporate profit margin increases retained earnings, leading to an increase in business fixed investments. An increase in the lending interest rate raises companies' funding costs, thus inducing them to cut back on business fixed investments due to reduction of investment profit. In the improved funding environment of greater corporate lending, companies are encouraged to boost their fixed investments.

(3) Model performance evaluation

Even if each equation fits data, it does not mean that the model performs well overall. Thus, the performance of the FMM is evaluated using two traditional approaches: one involving a final simulation, while the other a comparison with the vector auto-regression (VAR) model.

A. Final simulation approach

The final simulation method requires that predictions be made for endogenous variables in the model, taking as given the exogenous variables. The performance of the model is evaluated by comparing the predictions with the actual data for the endogenous variables.

The results of the final simulation are shown in Figures 4 and 5.[13] For each year from FY1989 to FY2009, the model is used to produce predictions for one year and two years ahead (thin line with circles) for seven variables, namely, household expenditure, business fixed investments, corporate lending volume, retail lending volume, credit costs,[14] the Tier I ratio, and the lending interest rate. The predictions then are compared with the actual data (thick line). The model predictions are accurate for all variables except for the Tier I ratio since the latter half of the 1990s. The predictions for the Tier I ratio are also accurate except for the period around the end of the 1990s. Moreover, the FMM captures the abrupt changes at the time of the Lehman shock in 2008.[15] This is remarkable, given that conventional macro-econometric models are usually subject to large prediction errors at turning points in business conditions.

For the period covering the development and collapse of the bubble economy, however, the FMM is inaccurate, except for the lending interest rate. For instance, looking at the one-year-ahead predictions for household expenditures and business fixed investments for FY1990, we find that the predictions fall far short of the data, the FMM failing to capture the rapid economic upturn during the development of the bubble. Conversely, for FY1992 and FY1993, the model prediction significantly exceeds the data, the FMM failing to capture the abrupt economic recession as the bubble burst. Similar statements can be made concerning credit cost and the Tier I ratio. The poor performance of the FMM around the turning point of the asset bubble may be attributable to a remarkable role of expectations outside the FMM during the

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[13] The call rate is assumed to be an exogenous variable; and thus actual data is used.

[14] The credit cost data of individual banks are only available from the second half of FY2002. Therefore, for the purpose of evaluating the credit cost function, the micro-based function is used from the second half of FY2002 on, while the macro-based function is used up to the first half of FY2002.

[15] Figures 6 and 7 show that there is no significant difference in performance between the macro-based and micro-based credit cost functions.

bubble economy.[16]

B. VAR model approach

It is useful to compare this model with other types of models to examine its validity. Here, the performance of the FMM is evaluated by comparing it with the VAR model, one of the conventional time-series models. First, a three-variable VAR model is estimated, comprising the lending interest rate, lending volume, and nominal GDP (Figure 8). Then the impulse response functions of the FMM are compared with those of the VAR model.[17]

Figure 9 presents the impulse response functions. The label X ⇒ Y denotes the impulse response of variable Y to a shock on variable X. The solid and dotted lines represent the impulse response of the VAR model and its 95% confidence interval, respectively. The solid line with circles represents the FMM's impulse response. Suppose that a shock is applied to the lending interest rate. The impulse responses of the FMM's lending interest rate and the lending volume move in the same direction as the VAR model's responses, falling mostly within the 95% confidence interval. However, the impulse response of the FMM's nominal GDP moves in the opposite direction for two years. Here, the VAR model's impulse response exhibits the same phenomenon as observed in the so-called price puzzle, while the FMM's response is consistent with economic theory.[18]

In most cases, when a shock is applied to the lending volume or the nominal GDP, the FMM's impulse responses move in the same direction as the VAR model, falling mostly within the 95% confidence interval. An exception is

16 Okina, et. al (2001) argue that the bubble economy, from the late 1980s to the early 1990s, is characterized by excessively optimistic expectations.

17 The call rate is assumed to change endogenously with the economic conditions.

18 The term price puzzle refers to a phenomenon in the VAR model that has prices declining initially, in response to monetary easing, as pointed out by Sims (1992). It is called a puzzle because, while in theory prices should rise as a result of monetary easing, the VAR model temporarily shows the opposite reaction.

the nominal GDP's impulse response to the nominal GDP, in which case the FMM's impulse response exceeds the 95% confidence interval for the first several periods, while moving in the same direction as the VAR model's response. On the whole, however, the direction and size of the impulse response are consistent in the context of the FMM and the VAR model.

III. SIMULATION ANALYSIS

The simulations performed using the FMM are classified into two categories. In the first category, called shock simulation, a shock is introduced to the model in order to observe the reaction of all the endogenous variables, such as when a negative shock is applied to the error term of the nominal GDP component. In the second category, called scenario simulation, a path is given exogenously to a certain variable in order to observe the development of all the other endogenous variables, such as when a decreasing path is given to the nominal GDP exogenously. An approach to be taken depends on a simulation purpose.

A reference path or baseline with which the simulation result is to be compared should be determined in a simulation. Below, the generation of the baseline adopted in this paper is discussed, followed by an explanation of the two simulation techniques mentioned above, with some examples.

(1) Generating the baseline

This paper identifies the baseline as the path of the variables calculated endogenously under the assumption that the economy will experience no shocks in the future.[19] Note, however, that we use this baseline only to interpret

[19] If the end of the actual period and the baseline are connected without any adjustment, a large difference is likely to occur at the time of the connection. Therefore, the function is usually adjusted so that the predicted value for the end of the actual period is closer to the actual data. It is necessary to continue discussions on the appropriate adjustment method from a practical viewpoint. In this paper, the functions are adjusted as a trial by adding the mean prediction error for the last one year for business fixed investments, shareholder's equity, and credit risk assets, for which the model shows significant prediction errors since

the simulation results, and do not exclude other ways to define a baseline. For instance, in the *Financial System Report* by the Bank of Japan, the baseline for the nominal GDP is given in terms of the ESP forecasts.

Below, we present a simulation up to FY2013, taking as given actual data up to FY2010. To generate the baseline, a path was set for the simulation period's 36 exogenous variables. The assumption here is that they would remain flat at 2011Q1 levels—except for inventory investments, government expenditures, exports, imports, and the potential nominal GDP. We use the mean of ESP forecasts (as of July 2011) for inventory investments, government expenditures, exports, and imports. The potential nominal GDP is assumed to increase around 0.3% from the previous year's level (i.e., the mean value for the period from FY2003 to FY2007).

In the model, the call rate—a policy instrument of the central bank—is treated as either an endogenous or an exogenous variable. If endogenous, the call rate moves along with a change in business conditions, though subject to the non-negativity constraint. If exogenous, the call rate is set equal to the mean prediction of the 23 private research agencies, rising from 0.088% and reaching 0.11% at the end of FY2012.[20]

(2) Shock simulations

A. Single-shock simulation: downward shock on nominal GDP

The single-shock simulation is used to see the behavior of model variables when one variable is the target of a shock or a number of shocks. For example, suppose that a negative shock of 0.5 of a percentage point per annum were introduced to the year-on-year growth rate of the nominal GDP over two years. We introduce to business fixed investments and household expenditures a

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the Lehman shock.

[20] The prediction of the call rate is not included in the ESP forecasts. Thus, we use the mean value of the private research agencies which predict the call rates.

common shock slightly higher than 0.5 of a percentage point so that a negative shock of exactly 0.5 of a percentage point is applied to the nominal GDP.[21] In addition, taking into account the fact that the economy is under great stress, we use the result of 90% quantile regression to calculate the transition probability of the credit cost function.

Figure 10 shows the developments of the nominal GDP, the Tier I ratio, the credit cost ratio, and the lending volume, when there is a downward shock on the nominal GDP. Here, the call rate is assumed to be an endogenous variable. The development of those variables in the first year shows that the credit cost ratio increases by slightly less than 70 basis points (bps) above the baseline, due to companies' worsened financial conditions caused by a reduction in the nominal GDP. As a result, the Tier I ratio falls 0.8 of a percentage point below the baseline. In addition, the year-on-year growth rate of the lending volume decreases 0.2 of a percentage point below the baseline, due to weakened demand for funds caused by a decline in the growth expectations of companies and households. Thus, the year-on-year growth rate of the nominal GDP declines 1.0 percentage point below the baseline, implying that the model amplifies the initial exogenous shock by 0.5 of a percentage point.

The developments of the variables in the second year show that the credit cost ratio increases by slightly less than 60 bps above the baseline, reflecting the worsened financial conditions of companies due to the nominal GDP shock. As a result, the Tier I ratio falls 1.4 percentage points. The decline in lending capacity of banks, due to the decrease in the capital adequacy ratio, coupled with the weakening demand for funds, reduces the lending volume 0.8 of a percentage point. Eventually, we see a decline of 2.5 percentage points in the nominal GDP. In the third year, business conditions continue to deteriorate

[21] Since business fixed investments and household expenditures are endogenous variables, they both have behavioral functions. In a shock simulation, we assume an error term to which a shock is given on the right-hand side of these functions. The shock is introduced to these variables for different reasons, reflecting the purpose of the simulation.

endogenously, although no additional shock is assumed on the nominal GDP. Consequently, the credit cost ratio rises slightly less than 70 bps, the Tier I ratio falls 2.0 percentage points, the lending volume declines 1.1 percentage points, and the nominal GDP decreases 3.1 percentage points.

Figure 11 assumes the call rate to be an exogenous variable and shows how the downward shock on the nominal GDP affects the economy. The year-on-year growth rate of the nominal GDP and lending volume both decline more than observed in Figure 10, where the call rate is assumed to be an endogenous variable. In the third year, the difference amounts to 0.1 of a percentage point for the nominal GDP and 0.4 of a percentage point for the lending volume. The reason is that, in Figure 10, the call rate is assumed to drop endogenously to ameliorate the economic deterioration caused by the negative shock. Note, however, that the difference is quite small in the first and second years. This is because the predictions of the 23 private research agencies—used when the call rate is assumed to be an exogenous variable—are almost zero, reflecting the current low-interest-rate environment.[22]

A shock simulation is conducted for other variables, including lending volume, lending interest rate, credit costs, the regulatory capital ratio, stock prices, and corporate profits. Figures 12 and 13 are multiplier tables, which show the dynamics of the FMM's variables in terms of percentage deviations from their baselines in response to a shock on a certain variable. The call rate is assumed to be endogenous in Figure 12 and exogenous in Figure 13.[23]

B. Multiple shock simulation: downward shock on expected growth rate

We can apply a shock to a number of variables simultaneously and observe how the model variables are influenced. While this is a common approach, it is quite

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[22] In other words, even if the call rate is assumed to be an endogenous value, the room for decline in the call rate is limited, due to the zero lower constraint under the current low-interest-rate environment.

[23] The zero lower constraint on the call rate is not considered in the multiplier table.

difficult to determine mechanically how large a shock should be applied to which variable. Below, we explain how to design an effective shock simulation, assuming a specific situation in which we draw from the model an economic implication of a decline in the expected growth rate.

We can consider a variety of combinations of shocks in this seemingly simple simulation. For example, we can examine impacts of the decline of growth expectations on various aspects of economy. If the decline in growth expectations is caused by a groundless vague feeling of anxiety about the future of the economy, we just apply a negative shock to the expected growth rate. However, if the lowered expectations are caused by a decline in the growth rate, we introduce a negative shock on the nominal GDP, which in turn endogenously affects the expected growth rate, as assumed in the FMM. If the current decline in the GDP is not temporary and is caused by a medium- to long-term decline in productivity, we also assume a negative shock to the potential GDP, which is an exogenous variable in the FMM. Finally, if the decline in the potential GDP makes economic agents take an excessively pessimistic view of the future, we apply a shock to all the three variables: the nominal GDP, potential GDP, and expected growth rate.

We conducted simulations of the fall of the expected growth rate under various scenarios mentioned above. Figure 14 is a multiplier table summarizing the results of simulations, with the call rate treated as an endogenous variable. The decline in nominal GDP is accelerated over time in every case, while the degree of decline varies, depending on the assumptions used. In the scenarios, the second-year decline in nominal GDP is smallest in case (1) and largest in case (4). The results here suggest that we have to hold clear image on a simulation before running it. It is also important to see that the simulation results reflect assumptions about the formation of expectations. In the FMM, expectations are based on events that have occurred. However, If the expectations were formed in a model-consistent way and based on forward-looking assumptions—as assumed in DSGE models—the results would be different.

Figure 15 shows the results of simulations conducted under various scenarios related to a decline in the expected growth rate under the assumption that the call rate is assumed to be an exogenous variable. The multipliers are shown to be larger when the call rate is assumed to be exogenous than they are when the call rate is treated as an endogenous variable (Figure 14).

C. Comprehensive shock simulation: a fan chart at work

A comprehensive shock simulation is conducted to observe how model variables behave when different shocks derived from historical data are applied to individual endogenous variables simultaneously. The shocks are stochastically applied to endogenous variables to show the kind of path the economy might follow in the future in terms of probability distribution. This distribution is usually called a fan chart.[24]

A relevant fan chart is created as follows. First, the difference between the model prediction and the actual data (namely, the prediction error) is calculated for each period to find the standard deviation. Then a shock is generated stochastically from a normal distribution with this standard deviation. Finally, the shock is applied to the corresponding behavioral equation to perform the final simulation.[25] A fan chart is obtained by applying the process to all the endogenous variables simultaneously and repeating it many times, 10,000 times in this paper. Had a micro-based credit cost function been used, it would take a number of days to complete the simulation. Thus, this paper uses a macro-based credit cost function to create fan charts, instead of a micro-based function.

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24 A fan chart is often used to express the uncertainty of the economic outlook. The *Inflation Report*, issued quarterly by the Bank of England, uses fan charts to indicate probability distributions for the forecast of inflation and GDP outlook.

25 Here, for the purposes of creating a fan chart, the stock and land prices are assumed to be exogenous variables. Were the variables endogenous, the stretch of the fan chart would be wider than that given here.

Figure 16 shows the fan charts for nominal GDP, the Tier I ratio, the credit cost ratio, and lending volume, with the call rate treated as endogenous. The solid line represents the baseline, while the area between the dotted lines represents the inter-quartile range. The longer the simulation period, the wider the inter-quartile range, indicating that, as the prediction period increases, more stochastic shocks are applied and cause greater uncertainty. Figure 17 shows the fan charts based on the assumption that the call rate is exogenous. The inter-quartile range is slightly wider than had it been obtained under the assumption that the call rate is endogenous. The difference reflects the stabilizing effect of monetary policy: When the call rate is endogenous, it can be adjusted to mitigate economic fluctuations.[26]

(3) Scenario simulation

A. Scenario for an exogenous variable: rise in the regulatory Tier I ratio

A scenario can be established for either exogenous or endogenous variables. Commencing with a scenario for an exogenous variable, we explore the economic implications of strengthening the regulatory capital ratio. Under Basel III, the regulatory Tier I ratio will be raised from the current 4.0% to 4.5% at the start of 2013, to 5.5% at the start of 2014, and to 6.0% at the start of 2015. Here it is assumed that banks adjust their target Tier I ratio in advance to satisfy this requirement, raising the ratio to 4.5% at the start of 2012, to 5.5% at the start of 2013, and to 6.0% at the start of 2014. The simulation would be better conducted, were it started from the Tier I ratio recalculated under the Basel III agreement. However, there is no public information on the Tier I ratio under that regulatory standard. Thus, one must use the Tier I ratio calculated under the Basel II agreement in this simulation.

The FMM employs the capital adequacy ratio gap, which includes Tier II

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[26] Since the call rate is virtually facing the zero lower bound constraint, reflecting the existing low-interest-rate environment, the stretch of the fan chart is not significantly affected by whether the call rate is endogenous or exogenous.

capital as well as Tier I capital, as an explanatory variable for corporate/retail lending volume, lending interest rate, and other functions. Here, we replace that term with the Tier I ratio gap. This assumes implicitly that the model has the same elasticity to the Tier I ratio gap as to the capital adequacy ratio gap. Clearly, the accuracy of the simulation depends on the validity of this assumption.

Figure 18 shows how the rise of the regulatory Tier I ratio affects nominal GDP, the Tier I ratio, the credit cost ratio, and lending volume, when the call rate is assumed to be an endogenous variable. From the first year, the lending volume starts declining below the baseline, and the Tier I ratio gradually rises. In the second year, the year-on-year growth rate of the lending volume declines 0.5 of a percentage point below the baseline, and the Tier I ratio rises 0.5 of a percentage point above the baseline. The year-on-year growth rate of the nominal GDP declines 0.1 of a percentage point below the baseline, but the credit cost ratio remains almost intact, because the deceleration of the nominal GDP is moderate. In the third year, the lending volume declines 0.5 of a percentage point, and the Tier I ratio rises 0.8 of a percentage point to a level slightly higher than 12%. The nominal GDP declines 0.3 of a percentage point.[27] Figure 19 assumes the call rate to be an exogenous variable, but the results do not differ significantly from those in Figure 18.

B. Scenario for an endogenous variable: slowdown of nominal GDP

Next, a scenario is given for an endogenous variable. As an example, we consider the economic effects of a stagnant nominal GDP. The assumption is that the year-on-year growth rate of the nominal GDP declines annually 0.5 of a percentage point below the baseline for the first two years and then returns to

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[27] Basel III adopts a stricter definition of capital. However, the analysis here does not consider the impact of such change in the definition. If the change in the definition is factored in, the evaluation of the existing Tier I ratio would be lower than that calculated based on Basel II. Hence, banks may need to increase the amount of additional capital further. Thus, economic activities could become more strained.

the baseline. Here, a common shock, slightly greater than 0.5 of a percentage point, to business fixed investments and household expenditures is assumed, which causes the nominal GDP to decline exactly 0.5 of a percentage point.[28] It should be noted that the nominal GDP is fixed exogenously here and, thus, is not affected by the feedback effects from other variables.

Figure 20 shows how the slowdown of the nominal GDP affects the Tier I ratio, credit cost ratio, and lending volume, when the call rate is assumed to be an endogenous variable. In the first year, since the year-on-year growth rate of the nominal GDP declines 0.5 of a percentage point below the baseline, the credit cost ratio rises slightly more than 60 bps above the baseline, reflecting the deterioration of corporate financial conditions. As a result, the Tier I ratio decreases 0.7 of a percentage point below the baseline. The decline in the nominal GDP leads companies and households to lower their growth expectations, which mitigates the demand for funds. As a consequence, the year-on-year growth rate of the lending volume declines 0.1 of a percentage point below the baseline.

In the second year, since the nominal GDP declines by another 0.5 of a percentage point, the credit cost ratio increases slightly less than 40 bps, and the Tier I ratio declines 1.0 percentage point. Coupled with the decline in the demand for funds, the squeezed lending capacity of banks due to the lower capital adequacy reduces the lending volume 0.4 of a percentage point. In the third year, the growth rate of the nominal GDP recovers to the baseline and so the credit cost ratio increases only slightly less than 35 bps. Nonetheless, the credit cost ratio remains at a high level, the Tier I ratio declines 1.2 percentage points, and the lending volume decreases 0.4 of a percentage point.

In Figure 21, the call rate is an exogenous variable. Yet the results are similar to those given in Figure 20, in which the call rate is assumed to be an

[28] The estimated parameter obtained at the 90% quantile was used to estimate the transition probability, assuming great stress on the economy.

endogenous variable. This contrasts with section (2) A, where we have quite different results, depending on whether the call rate is assumed to be endogenous or exogenous (Figures 10 and 11). This is because the call rate, if endogenous, moves to ameliorate the slowdown of the economy in section (2) A. In the current simulation, however, the path of the nominal GDP is given exogenously, and thus, economic conditions remain unchanged, irrespective of whether the call rate is exogenous or endogenous.

Although the current simulation is similar to that in section (2) A, the results are quite different. This is because the negative feedback loop comes into play in section (2) A, where the deterioration of the nominal GDP affects adversely the financial sector which, in turn, weakens the nominal GDP further. In contrast since, in the current simulation, the path of the nominal GDP is exogenous, there is no room for a feedback mechanism. In Figure 22, the negative feedback effects are extracted by calculating the difference between Figures 10 and 20 and between Figures 11 and 21. The negative feedback effects, created endogenously in the model, are almost as large as those of the shock applied exogenously.

C. Application of scenario simulation: credit cost simulation

Simulations can be conducted by setting scenarios for a number of endogenous variables simultaneously. For instance, a scenario simulation could be run as follows: the year-on-year growth rate of the nominal GDP declines below the baseline for two years, i.e., by 1.5 percentage points per annum in the first year and by 0.5 of a percentage point per annum in the second year (a slightly larger shock is applied equally to business fixed investment and household expenditure, so that nominal GDP declines as assumed). The lending interest rate declines about 0.1 of a percentage point at an almost constant pace until the third year. Stock prices tumble to a post-bubble historical low level in the first year and then rise gradually.[29] Note that the call rate is assumed to be an

[29] The estimated parameter obtained at the 90% quantile was used to estimate the

exogenous variable—to exclude any effects on the lending interest rate.

A similar simulation is introduced as a credit cost simulation in the *Financial System Report* as follows: First, a five-variable VAR model—comprising the real effective exchange rate, real GDP, GDP deflator, long-term contractual interest rate on loans, and TOPIX—is estimated based on quarterly data. Then, a negative shock that occurs with 5% probability is applied to the real GDP and TOPIX to calculate the future path of the five variables. Finally, the credit cost is calculated according to the scenario thus obtained. The advantage of running a simulation using the FMM is that a path consistent with the established scenario can be obtained for the variables that are not analyzed in the *Financial System Report*.

Figure 23 shows how nominal GDP, the Tier I ratio, the credit cost ratio, and lending volume develop according to the above scenario. In the first year, the year-on-year growth rate of nominal GDP declines 1.5 percentage points below the baseline. Then, due to deterioration of corporate financial conditions, the credit cost ratio rises slightly less than 75 bps above the baseline. Due to this credit cost and the decline in stock prices, the Tier I ratio declines 1.2 percentage points below the baseline. The decline in the nominal GDP lowers the growth expectations of companies and households and mitigates the demand for funds. Meanwhile, the declining lending interest rate boosts the demand for funds. As a result, the lending volume declines only 0.2 of a percentage point below the baseline.

In the second year, since the nominal GDP declines another 0.5 of a percentage point, the credit cost ratio rises slightly less than 40 bps. The Tier I ratio declines 1.3 percentage points (through a mechanism similar to that observed in the first year). The lending volume declines 0.6 of a percentage point, since the upward pressure on lending volume is still overwhelmed by the additional downward pressure emanating from the decline in the lending

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transition probability according to the assumption of great stress on the economy.

capacity of banks due to the reduced available capital. In the third year, although the nominal GDP returns to the baseline, the credit cost ratio rises slightly less than 35 bps, since the financial sector remains under stress. Additionally, since the credit cost ratio is still high, the Tier I ratio and lending volume decline 1.3 percentage points and 0.7 of a percentage point, respectively.

Lastly, we compare the current simulation results with those in the *Financial System Report*. First, since the FMM uses the same credit cost function as is used in *Financial System Reports*, the relationships between the nominal GDP and the credit cost ratio are almost the same. Second, according to the *Financial System Report* (Bank of Japan, 2010), the Tier I ratio decreases 1.0 percentage point when the credit cost ratio rises by 50 bps. In the FMM simulation, however, the degree of decline of the Tier I ratio is slightly larger. This is partly because the functions relating to Tier I capital are not the same in the FMM and the *Financial System Report*, as well as because the risk asset is endogenous in the FMM, but fixed in the *Financial System Report*.

IV. CONCLUSION

The Financial Macro-econometric Model (FMM) seeks to capture the complex interaction between financial activities and the macro-economy compactly. The FMM shapes actual risk management practice in the financial sector, which lends the model a character rarely observed in this type of model. The FMM displays sufficiently high performance for a practical use, as shown by its ability to forecast historical data and approximate the impulse response of the VAR model. Further, the model permits the conduct of a wide variety of simulations (including fan charts) in order to examine the robustness of the financial system and assess its impact on the macro-economy.

However, some issues remain to be tackled if the FMM is to be developed further. First, the FMM treats many important financial variables as an exogenous variable, including the amount of government bonds held by banks, the amount of deposits, and long-term interest rates. These variables must have a significant impact on financial and economic activities. We believe that as many as possible of these variables should be endogenized to enhance the FMM's simulation performance. Note also that important macroeconomic variables, such as commodity prices and capital stock, are not incorporated in the FMM. This places a limit on the FMM's ability to analyze exhaustively how a shock to the financial economy spreads over the real economy. Efforts should be made to remove this limitation from the model.

Second, the FMM's behavioral equations are based on empirical rules and thus cannot be immune to the so-called Lucas critique (Lucas, 1976), according to which policy analysis should take into account the reactions of economic agents to policy change. This can be an issue when we measure the effects on the economy of regulatory reforms, such as Basel III. We will modify the current model in accordance with the future developments of macro finance theory. From this perspective, several promising studies have been conducted by, among others, Hirakata, et al. (2009), Jeanne and Korinek (2010), and Christiano, et al. (2010), who have taken financial market imperfections as a theoretical backbone and have succeeded in circumventing the Lucas critique. Due attention should be paid to progress in this area.

Third, a variety of simulations should be run under realistic scenarios for increases in sovereign risk, changes in asset prices such as share/land prices, as well as changes in monetary policy stance. This would permit the FMM to be evaluated from various perspectives and enhance the model's completeness as a practical model.

Finally, the importance of modeling the bubble economy should not be disregarded. Looking back at the Japanese asset price bubble in the 1990s and at the latest global financial crisis, one can see that the destabilization of the financial system and the real economy resulted from an inability to identify the build-up of the bubble. The FMM is not an exception in this regard and fails to predict the development of a bubble economy. This is partly because the role of expectations is not fully incorporated into the model. Therefore, one should extend the current model by incorporating real world expectations, be they rational or irrational.

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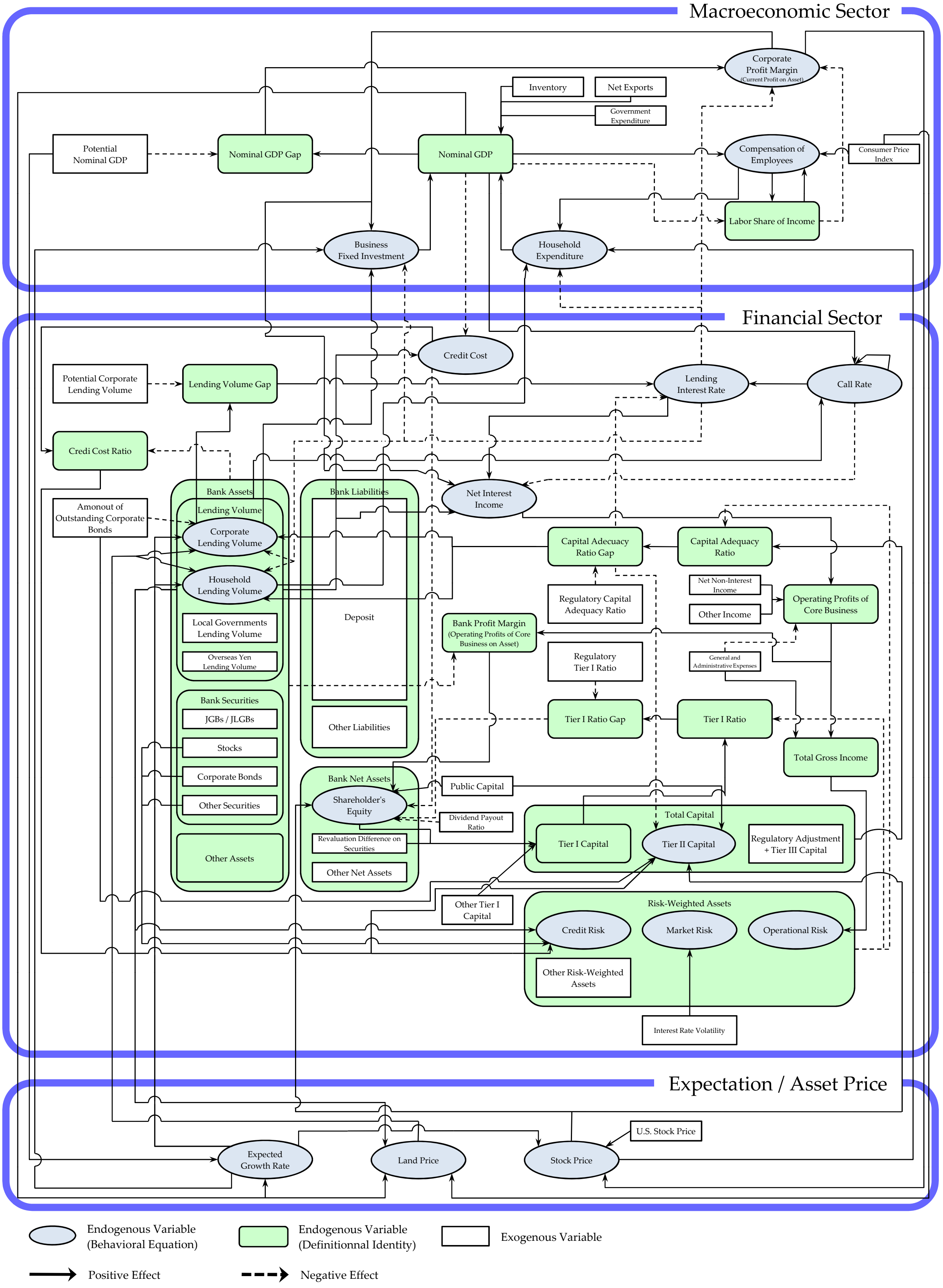
(Figure 1)

Structure of the FMM



(Figure 2)

Comparison with Other Macro-econometric Models

		FMM[1]	FMM[1]: Financial variable	Q-JEM[2]	Sugo and Ueda (2008)[3]
Endogenous variable	Behavioral equation	18	12	87[4]	29
	Definitional identity	23	20	109	8
Exogenous variable		36	28	46	10[5]
Total		77	60	242	47

Notes: *1.* The numbers of variables is based on macro-based credit cost function. If we use micro-based one, the number of behavioral equation is 1,556, of definitional identity is 3,463, of exogenous variable is 5,024.

2. Based on Fukunaga, et al. (2011).

3. Based on Sugo and Ueda (2008).

4. There are more than 1,000 endogenous varibles in Q-JEM for convenience to program by using definitional identity (e.g. growth rate of each of the variables). Here, we count only main endogenous variables.

5. The number of exogenous shocks.

Estimation Result of Transition Probability Function

(Behavioral Equation)

$$
\begin{aligned}
\ln\left(\frac{q_{i,t}^{mn}}{1-q_{i,t}^{mn}}\right) = {} & \alpha_i^{mn} \\
& + \beta^{mn} \times \text{two-period mean of semiannual growth rate of nominal GDP} \\
& + \gamma^{mn} \times \text{two-period mean of (quick ratio} \\
& \qquad \times \text{semiannual growth rate of nominal GDP)} \\
& + \delta^{mn} \times \text{two-period mean of (interest coverage ratio} \\
& \qquad \times \text{semiannual growth rate of nominal GDP)}
\end{aligned}
$$

$q_{i,t}^{mn}$ is transition probability of Bank i's self-assessment from m to n at period t.

(1) Estimation result of 50 % quantile regression

Assessment m \ Assessment n		Normal		Needs Attention		Special Attention		In Danger of Bankruptcy		Bankruptcy / de facto Bankruptcy	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Normal	β^{mn}			-21.3	0.00			-15.5	0.00	-16.7	0.00
	γ^{mn}			-	-			-	-	-	-
	δ^{mn}			4.02	0.00			-	-	-	-
Needs Attention	β^{mn}	10.3	0.00					-17.9	0.00	-24.9	0.00
	γ^{mn}	-	-					20.6	0.00	18.1	0.05
	δ^{mn}	-	-					-	-	-	-
Special Attention	β^{mn}										
	γ^{mn}										
	δ^{mn}										
In Danger of Bankruptcy	β^{mn}					33.8	0.00				
	γ^{mn}					-	-				
	δ^{mn}					-5.72	0.10				

(2) Estimation result of 90 % quantile regression

Assessment m \ Assessment n		Normal		Needs Attention		Special Attention		In Danger of Bankruptcy		Bankruptcy / de facto Bankruptcy	
		coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value	coefficient	p-value
Normal	β^{mn}			-21.3	0.00			-15.5	0.00	-35.2	0.00
	γ^{mn}			-	-			-	-	-	-
	δ^{mn}			4.02	0.00			-	-	-	-
Needs Attention	β^{mn}	10.3	0.00					-17.9	0.00	-36.7	0.01
	γ^{mn}	-	-					20.6	0.00	26.5	0.14
	δ^{mn}	-	-					-	-	-	-
Special Attention	β^{mn}										
	γ^{mn}										
	δ^{mn}										
In Danger of Bankruptcy	β^{mn}					33.8	0.00				
	γ^{mn}					-	-				
	δ^{mn}					-5.72	0.10				

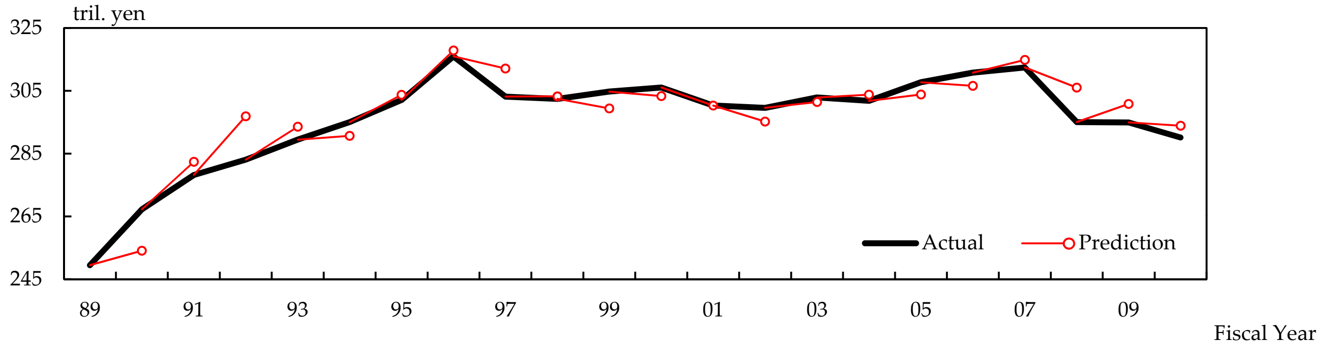
Notes: *1.* Estimation period: FY 2003/I through FY 2010/II. Estimation method: fixed effect model.
2. Shaded areas denote that transition probability is exogenous since estimates aren't statistically significant.
3. In (2), only "Normal to Bankruptcy" and "Needs Attention to Bankruptcy" are estimated by 90 % quantile regression, others are same as 50 % one.

(Figure 4-1)

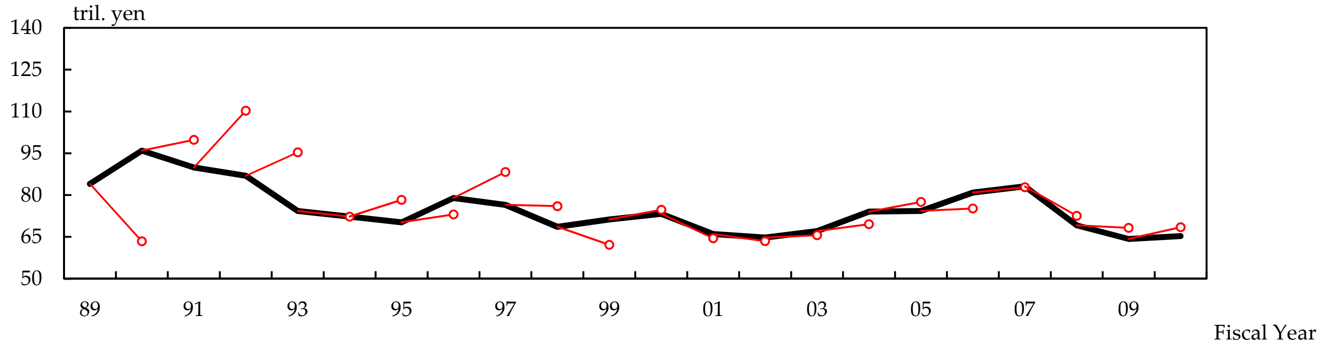
The FMM's Performance Evaluation (1)

(Prediction period: one year)

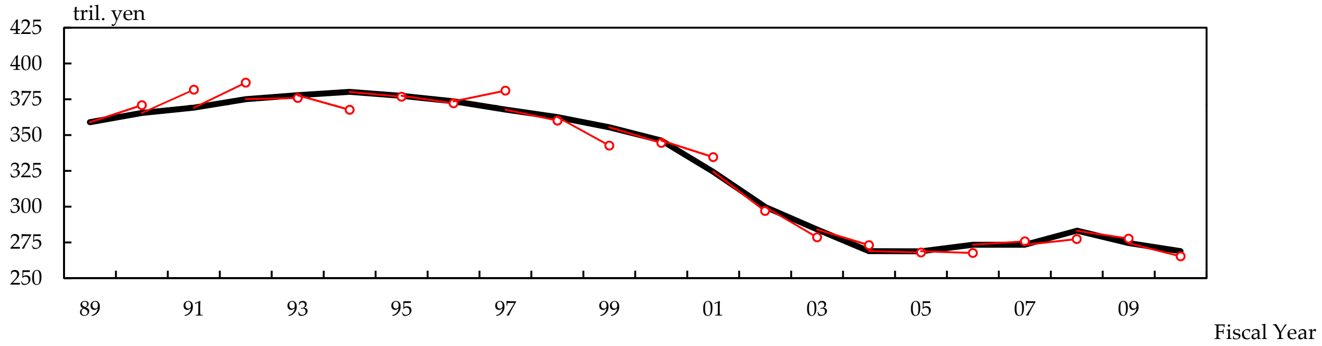
(1) Household Expenditure



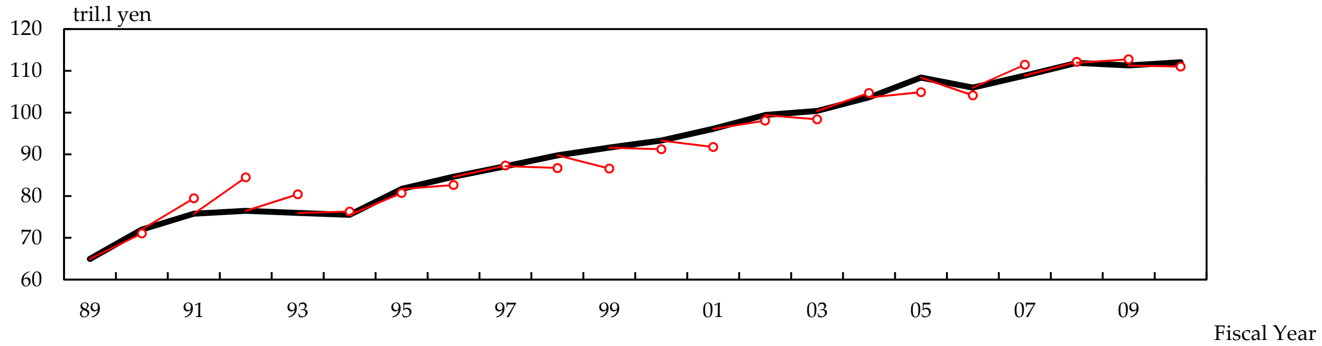
(2) Business Fixed Investment



(3) Corporate Lending Volume



(4) Household Lending Volume

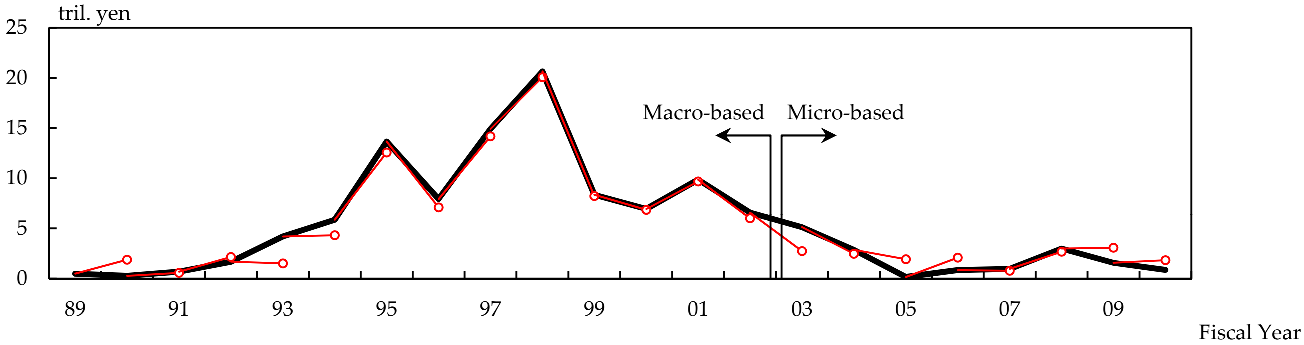


(Figure 4-2)

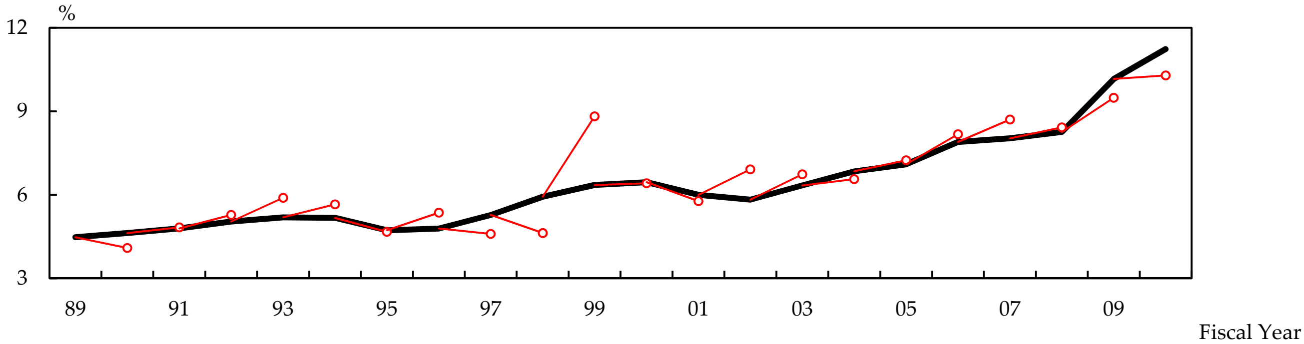
The FMM's Performance Evaluation (2)

(Prediction period: one year)

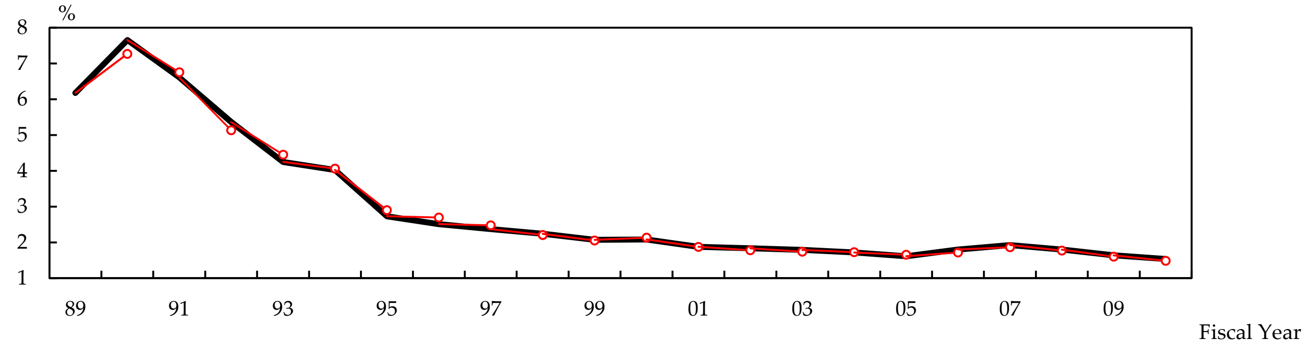
(5) Credit Cost



(6) Tier I Ratio



(7) Lending Interest Rate

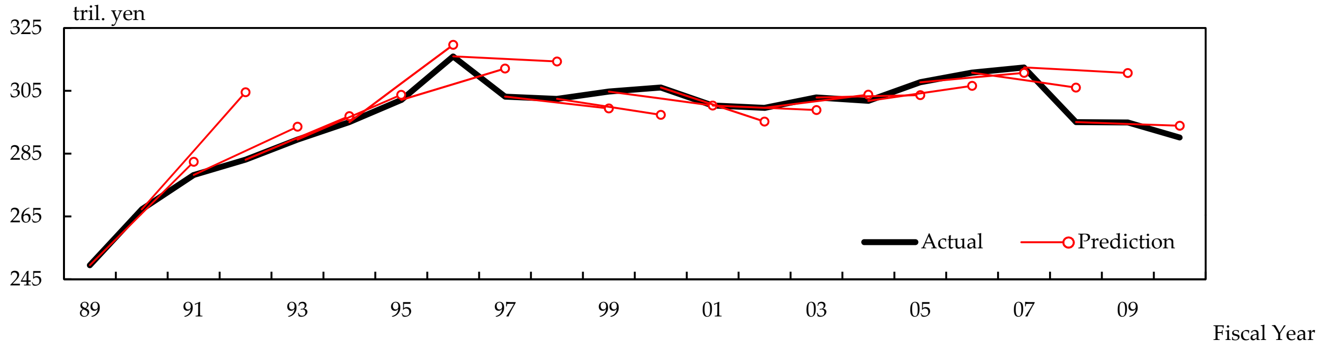


(Figure 5-1)

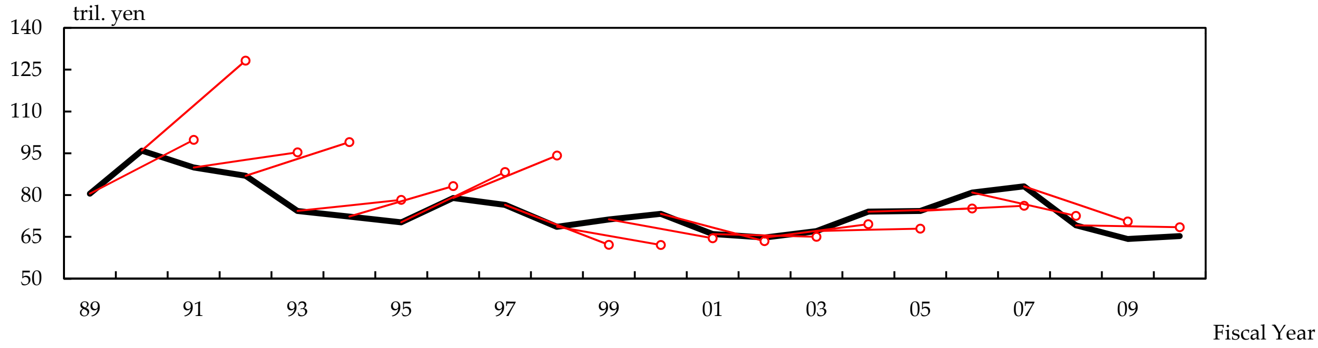
The FMM's Performance Evaluation (3)

(Prediction period: two years)

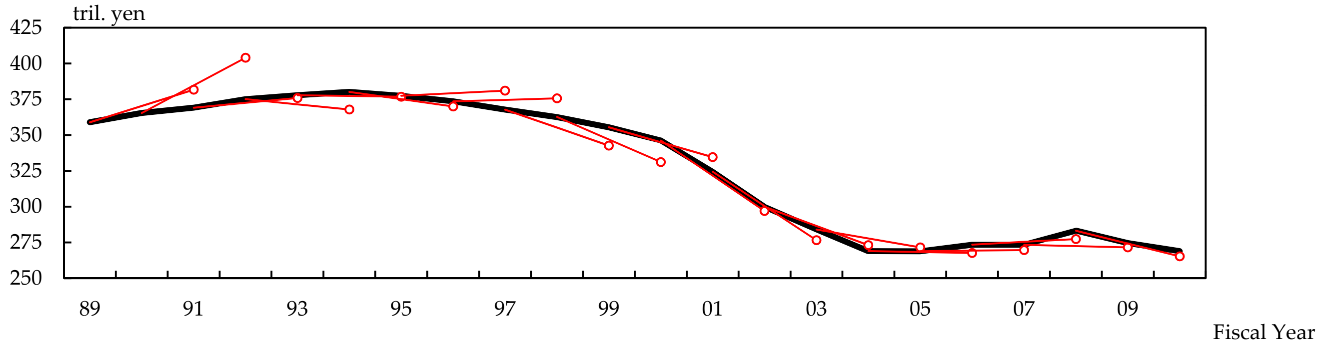
(1) Household Expenditure



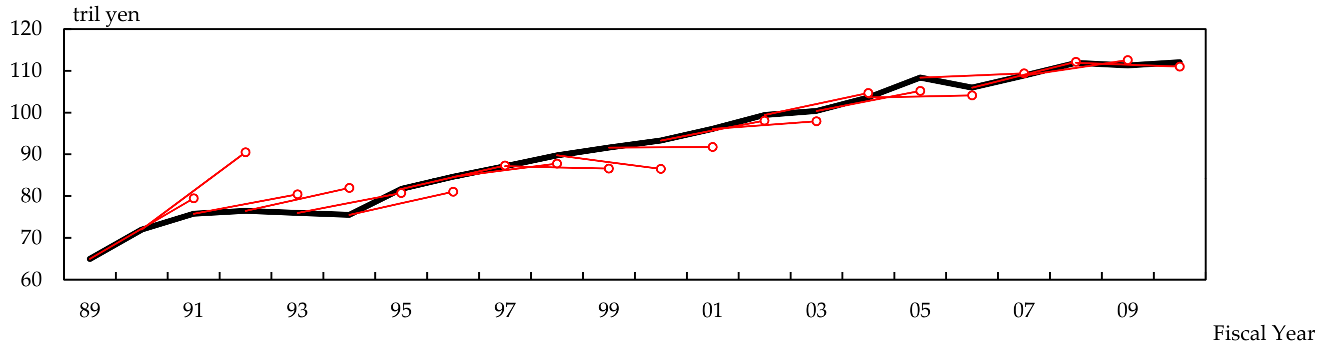
(2) Business Fixed Investment



(3) Corporate Lending Volume



(4) Household Lending Volume

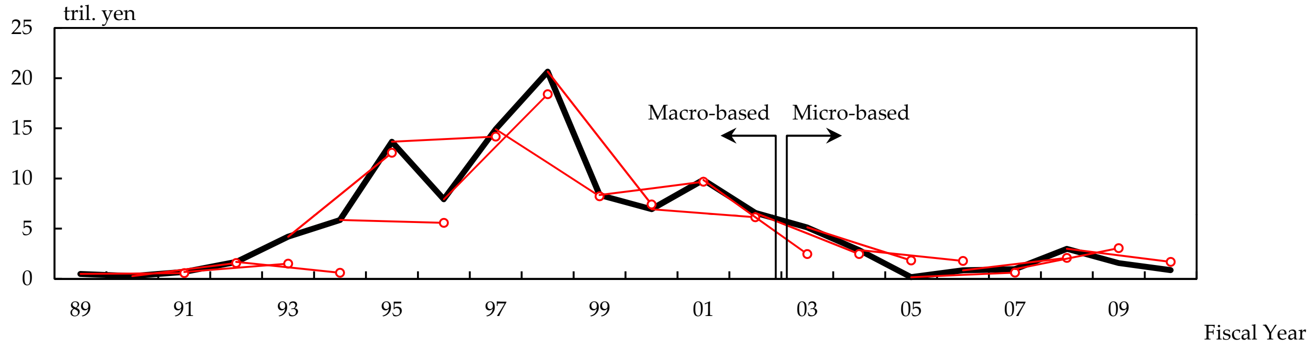


(Figure 5-2)

The FMM's Performance Evaluation (4)

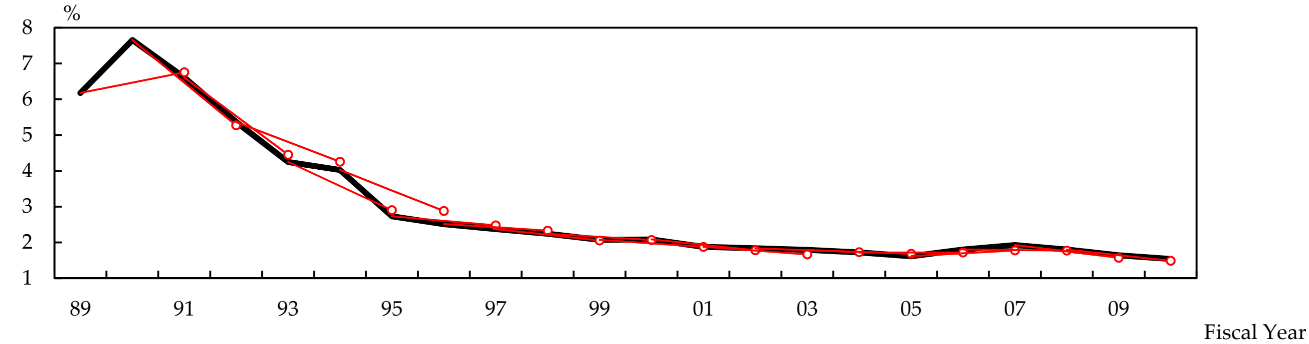
(Prediction period: two years)

(5) Credit Cost



(6) Tier I Ratio

(7) Lending Interest Rate

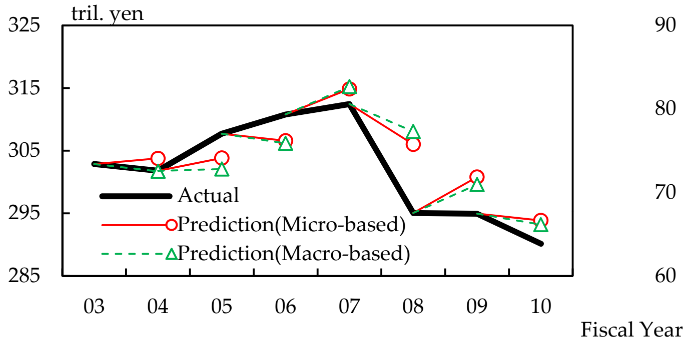


(Figure 6)

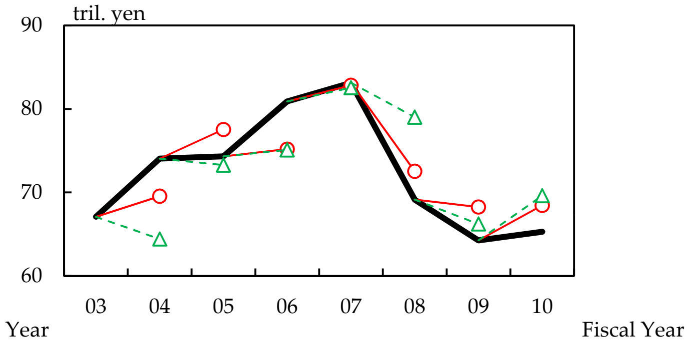
Comparison of Performance between Macro-based and Micro-based (1)

(Prediction period: one year)

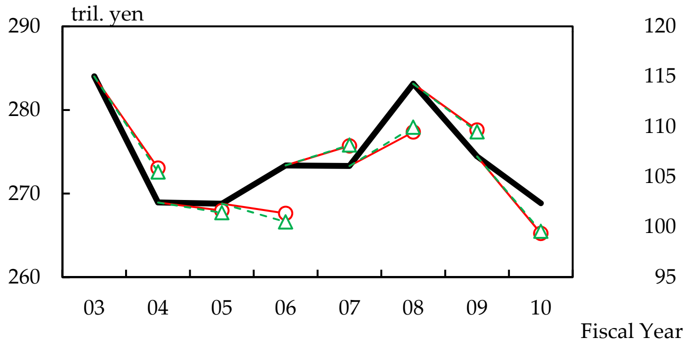
(1) Household Expenditure



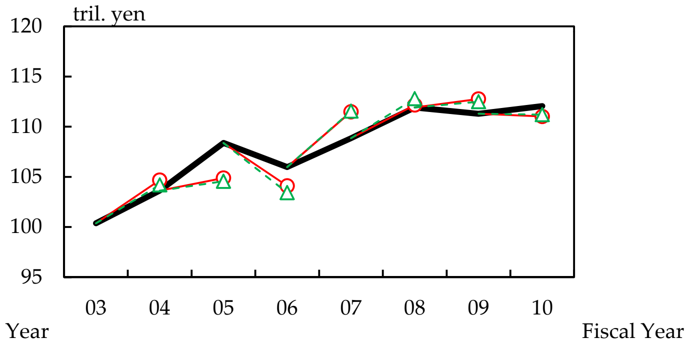
(2) Business Fixed Investment



(3) Corporate Lending Volume

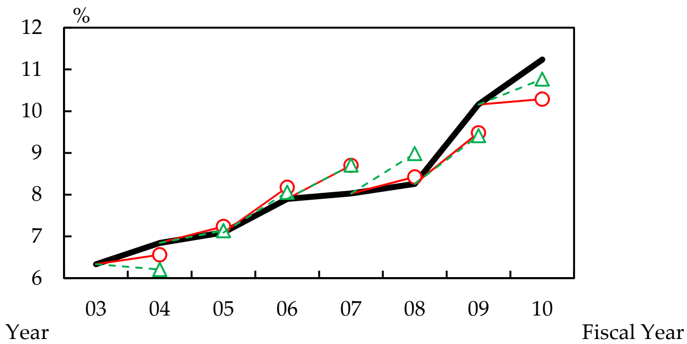


(4) Household Lending Volume

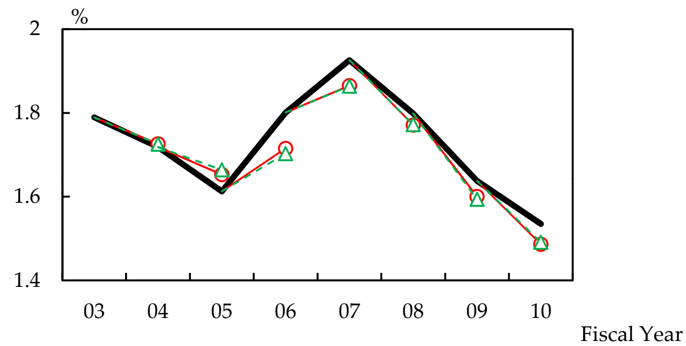


(5) Credit Cost

(6) Tier I Ratio



(7) Lending Interest Rate

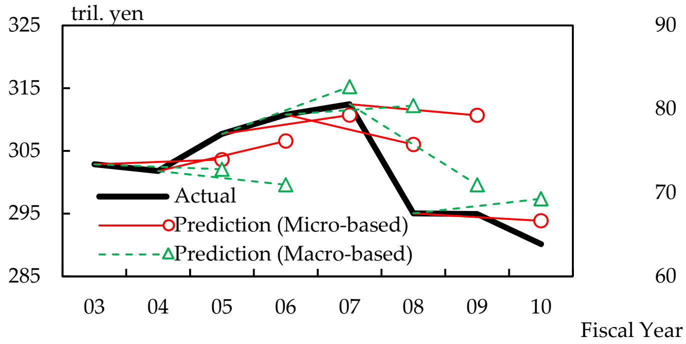


(Figure 7)

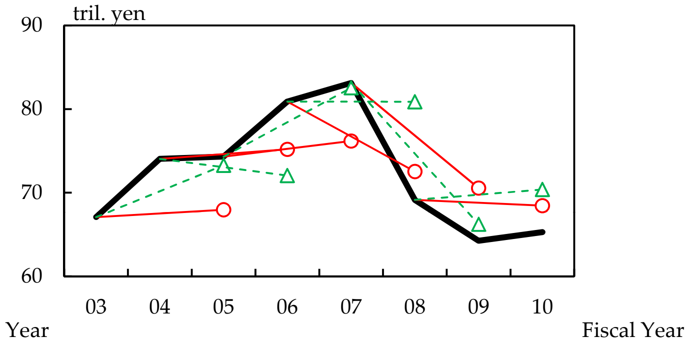
Comparison of Performance between Macro-based and Micro-based (2)

(Prediction period: two years)

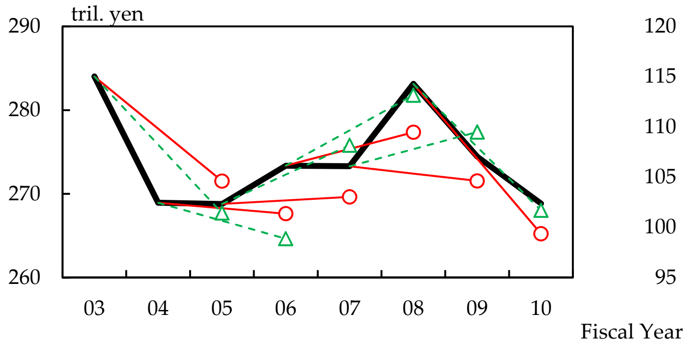
(1) Household Expenditure



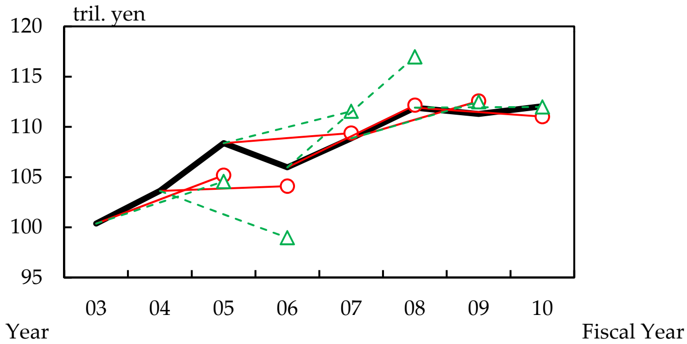
(2) Business Fixed Investment



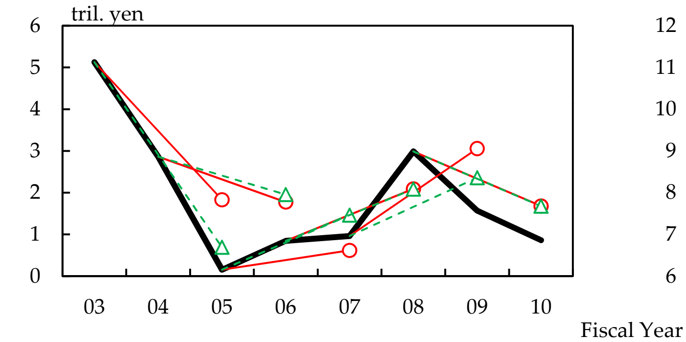
(3) Corporate Lending Volume



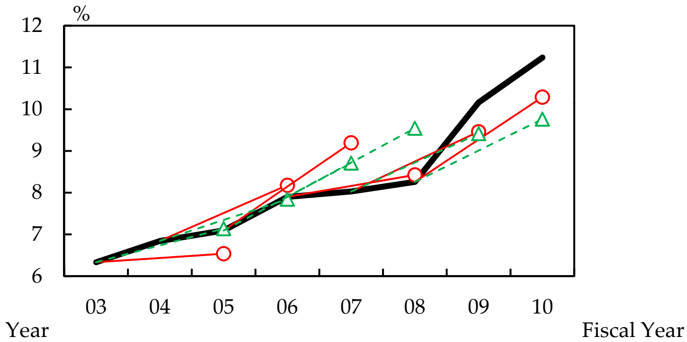
(4) Household Lending Volume



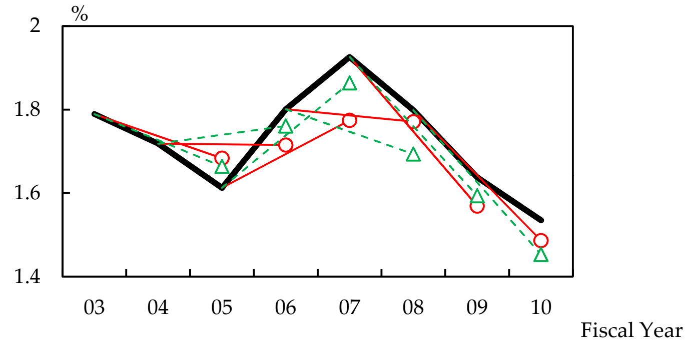
(5) Credit Cost



(6) Tier I Ratio



(7) Lending Interest Rate



(Figure 8)

Estimates of the Three-variable VAR Model

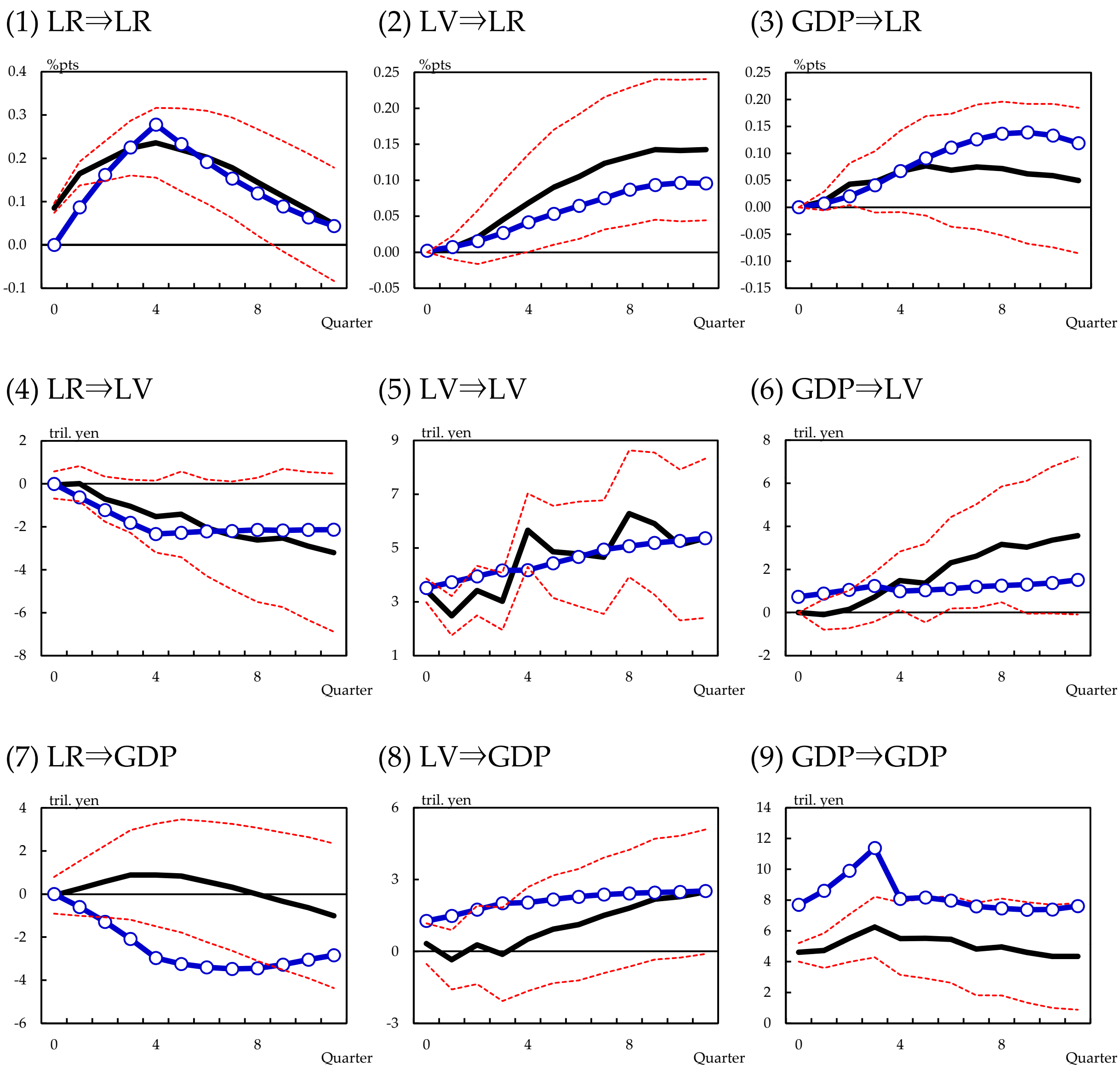
	Lending Interest Rate	Lending Volume	Nominal GDP
Lending Interest Rate (- 1)	1.94	546.3	3609.4
Lending Volume (- 1)	$1.57E^{-6}$	0.73	-0.20
Nominal GDP (- 1)	$2.54E^{-6}$	-0.02	1.02
Lending Interest Rate (- 2)	-1.48	-9096.7	-2943.8
Lending Volume (- 2)	$1.53E^{-6}$	0.46	0.31
Nominal GDP (- 2)	$1.84E^{-6}$	0.06	0.14
Lending Interest Rate (- 3)	1.07	10080.3	-1300.4
Lending Volume (- 3)	$2.30E^{-6}$	-0.17	-0.14
Nominal GDP (- 3)	$-9.01E^{-6}$	0.12	-0.03
Lending Interest Rate (- 4)	-0.99	-5515.6	-1383.3
Lending Volume (- 4)	$-5.05E^{-6}$	0.70	0.15
Nominal GDP (- 4)	$8.99E^{-6}$	0.07	-0.32
Lending Interest Rate (- 5)	0.64	8737.4	1500.3
Lending Volume (- 5)	$2.10E^{-6}$	-0.44	0.14
Nominal GDP (- 5)	$-8.35E^{-6}$	-0.27	0.17
Lending Interest Rate (- 6)	-0.25	-8530.9	1251.9
Lending Volume (- 6)	$-6.57E^{-6}$	-0.63	-0.30
Nominal GDP (- 6)	$4.26E^{-6}$	0.15	0.03
Lending Interest Rate (- 7)	0.04	3176.3	-947.3
Lending Volume (- 7)	$4.47E^{-6}$	0.33	0.07
Nominal GDP (- 7)	$-9.02E^{-7}$	-0.12	-0.06

Notes: *1.* For description of variables, see Appendix I.
2. Estimation period: 1981Q4 through 2011Q1, adjusted R^2 = 0.998, 0.998, 0.996.
3. The order of Cholesky decomposition is lending interest rate, lending volume, nominal GDP.
4. The lag order is 7 as suggested by AIC.
5. For more detail of the VAR model and further analysis by using it, see Teranishi and Uno (2011).

(Figure 9)

Comparison of Impulse Response of the VAR Model and the FMM

(Call rate is assumed to be endogenous)



Notes: 1. LR: lending interest rate, LV: lending volume, GDP: nominal GDP.

2. Solid line shows impulse response of the VAR model. Dotted line shows two standard deviation interval. And, solid line with circles shows response of the FMM to same shock.

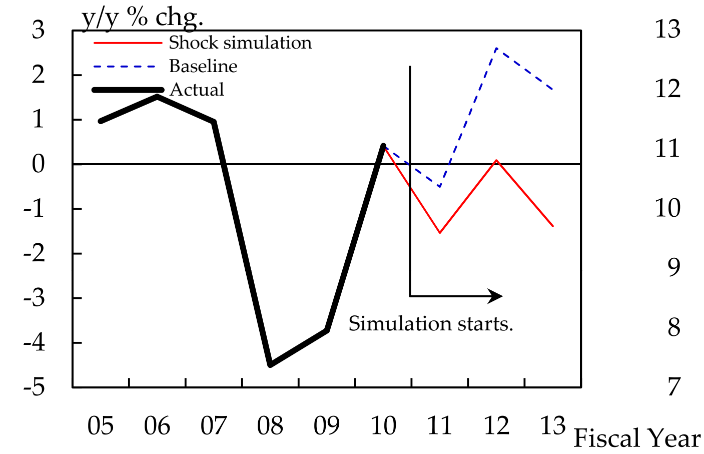
(Figure 10)

Single-shock Simulation: Downward Shock on Nominal GDP (1)

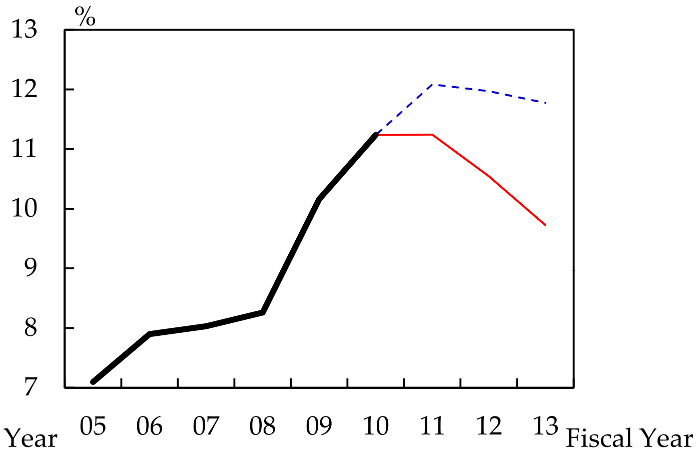
(Call rate is assumed to be endogenous)

Shock: Negative shock of 0.5%pt per annum to year-on-year growth rate of nominal GDP over the first two years from the baseline.

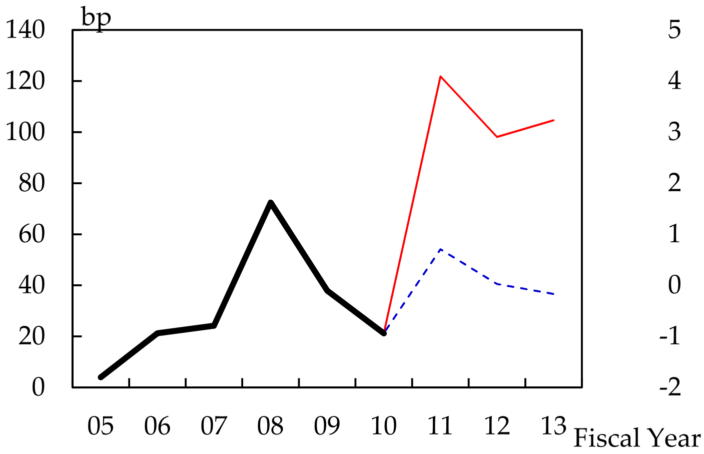
(1) Nominal GDP



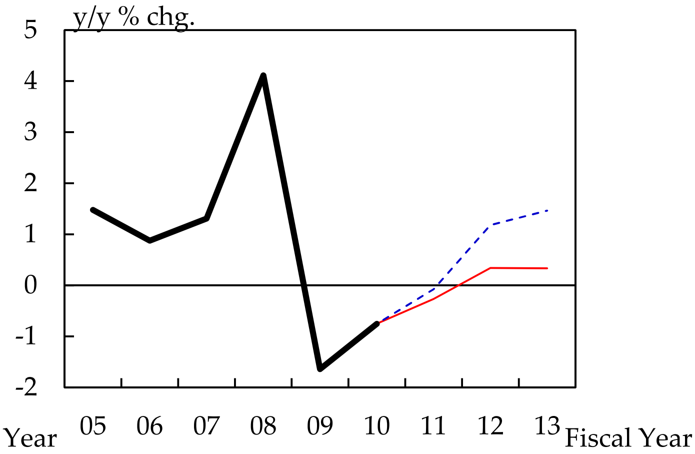
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



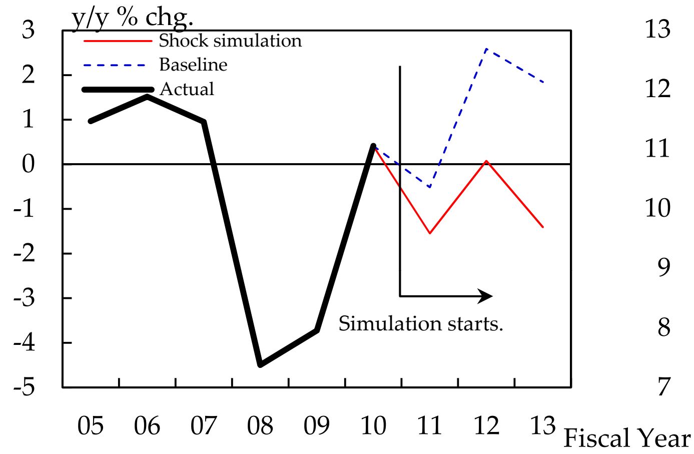
(Figure 11)

Single-shock Simulation: Downward Shock on Nominal GDP (2)

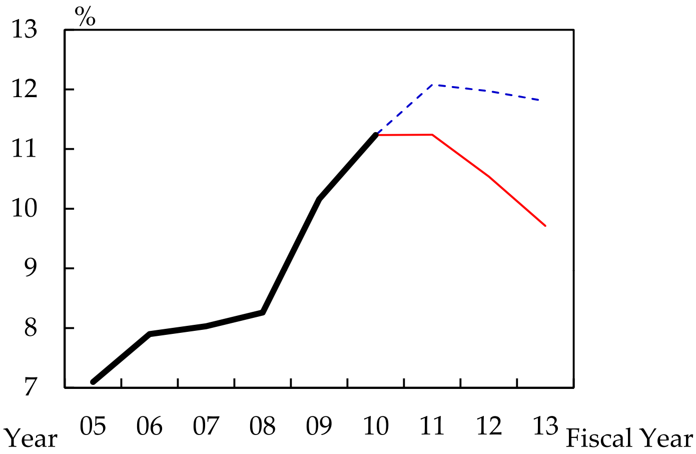
(Call rate is assumed to be exogenous)

Shock: Negative shock of 0.5%pt per annum to year-on-year growth rate of nominal GDP over the first two years from the baseline.

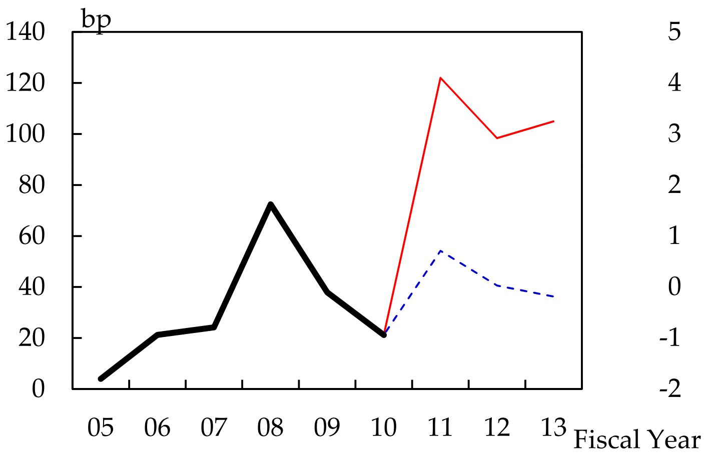
(1) Nominal GDP



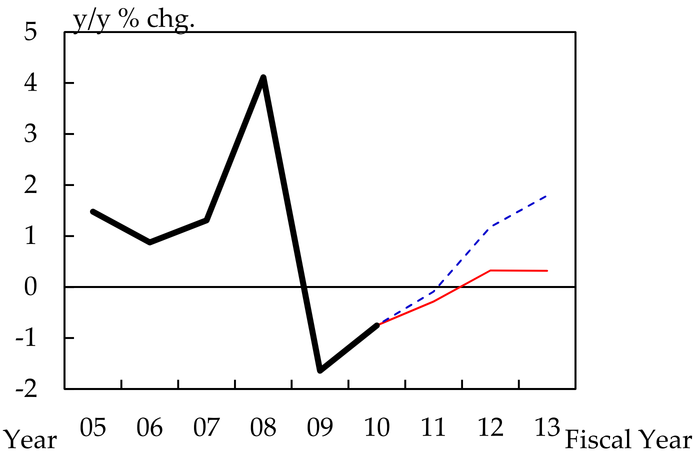
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



(Figure 12)

The Multiplier Table of the FMM (1)

(Call rate is assumed to be endogenous)

(1) Lending volume decrease 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-1.13	-1.17	-1.31	-0.02	-0.01	-0.41	-0.11	0.02	0.15	0.18
Second Year	-1.32	-1.33	-1.60	-0.07	-0.01	-0.54	-0.13	0.01	0.10	0.12
Third Year	-1.48	-1.48	-1.84	-0.11	-0.01	-0.59	-0.14	0.01	0.07	0.09

(2) Lending interest rate rises 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-1.98	-2.28	-1.79	0.96	0.08	-2.14	-0.94	0.08	0.34	0.28
Second Year	-2.38	-2.56	-2.54	0.80	0.08	-3.07	-1.18	0.05	0.42	0.33
Third Year	-2.61	-2.73	-2.96	0.66	0.07	-3.30	-1.21	0.01	0.62	0.53

(3) Credit Cost rate rises 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-0.72	-0.69
Second Year	-0.25	-0.17	-0.51	0.01	0.00	-0.12	-0.04	1.01	-1.69	-1.60
Third Year	-0.93	-0.61	-1.82	0.02	0.00	-0.47	-0.15	1.02	-2.51	-2.34

(4) Regulatory capital adequacy ratio rises 1%pt until the third year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.38	-0.25	-0.78	0.01	0.00	-0.20	-0.06	0.01	0.24	0.31
Second Year	-0.74	-0.50	-1.45	0.00	0.00	-0.40	-0.12	0.01	0.43	0.54
Third Year	-1.06	-0.72	-2.02	-0.02	0.00	-0.58	-0.16	0.01	0.59	0.72

(5) Stock price down 10% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.03	-0.02	-0.07	0.00	0.00	-0.24	-0.07	0.01	-0.17	-0.34
Second Year	-0.16	-0.10	-0.35	-0.01	0.00	-0.36	-0.10	0.00	-0.24	-0.37
Third Year	-0.34	-0.21	-0.69	-0.02	0.00	-0.47	-0.13	0.00	-0.19	-0.28

(6) Corporate profit margin decreases 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.23	-0.13	-0.51	-0.01	-0.01	-1.91	-1.54	0.06	-0.22	-0.43
Second Year	-0.61	-0.32	-1.39	-0.11	-0.01	-3.58	-2.02	0.07	-0.50	-0.72
Third Year	-0.97	-0.49	-2.24	-0.24	-0.03	-4.07	-2.13	0.01	-0.52	-0.68

Note: *1.* Deviation from the baseline.

(Figure 13)

The Multiplier Table of the FMM (2)

(Call rate is assumed to be exogenous)

(1) Lending volume decrease 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-1.14	-1.19	-1.32	-0.01	-0.01	-0.43	-0.12	0.02	0.15	0.18
Second Year	-1.43	-1.46	-1.70	-0.01	-0.01	-0.65	-0.19	0.01	0.08	0.10
Third Year	-1.72	-1.74	-2.10	-0.02	-0.02	-0.86	-0.25	0.01	0.03	0.04

(2) Lending interest rate rises 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-2.03	-2.34	-1.83	0.99	0.08	-2.18	-0.96	0.08	0.34	0.28
Second Year	-2.72	-2.96	-2.84	0.97	0.06	-3.38	-1.32	0.06	0.37	0.28
Third Year	-3.36	-3.55	-3.73	0.96	0.04	-4.05	-1.53	0.03	0.49	0.38

(3) Credit Cost rate rises 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	-0.72	-0.69
Second Year	-0.26	-0.17	-0.52	0.01	0.00	-0.12	-0.04	1.01	-1.69	-1.60
Third Year	-0.96	-0.65	-1.85	0.04	0.00	-0.51	-0.16	1.02	-2.52	-2.35

(4) Regulatory capital adequacy ratio rises 1%pt until the third year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.39	-0.26	-0.78	0.02	0.00	-0.20	-0.06	0.01	0.24	0.31
Second Year	-0.79	-0.55	-1.49	0.03	0.00	-0.45	-0.14	0.01	0.42	0.54
Third Year	-1.19	-0.87	-2.16	0.03	-0.01	-0.72	-0.22	0.01	0.57	0.69

(5) Stock price down 10% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.03	-0.02	-0.07	0.00	0.00	-0.24	-0.07	0.01	-0.17	-0.34
Second Year	-0.19	-0.13	-0.38	0.01	0.00	-0.39	-0.12	0.00	-0.24	-0.37
Third Year	-0.41	-0.29	-0.77	0.01	0.00	-0.55	-0.17	0.00	-0.20	-0.30

(6) Corporate profit margin decreases 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.25	-0.15	-0.52	0.00	-0.01	-1.93	-1.55	0.06	-0.22	-0.44
Second Year	-0.82	-0.57	-1.58	0.00	-0.03	-3.76	-2.10	0.07	-0.53	-0.75
Third Year	-1.56	-1.15	-2.81	0.01	-0.06	-4.62	-2.38	0.03	-0.61	-0.78

Note: *1.* Deviation from the baseline.

(Figure 14)

Multiple Shock Simulation: Downward Shock on Expected Growth Rate (1)

(Call rate is assumed to be endogenous)

(1) Case 1: Expected growth rate declines 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.94	-0.54	-2.12	-0.01	-0.01	-0.67	-0.19	-1.08	0.02	0.08	0.07
Second Year	-1.15	-0.69	-2.45	-0.07	0.00	-0.87	-0.23	-0.03	0.01	0.02	0.01
Third Year	-1.34	-0.83	-2.75	-0.12	-0.01	-0.96	-0.25	-0.01	0.01	0.01	0.01

(2) Case 2: Nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.25	-0.14	-0.56	-0.02	0.00	-2.05	-0.58	-0.26	0.07	-0.09	-0.16
Second Year	-0.39	-0.18	-0.94	-0.11	0.00	-2.60	-0.73	-0.07	0.03	-0.20	-0.28
Third Year	-0.53	-0.23	-1.29	-0.19	-0.01	-2.75	-0.76	-0.02	0.00	-0.18	-0.23

(3) Case 3: Nominal GDP and potential nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.43	-0.24	-0.96	-0.02	0.00	-1.74	-0.24	-0.47	0.06	-0.01	-0.04
Second Year	-0.75	-0.40	-1.71	-0.10	0.00	-2.06	-0.32	-0.29	0.02	-0.05	-0.08
Third Year	-1.13	-0.61	-2.50	-0.17	0.00	-2.28	-0.36	-0.28	0.01	-0.02	-0.03

(4) Case 4: Expected growth rate declines 1%pt and nominal GDP and potential nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-1.37	-0.78	-3.08	-0.03	-0.01	-2.41	-0.43	-1.55	0.09	0.07	0.03
Second Year	-1.89	-1.09	-4.14	-0.17	0.00	-2.92	-0.55	-0.32	0.03	-0.04	-0.08
Third Year	-2.46	-1.44	-5.20	-0.29	-0.01	-3.22	-0.61	-0.29	0.01	-0.01	-0.03

Note: *1.* Deviation from the baseline.

(Figure 15)

Multiple Shock Simulation: Downward Shock on Expected Growth Rate (2)

(Call rate is assumed to be exogenous)

(1) Case 1: Expected growth rate declines 1%pt in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.96	-0.56	-2.14	0.00	-0.01	-0.68	-0.19	-1.09	0.02	0.08	0.07
Second Year	-1.28	-0.84	-2.57	-0.01	-0.01	-1.00	-0.29	-0.04	0.02	0.00	-0.01
Third Year	-1.62	-1.13	-3.04	-0.01	-0.02	-1.27	-0.37	-0.03	0.01	-0.04	-0.05

(2) Case 2: Nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.28	-0.18	-0.58	0.00	0.00	-2.07	-0.59	-0.26	0.07	-0.09	-0.17
Second Year	-0.61	-0.44	-1.15	0.00	-0.01	-2.81	-0.83	-0.10	0.03	-0.23	-0.31
Third Year	-1.02	-0.76	-1.79	0.00	-0.02	-3.27	-0.97	-0.06	0.01	-0.26	-0.32

(3) Case 3: Nominal GDP and potential nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-0.46	-0.28	-0.99	0.00	0.00	-1.77	-0.26	-0.47	0.06	-0.02	-0.04
Second Year	-0.96	-0.64	-1.90	0.00	-0.01	-2.26	-0.41	-0.31	0.02	-0.08	-0.11
Third Year	-1.57	-1.09	-2.96	-0.01	-0.02	-2.76	-0.57	-0.31	0.02	-0.09	-0.12

(4) Case 4: Expected growth rate declines 1%pt and nominal GDP and potential nominal GDP declines 1% in the first year.

	Lending Volume (%)	Corporate Lending Volume (%)	Household Lending Volume (%)	Lending Interest Rate (%pts)	Bank Profit Margin (%pts)	Nominal GDP (%)	Corporate Profit Margin (%pts)	Expected Growth Rate (%pts)	Credit Cost Ratio (%pts)	Tier I Ratio (%pts)	Capital Adequacy Ratio (%pts)
First Year	-1.42	-0.84	-3.13	0.00	-0.01	-2.45	-0.46	-1.56	0.09	0.06	0.03
Second Year	-2.23	-1.48	-4.45	-0.01	-0.02	-3.24	-0.70	-0.35	0.04	-0.09	-0.13
Third Year	-3.16	-2.21	-5.93	-0.01	-0.04	-3.97	-0.93	-0.35	0.03	-0.14	-0.17

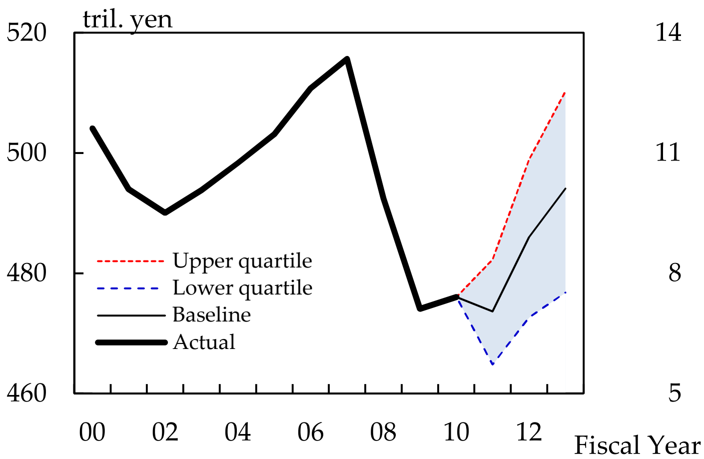
Note: *1.* Deviation from the baseline.

(Figure 16)

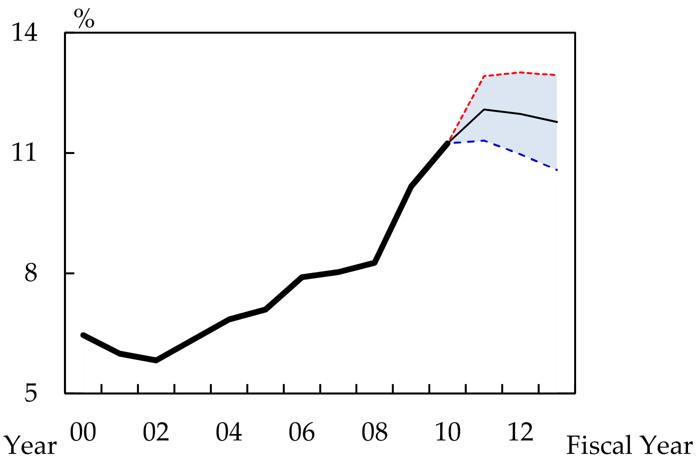
Comprehensive Shock Simulation: A Fan Chart (1)

(Call rate is assumed to be endogenous)

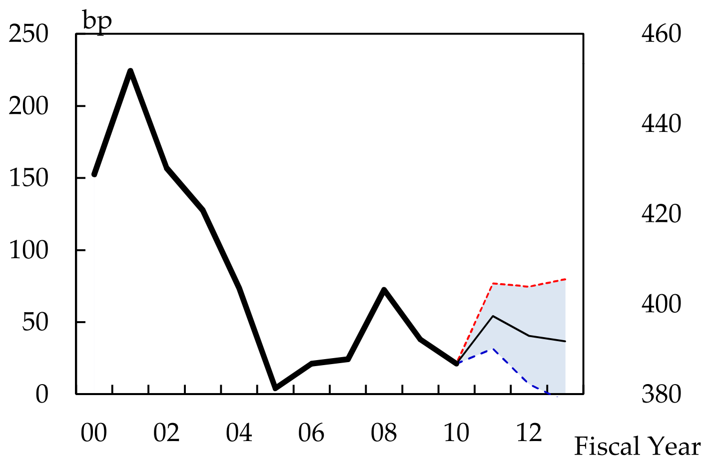
(1) Nominal GDP



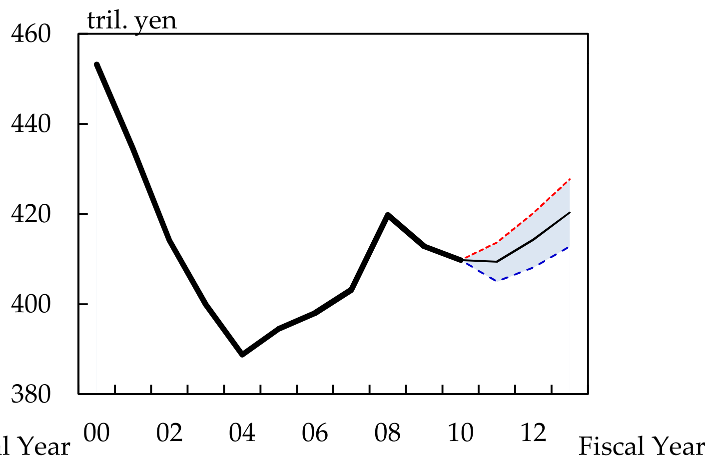
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume

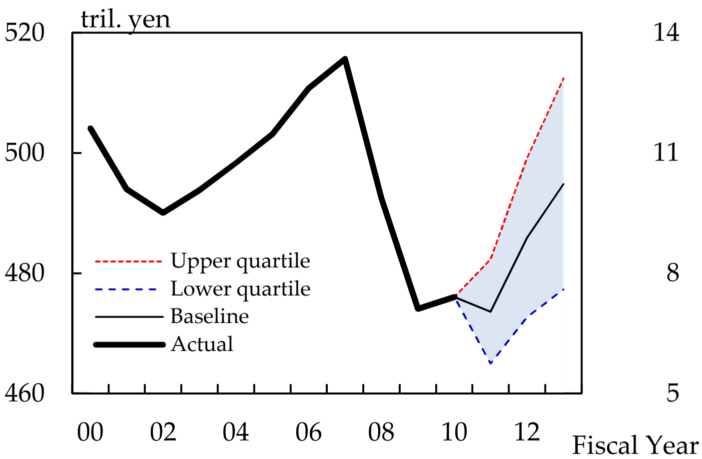


(Figure 17)

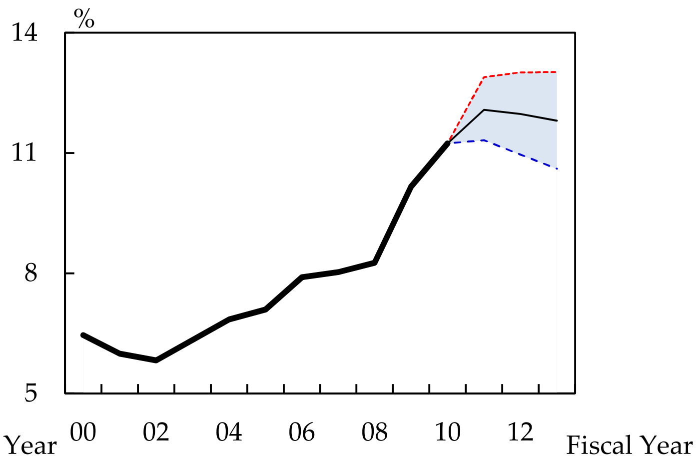
Comprehensive Shock Simulation: A Fan Chart (2)

(Call rate is assumed to be exogenous)

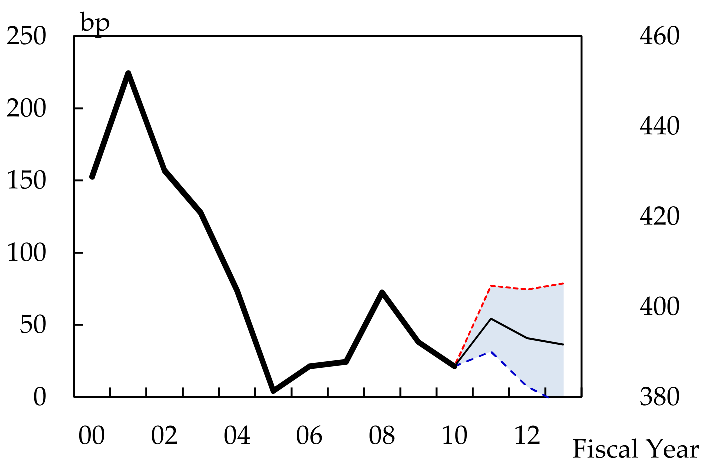
(1) Nominal GDP



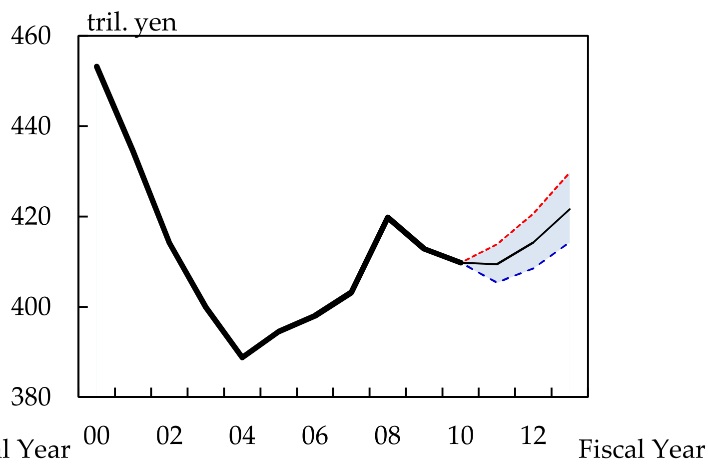
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume

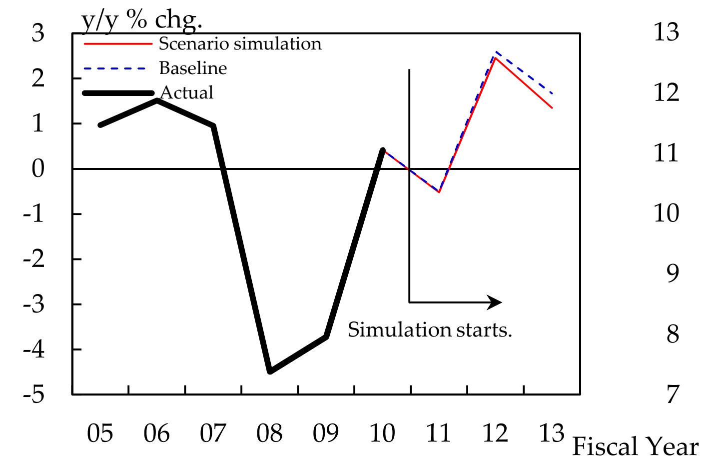


Scenario Simulation: Rise in the Regulatory Tier I Ratio (1)

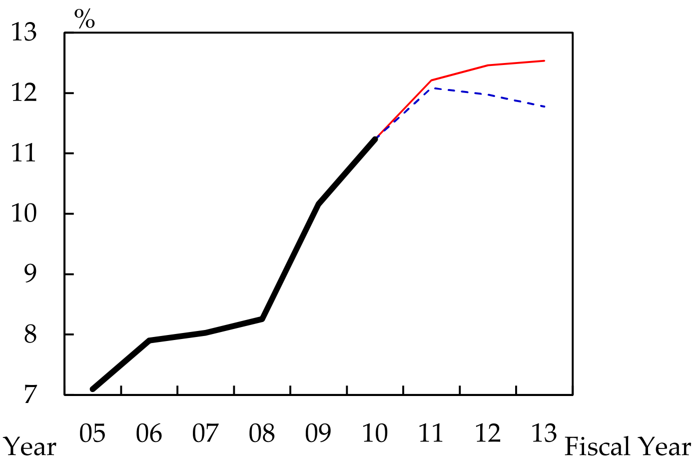
(Call rate is assumed to be endogenous)

Scenario: Bank's target Tier I ratio rises from 4.0% to 4.5% at the start of 2012, to 5.5% at the start of 2013, to 6.0% in the start of 2014 under Basel III.

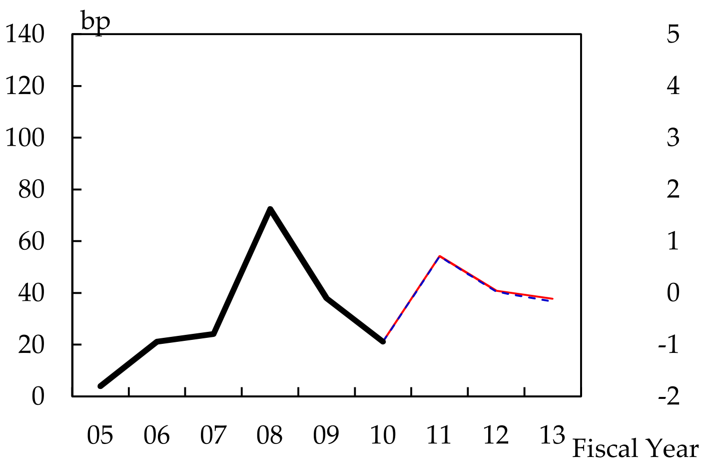
(1) Nominal GDP



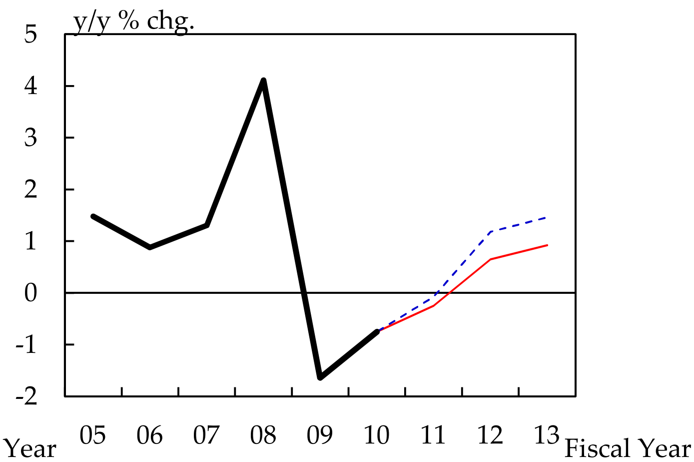
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



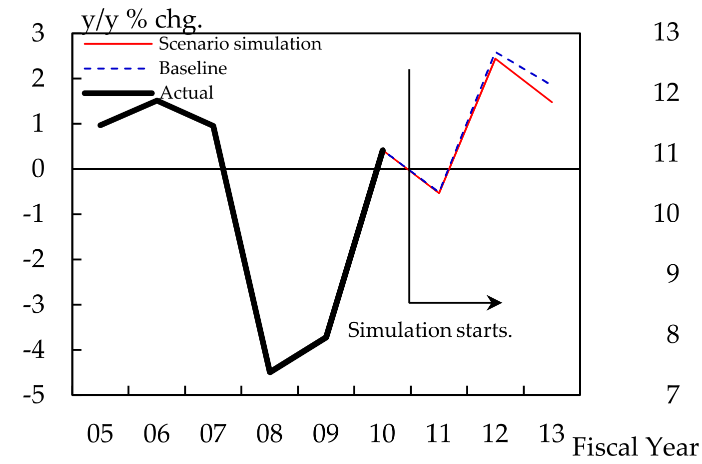
(Figure 19)

Scenario Simulation: Rise in the Regulatory Tier I Ratio (2)

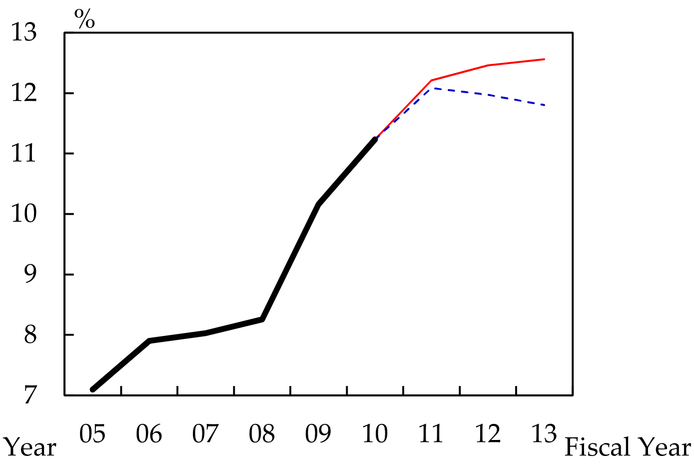
(Call rate is assumed to be exogenous)

Scenario: Bank's target Tier I ratio rises from 4.0% to 4.5% at the start of 2012, to 5.5% at the start of 2013, to 6.0% in the start of 2014 under Basel III.

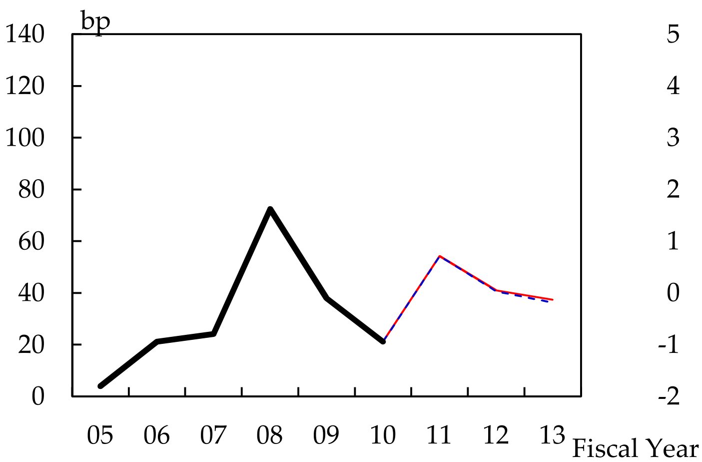
(1) Nominal GDP



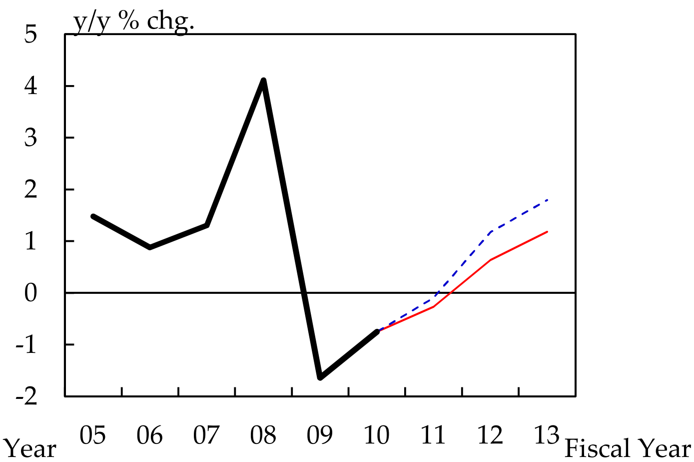
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



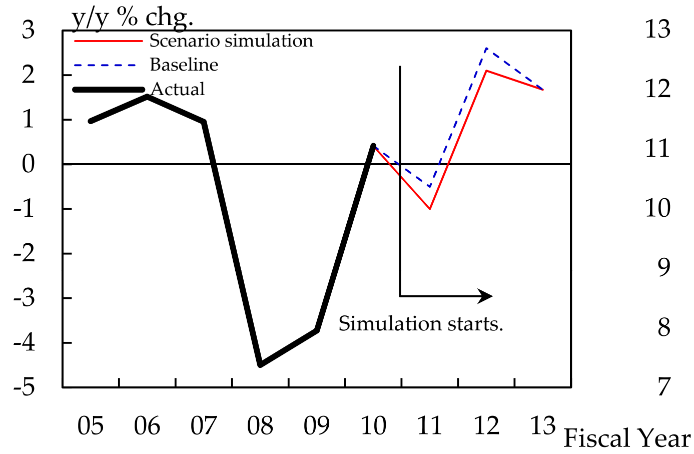
(Figure 20)

Scenario Simulation: Slowdown of Nominal GDP (1)

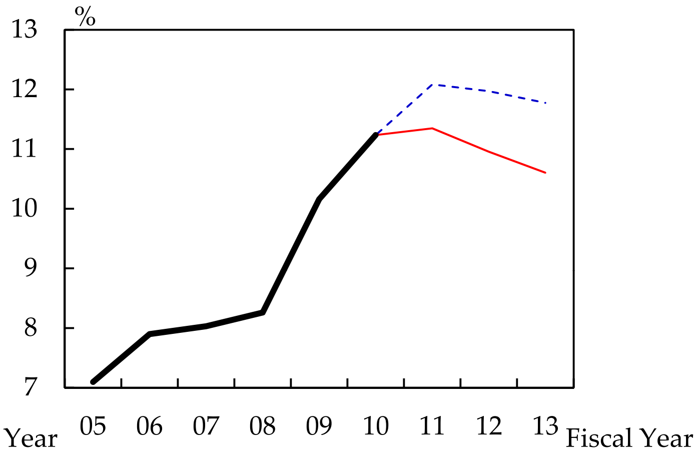
(Call rate is assumed to be endogenous)

Scenario: Year-on-year nominal GDP growth rate declines 0.5%pt per annum for the first two years from the baseline.

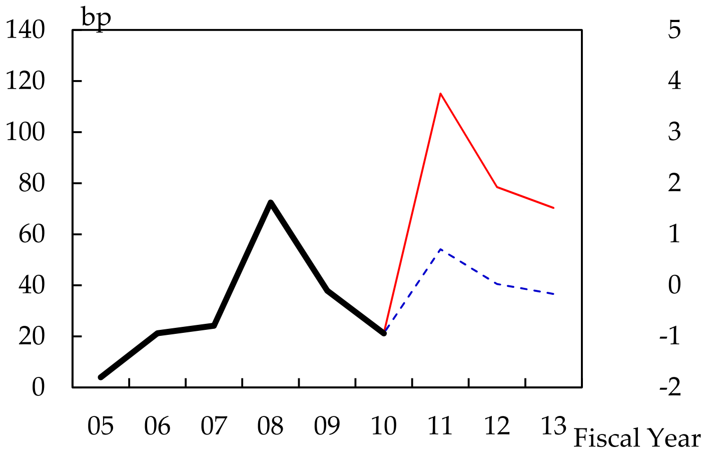
(1) Nominal GDP



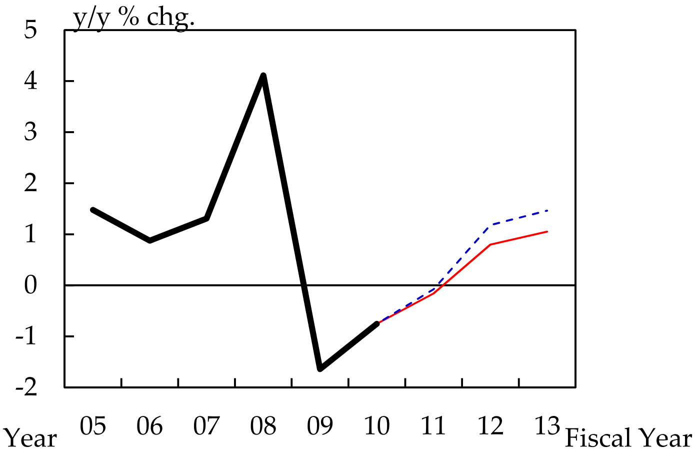
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



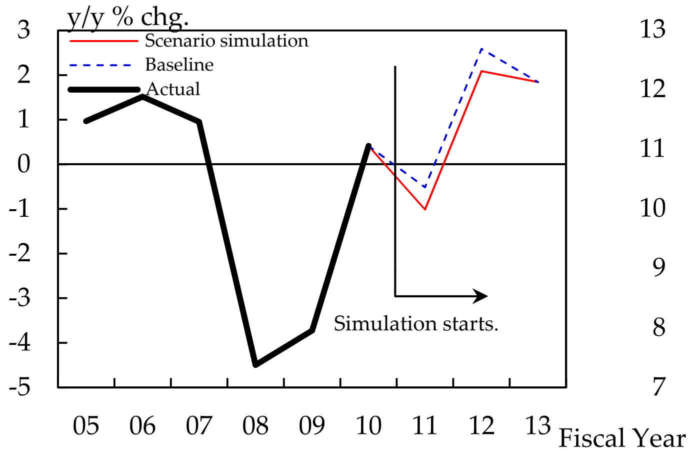
(Figure 21)

Scenario Simulation: Slowdown of Nominal GDP (2)

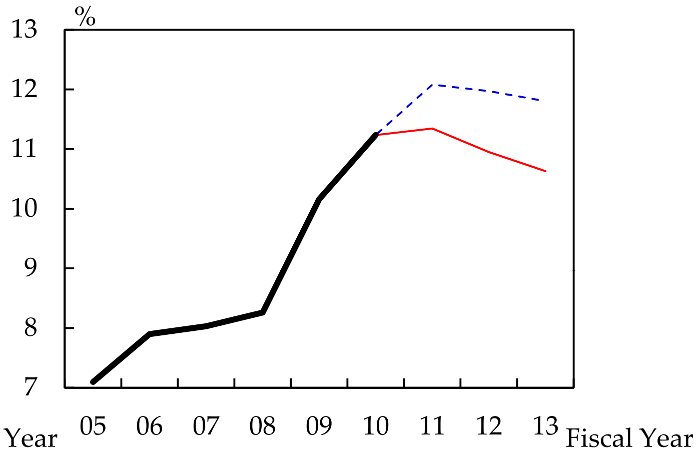
(Call rate is assumed to be exogenous)

Scenario: Year-on-year nominal GDP growth rate declines 0.5%pt per annum for the first two years from the baseline.

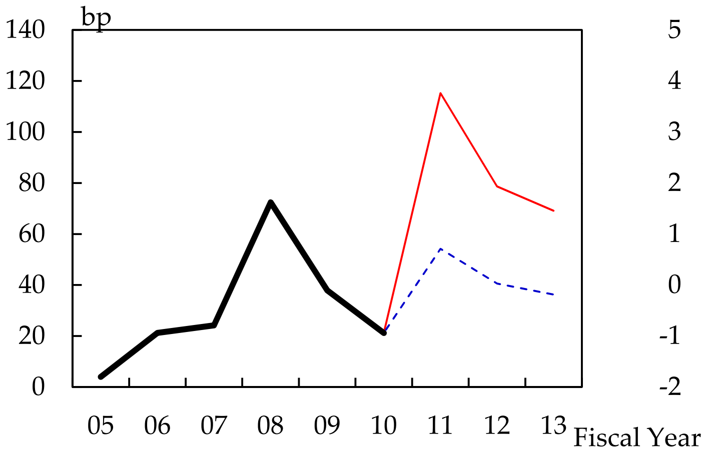
(1) Nominal GDP



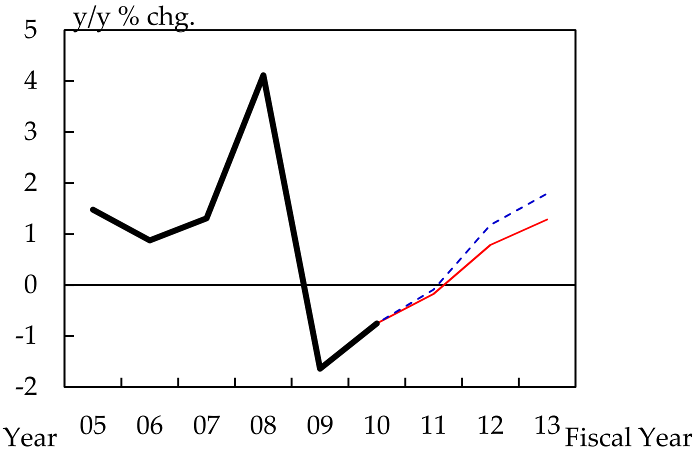
(2) Tier I Ratio



(3) Credit Cost Ratio



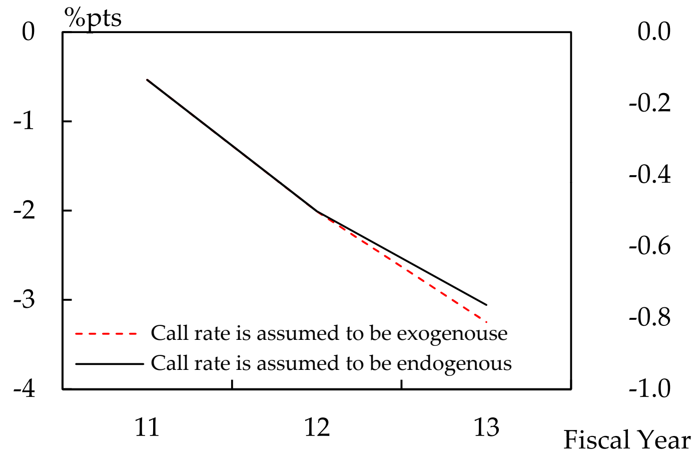
(4) Lending Volume



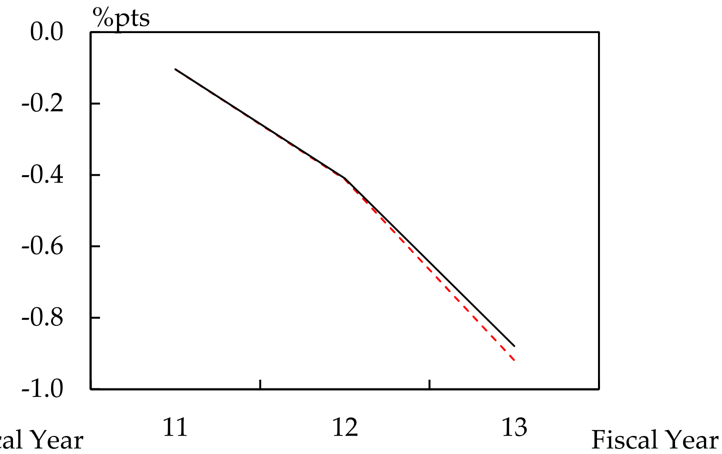
(Figure 22)

The Negative Feedback Effects

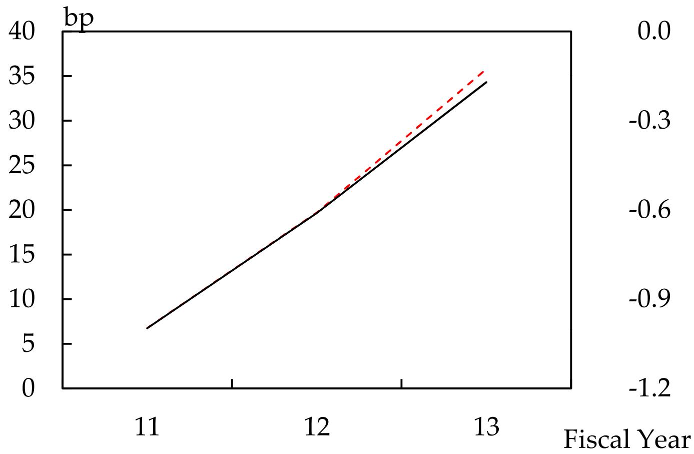
(1) Nominal GDP



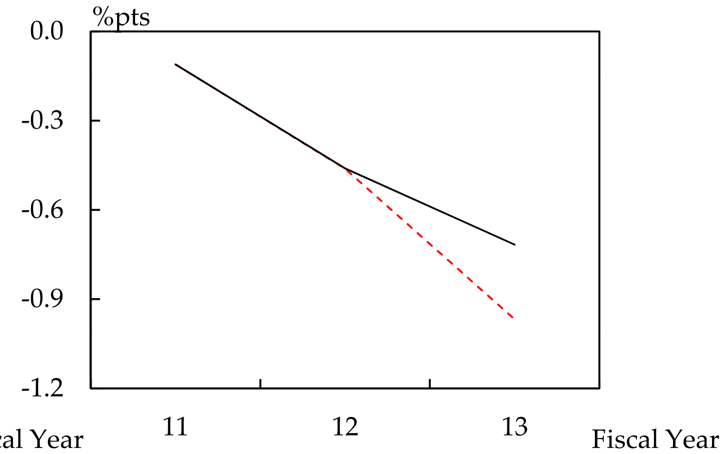
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



Note: *1.* Negative feedback effect is calculated by deviation from baseline in shock simulation (Figure 10, 11) minus deviation from the baseline in scenario simulation (Figure 20, 21).

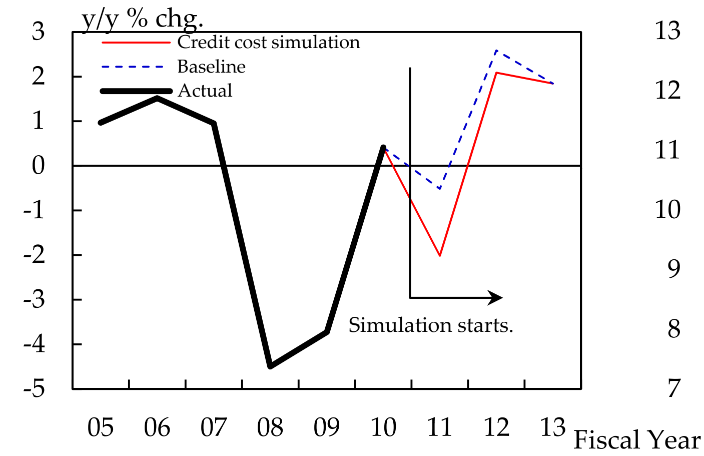
(Figure 23)

Scenario Simulation: Credit Cost Simulation

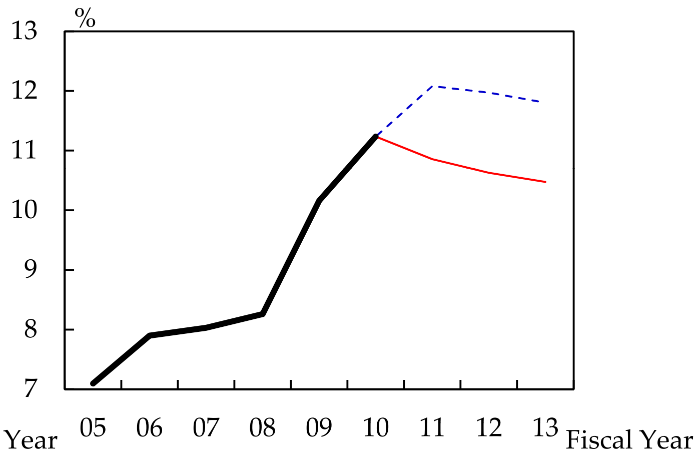
(Call rate is assumed to be exogenous)

Scenarios: *1.* Year-on-year nominal GDP growth rate declines from the baseline by 1.5%pts per annum in the first year and by 0.5%pt per annum in the second year.
2. Lending interest rate declines about 0.1%pt until the third year.
3. Stock price tumble to a post-bubble histrical low in the first year, before gradually rising.

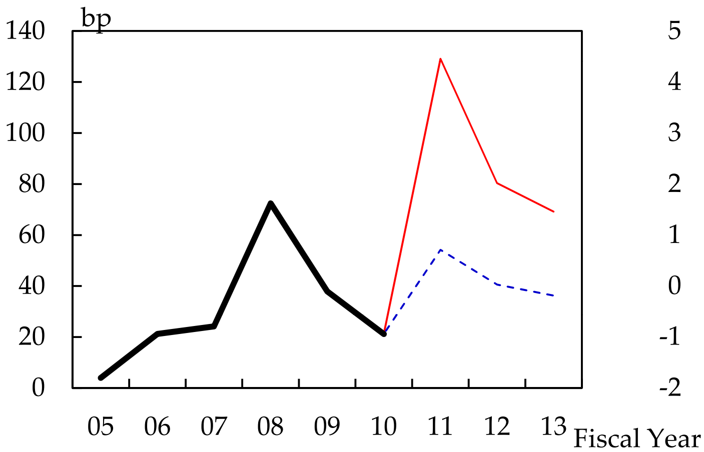
(1) Nominal GDP



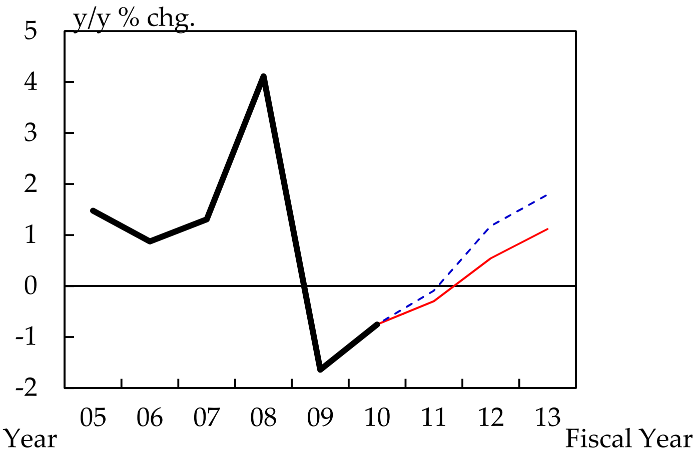
(2) Tier I Ratio



(3) Credit Cost Ratio



(4) Lending Volume



APPENDIX I. LIST OF VARIABLES

I. Endogenous Variable

(1) Financial sector variable

	Name	Unit	Source and Calculation
BKASOR	Bank Assets	bil. yen	Bank of Japan
BKCBICOR	Operating Profits of Core Business	bil. yen	Bank of Japan
BKEXASOR	Bank Other Assets	bil. yen	Bank assets - (lending volume + bank securities)
BKIICOR	Net Interest Income	bil. yen	Interest income - interest expenses (Original data: Bank of Japan)
BKIVSCOR	Bank Securities	bil. yen	Bank of Japan
BKLIOR	Bank Liabilities	bil. yen	Bank of Japan
BKOEQOR	Bank Net Assets	bil. yen	Bank of Japan
BKOPGPOR	Total Gross Income	bil. yen	Operation profits of core business + general and administrative expenses
BKPCREOR	Shareholder's Equity	bil. yen	Bank of Japan
CALLROR	Call Rate	%, annualized	Bank of Japan, "Uncollateralized Overnight Call Rate"
CPTLRTOR	Capital Adequacy Ratio	%	Capital / risk asset × 100
CPTLRTGAPCOR	Capital Adequacy Ratio Gap (excl. Public Funds)	%	(Capital adequacy ratio(- 4) – (public funds(- 4) / risk asset × 100)) – regulatory capital adequacy ratio
CPTLRTGAPOR	Capital Adequacy Ratio Gap	%	Capital adequacy ratio(- 4) - regulatory capital adequacy ratio
CPTLOR	Capital	bil. yen	Bank of Japan
CPTLT1RTOR	Tier I Ratio	%	Tier I capital / risk asset × 100
CPTLRTT1GAPCOR	Tier I Ratio Gap (excl. Public Funds)	%	(Tier I ratio(- 4) – (public funds (Tier I)(- 4) / risk asset)) –

	Name	Unit	Source and Calculation
			regulatory Tier I ratio
CPTLT1RTGAPOR	Tier I Ratio Gap	%	Tier I ratio(- 4) – regulatory Tier I ratio
CPTLT1OR	Tier I Capital	bil. yen	Bank of Japan
CPTLT2OR	Tier II Capital	bil. yen	Bank of Japan
CRDCOR	Credit Cost	bil. yen	Loan-loss provisions + write-offs – recoveries of write-offs (Original data: Bank of Japan)
CRDCRTOR	Credit Cost Ratio	%	Four-quarters sum of (credit cost / lending volume × 100)
CRISKASOR	Credit Risk Asset	bil. yen	Bank of Japan
LENDROR	Lending Interest Rate	%, annualized	Bank of Japan, "Average Contract Interest Rates on Loan and Discounts"
LENDVCORPOR	Corporate Lending Volume	bil. yen	Bank of Japan, "Loan and Bills Discounted by Sector"
LENDVGAPOR	Lending Volume Gap	%	Corporate lending volume / potential corporate lending volume × 100 – 100
LENDVIDVOR	Household Lending Volume	bil. yen	Bank of Japan, "Loan and Bills Discounted by Sector"
LENDVOR	Lending Volume	bil. yen	Bank of Japan, "Loan and Bills Discounted by Sector"
MRISKASOR	Market Risk Asset	bil. yen	Bank of Japan
ORISKASOR	Operational Risk Asset	bil. yen	Bank of Japan
RISKASOR	Risk Asset	bil. yen	Bank of Japan
ROABKCBOR	Bank Profit Margin (Operating Profits of Core Business on Asset)	%, annualized	Operating profits of core business / bank assets × 100 × 4
STKPOR	Stock Price	pt	Tokyo Stock Exchange, "TOPIX"

(2) Macroeconomic sector variable

	Name	Unit	Source and Calculation
EXGROR	Expected Growth Rate	%	Forecast of national real economic growth rate for the next three years from Cabinet Office, "Annual Survey of Corporate Behavior"
LANDPOR	Land Price	The end of March, 2000 = 100	Japan Real Estate Institute, "Urban Land Price Index"
LSRTOR	Labor Share of Income	%	Compensation of employees / nominal GDP × 100
NGDPGAPSA	Nominal GDP Gap	%	Nominal GDP / potential nominal GDP × 100
NGDPSA	Nominal GDP	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
NINVSA	Business Fixed Investment	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
NPREXPSA	Household Expenditure	bil. yen	Consumption of households + residential investment (Original data: Cabinet Office, "Quarterly Estimates of GDP")
ROACORPOR	Corporate profit margin (Current Profit on Asset)	%, annualized	Ministry of Finance, "Financial Statements Statistics of Corporation by Industry, Quarterly"
YWAGESA	Compensation of Employees	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"

II. Exogenous Variable

(1) Financial sector variable

	Name	Unit	Source and Calculation
BASEL	Regulatory Capital Adequacy Ratio	%	Weighted average of regulatory capital adequacy ratio for internationally and domestically active bank. Risk asset is used as

	Name	Unit	Source and Calculation
			weights.
BASELT1	Regulatory Tier I Ratio	%	Weighted average of regulatory Tier I ratio for internationally and domestically active bank. Risk asset is used as weights.
BKEXICOR	Other Income	bil. yen	Operating profits of core business – (net interest income + net non-interest income – general and administrative expenses)
BKEXIVOR	Other Securities held by Bank	bil. yen	Bank of Japan
BKEXLIOR	Bank Other Liabilities	bil. yen	Bank liabilities – deposit
BKEXOEQOR	Bank Other Net Assets	bil. yen	Bank net assets – (shareholder's equity + revaluation difference on securities + revaluation difference on land)
BKEXOR	General and Administrative Expenses	bil. yen	Bank of Japan
BKIVCBOR	Corporate Bonds held by Bank	bil. yen	Bank of Japan
BKIVGBOR	Japan Government Bonds held by Bank	bil. yen	Bank of Japan
BKIVLGBOR	Japan Local Government Bonds held by Bank	bil. yen	Bank of Japan
BKIVSTKOR	Stocks held by Bank	bil. yen	Bank of Japan
BKNIICOR	Net Non-Interest Income	bil. yen	Net fees and commissions + profits on specified transactions + other operating profits – realized gains/losses on bonds. (Original data: Bank of Japan)
BKRRLOR	Revaluation Difference on Land	bil. yen	Bank of Japan
BKRRSOR	Revaluation Difference on	bil. yen	Bank of Japan

	Name	Unit	Source and Calculation
	Securities		
BONDVOLOR	Amount Outstanding of Corporate Bonds	bil. yen	Corporate straight bonds + asset backed bonds + convertible bonds + government-guaranteed bonds. (Original data: Japan Securities Dealers Association, "Issuing, Redemption and Outstanding Amount of Bonds")
CPTLEXOR	Regulatory Adjustment (+ Tier III Capital)	bil. yen	Bank of Japan
CPTLIJTOR	Public Funds	bil. yen	Deposit Insurance Corporation of Japan, "List of Capital Injection Operations"
CPTLT1IJTOR	Public Funds (Tier I)	bil. Yen	Deposit Insurance Corporation of Japan, "List of Capital Injection Operations"
CPTLT2IJTOR	Public Funds (Tier II)	bil. Yen	Deposit Insurance Corporation of Japan, "List of Capital Injection Operations"
DPROR	Dividend Payout Ratio	%	Bank of Japan
DPVOR	Deposit	bil. yen	Bank of Japan, "Amounts Outstanding of Deposits by Depositor"
EXCPTLT1OR	Other Tier I Capital	bil. yen	Tier I capital – (shareholder's equity + revaluation difference on securities (if negative))
EXRISKASOR	Other Risk Asset	bil. yen	Bank of Japan
LENDVGOVOR	Local Governments Lending Volume	bil. yen	Bank of Japan, "Loan and Bills Discounted by Sector"
LENDVOSOR	Overseas Yen Lending Volume	bil. yen	Bank of Japan, "Loan and Bills Discounted by Sector"
LTRV30OR	Interest Rate Volatility	%	30 days volatility of 10 year JGB yield (Original data: Bloomberg)
NYDSTKPOR	US Stock Price	Dollar	Dow Jones, "Dow Jones

	Name	Unit	Source and Calculation
			Industrial Average"
PLENDVCORPSA	Potential Corporate Lending Volume[1]	bil. yen	Bank of Japan

(2) Macroeconomic sector variable

	Name	Unit	Source and Calculation
CPICOR	Consumer Price Index	CY 2005 = 100	All item, less fresh food from Ministry of Affairs and Communications, "Consumer Price Index"
CROR	Quick Ratio	%	Quick assets / short-term debt × 100 (Original data: Ministry of Finance, "Financial Statements Statistics of Corporation by Industry, Quarterly"; Bank of Japan, "Loan and Bills Discounted by Sector")

[1] We define as the level of long-term equilibrium the potential corporate lending volume that matches the potential nominal GDP. To calculate the potential corporate lending volume, we estimate the potential real GDP (using the method given in N. Hara; N. Hirakata; Y. Inomata; S. Ito; T. Kawamoto; T. Kurozumi; M. Minegishi; and I. Takagawa, 2006, "The New Estimates of Output Gap and Potential Growth Rate," Bank of Japan Review, 2006-E-3) and calculate the potential nominal GDP using a GDP deflator. Then, we calculate the potential lending volume for each lending purpose (business fixed investments and working). First, we assume that corporations potentially need capital to maintain or renew their capital stock, and define this capital as the potential corporate lending volume for business fixed investments. We calculate the potential corporate lending volume for business fixed investments by multiplying the figure for nominal net capital stock by the potential lending volume for the business fixed investment multiplier (which is the average of the lending volume for business fixed investment / nominal capital stock). Second, to calculate the potential corporate lending volume for working, we assume that corporations potentially need capital to pay wages etc. in an amount equal to the labor input (which is labor input times wages), and define this capital as potential corporate lending volume for working. We reach our estimate by multiplying potential labor input by the average wage by the potential lending volume for the working multiplier (which is the average of lending volume for working / amount of labor input). Here, the average wage represents the average total cash earnings per worker per hour; potential labor input represents the labor input that is used to estimate the potential real GDP based on the production function approach.

	Name	Unit	Source and Calculation
GDPDEFSA	GDP Deflator	CY 2000 = 100	Cabinet Office, "Quarterly Estimates of GDP"
ICROR	Interest Coverage Ratio	%	(Operating income + interest and dividends received) / interest expenses × 100 (Original data: Ministry of Finance, "Financial Statements Statistics of Corporation by Industry, Quarterly"; Bank of Japan, "Loan and Bills Discounted by Sector")
NEXPTSA	Exports	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
NGOVEXPSA	Government Expenditure	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
NIIVNSA	Inventory	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
NIMPTSA	Imports	bil. yen	Cabinet Office, "Quarterly Estimates of GDP"
PNGDPSA	Potential Nominal GDP	bil. yen	Potential real GDP / GDP deflator × 100 (Estimation of potential real GDP is based on Hara *et al.* (2006))

APPENDIX II. LIST OF EQUATIONS

The number in <> is in the estimated result indicates *p*-value. For detail of independent variables and dependent variables, see Appendix I.

(1) Lending Volume (LENDVOR)

Lending volume = corporate lending volume + household lending volume
+ local governments lending volume + overseas yen lending volume

(2) Corporate Lending Volume (LENDVCORPOR)

Year-to-year growth rate of corporate lending volume
= 0.43 × expected growth rate <0.07>
– 2.00 × year-to-year change in (lending interest rate – eight-quarters mean of year-to-year growth rate of consumer price index) <0.00>
+ 0.18 × capital adequacy ratio gap (excl. public funds) <0.13>
– 0.06 × ten-quarters mean of year-on-year growth rate of amount of outstanding corporate bonds(- 4) <0.29>
+ 0.45 × year-on-year growth rate of land price <0.00>
– 2.85 × Off-balance-sheet dummy <0.00>
– 1.90 × Financial Revitalization Program dummy <0.01>
+ 1.38 × Independent administrative institution dummy <0.12>
+ 2.52 × Company-specific factors (2006) dummy <0.14>
Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.82

An rise in an expected growth rate leads to an increase in corporate demand for loans and thus to an expansion of lending. When the real lending interest rate rises, funding costs increase, and thus the lending volume decreases. When the capital adequacy ratio is below the regulation ratio, banks reduce their risk assets, and thus their lending volume decreases. A rise in the amount of outstanding corporate bonds implies an increase in funding through loan-alternative sources, which induces a reduction in lending volume. When land prices rise, lending volume increases due to an increase in the collateral value.

Off-balance-sheet dummy: In April 2002, among its measures to develop a stronger financial system, the Financial Services Agency (FSA) issued guidelines encouraging major banks to take their nonperforming loans off balance sheet, with a result in a reduction of their lending volume.

Financial Revitalization Program dummy: In October 2002, the FSA's Financial Revitalization Program set the time-limit for the disposal of nonperforming loans by the nation's major banks. This program promoted nonperforming loan disposal and resulted in the decrease in the lending volume.

Independent administrative institution dummy: In 2005, some independent institutions substituted funding from the Fiscal Investment and Loan Program for that from private-sector bodies, thereby increasing their lending volume.

Company-specific factors (2006) dummy: In 2006, when certain companies used special funding schemes, some lending was counted twice.

(3) Household Lending Volume (LENDVIDVOR)

Year-on-year growth rate of household lending volume
= 1.88 × expected growth rate <0.00>
– 1.04 × year-on-year change in (lending interest rate – eight-quarter mean of year-on-year growth rate of consumer price index) <0.09>
+ 0.68 × capital adequacy ratio gap <0.00>
+ 0.69 × year-on-year growth rate of land price <0.00>
+ 4.67 × Consumption tax(on loans, 1997) dummy <0.02>
+ 1.77 × Transition from housing loan company dummy <0.29>
+ 4.40 × Government Housing Loan Corporation's reduced business dummy <0.00>
– 4.82 × Discontinuity of statistics (2004) dummy <0.00>
– 7.24 × Discontinuity of statistics (2006) dummy <0.00>
– 1.85 × Discontinuity of statistics (2009) dummy <0.21>
Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.77

A rise in the expected growth rate induces the expectations of a surge in household income, sparking demand for housing loans and increasing lending volume. When the real lending interest rate rises, funding costs for households increase, pushing down lending volume. When the capital adequacy ratio is below the regulation ratio, banks reduce their risk assets by decreasing their lending volume. When land prices rise, lending volumes increase due to a rise in the collateral value.

Consumption tax (on loans, 1997) dummy: A last-minute rise in demand for residential investments was induced by anticipating a rise in the consumption tax in April 1997, thereby boosting lending volume.

Transition from housing loan company dummy: Accompanied by a resolution of housing loan companies in 1995, substitution demand for housing loans from private banks surged, increasing the lending volume.

Government Housing Loan Corporation's reduced business dummy: In 2001, the cabinet decided the Reorganization and Rationalization Plan for Special Public Institutions. The business of the Government Housing Loan Corporation was substituted by private banks, increasing their lending volume commencing in FY2002

<u>Discontinuity of statistics (2004) dummy</u>: In 2004Q1, some financial institutions changed the category according to which they extended business-related loans, an alteration that required adjustment for time series data to remain consistent.

<u>Discontinuity of statistics (2006) dummy</u>: In 2006Q3, some financial institutions changed the category according to which they extended business-related loans, a change that required adjustment for time series data is to remain consistent.

<u>Discontinuity of statistics (2009) dummy</u>: In 2009Q2, some financial institutions changed the category according to which they extended business-related loans, requiring adjustment for time series data to remain consistent.

(4) Lending Interest Rate (LENDROR)

Year-on-year change in lending interest rate
= 0.60 × year-on-year change in call rate(- 1) <0.00>
+ 0.01 × four-quarters mean of year-on-year change in lending volume gap <0.06>
– 0.02 × capital adequacy ratio gap <0.01>
Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.94

Policy interest rates affect lending interest rates. When the lending volume gap increases, supply and demand conditions tighten in funding markets and enlarge the lending interest rate margin. As lending volume increases, loans are implemented toward risky borrowers. The lending interest rate is raised to reflect the higher risk premium. When the capital adequacy ratio declines, a bank decreases its risk assets by raising the lending interest rate.

(5) Operating Profits of Core Business (BKCBICOR)

> Operating profits of core business = net interest income + net non-interest income
> + other income – general and administrative expenses

(6) Net Interest Income (BKIICOR)

> Year-on-year change in net interest income
> = 0.003 × year-on-year change in lending volume <0.00>
> + 205.1 × year-on-year change in (lending interest rate – call rate) <0.00>
> + 58.2 × twelve-quarters mean of year-on-year change in corporate profit margin <0.17>
> Note: Sample = 1986Q3 through 2011Q1; adjusted R^2 = 0.46

When the lending volume increases, net interest rate income increases, reflecting loan-related profits. When the lending interest rate margin increases, there is also an increase in the loan-related profits and in interest rate income from government bonds, local government bonds, and foreign securities, boosting net interest rate income. Here, the spread between the lending interest rate and the policy rate is used as a proxy of the interest rate margin. When the corporate profit margin rises, so too does the stock dividend, pushing up the net interest rate income.

(7) Credit Cost (CRDCOR)

Year-on-year change in credit cost

= – 43.0 × two-years mean of year-on-year growth rate of nominal GDP <0.00>

– 23.7 × two-years mean of year-on-year growth rate of land price <0.00>

– 170.6 × four-quarters mean of year-on-year change in corporate profit margin <0.00>

– 55.9 × year-on-year change in quick ratio <0.00>

+ 0.02 × year-on-year change in lending volume <0.00>

+ 3182.1 × Housing loan companies' bad-loan write-off dummy <0.00>

+ 3037.9 × Self-assessment dummy <0.00>

+ 5267.9 × Publication of FSA inspection manual dummy <0.00>

+ 295.1 × Detailed FSA and Bank of Japan examination dummy <0.03>

+ 1070.0 × Detailed FSA inspection of city and long-term credit banks dummy <0.00>

+ 319.2 × Company-specific factors (2003) dummy <0.02>

– 493.3 × Negative loan-loss provisions by major banks dummy <0.00>

– 385.8 × Act Concerning Temporary Measures to Facilitate Financing for SMEs, etc. (SME Financing Facilitation Act) dummy <0.02>

Note: Sample = 1983Q2 through 2011Q1; adjusted R^2 = 0.96

When bankruptcies decrease in times of economic boom, credit costs also decrease. When land prices drop, the number of bankruptcies increases because company and household balance sheet conditions deteriorate and the value of collateral decreases. This boosts up credit costs. When corporate profit margins or the quick ratio rise, the repayment capacity of companies improves and credit costs decrease. When lending volumes increase, loan loss provisions increase, so do credit costs.

Housing loan companies' bad-loan write-off dummy: When the bad loans of housing loan companies were written off in the latter half of FY1995, the cost of credit rose.

Self-assessment dummy: The introduction of self-assessment for banks in FY1997 raised the cost of credit.

Publication of FSA inspection manual dummy: The reevaluation of the guidelines in the FSA's inspection manual (FY1998) raised the cost of credit.

Detailed FSA and Bank of Japan examination dummy: In FY1998, detailed FSA and Bank of Japan inspections revealed credit costs.

Detailed FSA inspection of city and long-term credit banks dummy: In FY2001, the detailed inspection by the FSA of city banks, long-term credit banks, and trust banks revealed credit costs.

Company-specific factors (2003) dummy: In the first half of FY2003, some financial institutions registered high credit costs.

Negative loan-loss provisions by major banks dummy: In FY2005, a large negative loan-loss provision for major banks decreased credit costs.

Act Concerning Temporary Measures to Facilitate Financing for SMEs, etc. (SME Financing Facilitation Act) dummy: In 2009, the SME Financing Facilitation Act deemphasized the need for self-assessments, thus decreasing credit costs.

(8) Capital (CPTLOR)

Capital = Tier I capital + Tier II capital + (Regulatory Adjustment + Tier III capital)

(9) Tier I Capital (CPTLT1OR)

Tier I capital = shareholder's equity + other Tier I capital
+ min(0, revaluation difference on securities)

(10) Tier II Capital (CPTLT2OR)

Year-on-year growth rate of (Tier II capital – public funds (Tier II))
= 0.44 × year-on-year growth rate of amount of outstanding corporate bonds <0.08>
– 1.72 × capital adequacy ratio gap (excl. public funds) <0.00>
+ 575.3 × four-quarters mean of year-on-year change in credit cost ratio <0.34>
+ 0.39 × year-on-year growth rate of stock price <0.00>
+ 9.69 × Preparation for the introduction of Basel III (2009) dummy <0.10>
Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.40

An improvement in the funding environment of a corporate bond market promotes an increase in capital through subordinated bonds, which increase Tier II capital. When the capital adequacy ratio is below the regulation ratio, banks increase their Tier II capital through subordinated bonds and other Tier II related funds. Part of a loan loss provision above any expected loss (EL) can be counted as Tier II capital. Thus, given its upper limit, Tier II capital increases when credit costs increase. When stock prices rise, the revaluation difference for securities increases, pushing up the Tier II capital.

Preparation for the introduction of Basel III (2009) dummy: In 2009, the Tier II capital of major banks increased subordinated bonds before the introduction of Basel III.

(11) Risk Asset (RISKASOR)

Risk asset = credit risk asset + market risk asset + operational risk asset + other risk asset

(12) Credit Risk Asset (CRISKASOR)

Year-on-year growth rate of credit risk asset
= 1.44 × year-on-year growth rate of lending volume <0.00>
+ 0.14 × year-on-year growth rate of stocks held by bank <0.00>
+ 0.14 × year-on-year growth rate of (corporate bonds held by bank + other securities held by bank) <0.00>
+ 0.40 × year-on-year change in credit cost ratio <0.43>
– 8.73 × Introduction of Advanced Internal Rating-Based (AIRB) risk analysis dummy <0.00>
– 10.5 × Introduction of Basel II dummy <0.00>
Note: Sample = 2000Q1 through 2011Q1; adjusted R^2 = 0.76

The rise in lending volume, as well as increased holdings of outstanding stocks, corporate bonds, and other securities (foreign securities) expanded exposure to credit risk and thus increased credit risk assets. When a rise in the credit cost ratio is induced by the downgrading of self-assessment due to deteriorating credit quality, a rise in risk weight increases the amount of risk assets.

Introduction of Advanced Internal Rating-Based (AIRB) risk analysis dummy: At the end of FY2008, adoption of the AIRB method by major banks caused credit risk assets to decrease.

Introduction of Basel II dummy: At the end of FY2006, credit risk assets decreased, due to the implementation of Basel II.

(13) Market Risk Asset (MRISKASOR)

Year-on-year change in market risk asset
= 3.77 × year-on-year change in interest rate volatility <0.15>
+ 3947.6 × Introduction of market risk asset dummy <0.00>
Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.78

When interest rate volatility increases, so do interest rate risk and market risk-related assets.

Introduction of market risk asset dummy: When the market risk was assessed according to the Basel regulations at the end of FY1998, adjustment was necessary for the time series data to remain consistent.

(14) Operational Risk Asset (ORISKASOR)

Year-on-year change in operational risk asset
= 5.23 × Three-years mean of year-on-year change in total gross income <0.02>
+ 25784.0 × Introduction of operational risk asset dummy <0.00>
Note: Sample = 2007Q1 through 2011Q1; adjusted R^2 = 0.997

If a bank does not adopt the Advanced Measurement Approaches (AMA) method, operational risk assets increase, as gross income rises.

Introduction of operational risk asset dummy: At the end of FY2006, when operational risk was included in the Basel regulations, adjustment was necessary for the time series data to remain consistent.

(15) Bank Liabilities (BKLIOR)

Bank liabilities = deposit + bank other liabilities

(16) Bank Net Assets (BKOEQOR)

Bank net assets = shareholder’s equity + revaluation difference on securities
+ revaluation difference on land + bank other net assets

(17) Bank Assets (BKASOR)

Bank assets = bank liabilities + bank net assets

(18) Bank Other Assets (BKEXASOR)

Bank other assets = bank assets – lending volume – bank securities

(19) Bank Investment Securities (BKIVSCOR)

Bank securities = Japan government bonds held by bank
+ Japan local government bonds held by bank
+ corporate bonds held by bank + stocks held by bank
+ other securities held by bank

(20) Shareholder's Equity (BKPCREOR)

Year-on-year growth rate of (shareholder's equity – public funds (Tier I))(including credit cost)
= – 0.02 × year-on-year change in dividend payout ratio <0.05>
+ 0.26 × four-quarters mean of year-on-year growth rate of stock price <0.01>
– 2.07 × Tier I ratio gap (excl. public funds) <0.09>
+ 38.4 × four-quarter mean of bank profit margin <0.00>
+ 9.00 × Capital increased to counter a deficit dummy <0.20>
+ 44.5 × Introduction of tax-effect accounting dummy <0.00>
+ 61.3 × Capital increase for bad-loan write-offs dummy <0.00>
+ 12.0 × Preparation for the introduction of Basel III dummy <0.12>

Note: Sample = 1989Q1 through 2011Q1; adjusted R^2 = 0.60

When the dividend payout ratio rises, there is an increase in the payments a company makes out of its net profit, slowing the accumulation of earned reserves. When there is a stock market boom, there is more incentive for banks to increase their capital, thus strengthening shareholder equity. When the Tier I ratio is below the regulation ratio, a bank increases its capital by, for example, issuing stocks, thus boosting shareholder equity. A higher bank profit margin increases net profit, while earned reserves raise shareholders' equity.

Capital increased to counter a deficit dummy: In FY1996, banks increased their capital holdings, by issuing preferred stock, to counter any reduction in capital caused by the previous year's deficit, thus boosting shareholders' equity.

Introduction of tax-effect accounting dummy: In FY1998, the introduction of tax-effect accounting led to deferred tax assets being counted as a capital and thus boosted shareholders' equity.

Capital increase for bad-loan write-offs dummy: In FY1999, shareholders' equity expanded when regional banks increased their capital in the face of a possible reduction in capital resulting from the disposal of nonperforming loans.

Preparation for the introduction of Basel III dummy: In FY2009, ahead of the introduction of the Basel III, the major banks increased their capital by issuing a common stock, thus raising shareholders' equity.

(21) Nominal GDP (NGDPSA)

Nominal GDP = household expenditure + business fixed investment + inventory
+ government expenditure + exports – imports

(22) Household Expenditure (NPREXPSA)

Year-on-year growth rate of household expenditure
= 0.59 × year-on-year growth rate of compensation of employees <0.00>
+ 0.02 × year-on-year growth rate of stock price <0.01>
+ 0.14 × year-on-year growth rate of household lending volume <0.00>
– 0.24 × year-on-year change in lending interest rate <0.30>
+ 3.81 × Consumption tax (1997) dummy <0.00>
Note: Sample = 1981Q1 through 2011Q1; adjusted R^2 = 0.78

When employee compensation rises, so does disposal income, allowing household expenditure to increase. When stock prices rise, the asset effect pushes up household expenditures. When borrowing constraints are eased, the lending volume of households increases, permitting households greater expenditure. When lending interest rates rise, household expenditures decrease, due to higher interest rate costs.

Consumption tax (1997) dummy: The anticipated April 1997 increase in consumption tax induced a last-minute hike in household expenditures.

(23) Business Fixed Investment (NINVSA)

Year-on-year growth rate of business fixed investment
= 10.2 × four-quarters mean of year-on-year change in corporate profit margin <0.00>
+ 0.72 × expected growth rate <0.01>
– 2.12 × year-on-year change in (lending interest rate – eight-quarter mean of year-on-year growth rate of consumer price index) <0.01>
+ 0.67 × year-on-year growth rate of corporate lending volume <0.00>
Note: Sample = 1981Q1 through 2011Q1; adjusted R^2 = 0.57

A rise in the corporate profit margin makes it easy for companies to augment their investments using retained profits. When the expected growth rate rises, the marginal efficiency of business fixed investments improves, causing these investments to expand. A rise in the real lending interest rate increases funding costs, which decreases the benefits that accrue from investments, thereby reducing business fixed investments. When borrowing constraints are eased, the lending volume and business fixed investments of companies increase.

(24) Compensation of Employees (YWAGESA)

Year-on-year growth rate of compensation of employees
= 0.64 × year-on-year growth rate of nominal GDP <0.00>
+ 0.43 × year-on-year change in labor share of income(- 1) <0.00>
+ 0.90 × year-on-year growth rate of consumer price index <0.00>
Note: Sample = 1981Q2 through 2011Q1; adjusted R^2 = 0.86

During a boom, employee compensation increases, because robust business activity leads to increased overtime jobs and the number of employees. When the income share of labor rises over the short term, employee compensation increases. When the price of goods rises (inflation) and is passed on to nominal wages, employee compensation increases.

(25) Corporate Profit Margin (ROACORPOR)

Year-on-year change in corporate profit margin
= 25.9 × year-on-year change in nominal GDP gap <0.00>
– 0.34 × year-on-year change in (lending interest rate – eight-quarter mean of year-on-year growth rate of consumer price index) <0.00>
– 15.9 × year-on-year change in labor share of income <0.00>
Note: Sample = 1981Q1 through 2011Q1; adjusted R^2 = 0.70

When the GDP gap is positive, production exceeds the average level, raising corporate profit margins through greater sales and higher profits. When the real lending interest rate rises, funding costs (financial costs) increase, placing corporate profits under downward pressure and lowering the corporate profit margin. If, as a result of rising labor costs, labor's income share constrains corporate profits, corporate profit margins decline.

(26) Expected Growth Rate (EXGROR)

Expected growth rate
= 0.74 × three-years mean of year-on-year growth rate of potential real GDP <0.00>
+ 0.13 × year-on-year growth rate of real GDP <0.00>
Note: Sample = 1983Q1 through 2011Q1; adjusted R^2 = 0.67

A medium-term rise in the potential GDP fosters the expectations of improving economic growth, or enhances the expected growth rate. When real GDP increases, the expected growth rate rises at least over the short term.

(27) Stock Price (STKPOR)

Year-on-year growth rate of stock price
= 9.49 × year-on-year change in corporate profit margin <0.00>
+ 1.38 × expected growth rate <0.00>
+ 0.33 × year-on-year growth rate of U.S. stock price <0.00>
– 19.2 × PER convergence dummy <0.03>
Note: Sample = 1974Q1 through 2011Q1; adjusted R^2 = 0.37

When corporate profit margins rise, so do stock prices. When expected growth rates rise, stock prices also rise, reflecting strengthened expectations of medium-term growth. When U.S. stock prices rise, Japan's domestic stock prices also rise.

PER convergence dummy: During the one year commencing in 2002Q3, foreign investors played an active role in the financial markets, which caused the PER to reach the same level as in other advanced economies.

(28) Land Price (LANDPOR)

Year-on-year growth rate of land price

= – 4.10 <0.00>

+ 0.17 × eight-quarter mean of year-on-year growth rate of nominal GDP <0.26>

+ 1.02 × eight-quarter mean of year-on-year growth rate of lending volume (- 1) <0.00>

+ 1.77 × year-on-year change in eight-quarter mean of year-on-year growth rate of consumer price index <0.00>

Note: Sample = 1982Q4 through 2011Q1; adjusted R^2 = 0.82

The constant term captures the continuous downward pressure on land prices through a reverse mechanism following the bursting of the asset bubble and the decline in the birth rate. The nominal GDP is a proxy variable for rent. Thus, the price of land rises in line with a rise in the GDP growth trend, which implies increased returns on land holdings. An increase in lending volume reactivates company and household mortgage investments which, in turn, cause land prices to rise. When the price of goods rises, so do land prices.

(29) Call Rate (CALLROR)

Call rate

= 0.88 × call rate(- 1) <0.00>

+ 0.05 × eight-quarter mean of year-on-year growth rate of nominal GDP <0.04>

+ 0.03 × eight-quarter mean of year-on-year growth rate of lending volume <0.02>

Note: Sample = 1985Q4 through 2011Q1; adjusted R^2 = 0.98

The lag term of the call rate implies that it is gradually being adjusted. The call rate is raised when the growth rate of the nominal GDP rises, since the nominal GDP growth captures a rise in both the inflation rate and the economic growth rate. When the loan market experiences a boom, the call rate is raised to mitigate tighter demand–supply conditions.

Here, we assume a non-negativity constraint on the nominal interest rate in the following equation.

Call rate = max (0.88 × call rate(- 1)
+ 0.05 × eight-quarter mean of year-on-year growth rate of nominal GDP
+ 0.03 × eight-quarter mean of year-on-year growth rate of lending volume
, 0.088)

(30) Lending Volume Gap (LENDVGAPOR)

Lending volume Gap = corporate lending volume / potential corporate lending volume
× 100 – 100

(31) Total Gross Income (BKOPGPOR)

Total gross income = operation profits of core business
+ general and administrative expenses

(32) Bank Profit Margin (Operating Profits of Core Business on Asset) (ROABKCBOR)

Bank profit margin = operating profits of core business / bank assets × 100 × 4

(33) Credit Cost Ratio (CRDCRTOR)

Credit cost ratio = four-quarters sum of credit cost / lending volume × 100

(34) Capital Adequacy Ratio (CPTLRTOR)

Capital adequacy ratio = capital / risk asset × 100

(35) Tier I Ratio (CPTLT1RTOR)

Tier I ratio = Tier I capital / risk asset × 100

(36) Capital Adequacy Ratio Gap (CPTLRTGAPOR)

Capital adequacy ratio gap = capital adequacy ratio(- 4) – regulatory capital adequacy ratio

(37) Capital Adequacy Ratio Gap (excluding Public Funds) (CPTLRTGAPCOR)

capital adequacy ratio gap (excluding public funds)
= (capital(- 4) – public funds(- 4)) / risk asset(- 4) × 100
– regulatory capital adequacy ratio

(38) Tier I Ratio Gap (CPTLT1RTGAPOR)

Tier I ratio gap = Tier I ratio(- 4) – regulatory Tier I ratio

(39) Tier I Ratio Gap (excluding Public Funds) (CPTLT1RTGAPCOR)

Tier I ratio gap (excluding public funds)
= (Tier I capital(- 4) – public funds (Tier I)(- 4)) / risk asset(- 4) × 100
– regulatory Tier I ratio

(40) Labor Share of Income (LSRTOR)

Labor share of income = compensation of employees / nominal GDP × 100

(41) Nominal GDP Gap (NGDPGAPSA)

Nominal GDP gap = nominal GDP / potential nominal GDP × 100 − 100