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New Financial Activity Indexes: Early Warning System for Financial Imbalances in Japan

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NEW FINANCIAL ACTIVITY INDEXES: EARLY WARNING SYSTEM FOR FINANCIAL IMBALANCES IN JAPAN*

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Abstract

This paper describes Financial Activity Indexes (FAIXs), early warning system for financial imbalances in Japan. We introduced the first version of FAIXs in 2012 and revise FAIXs this time. First, we sort the candidate financial indicators into 14 categories. Second, in each category, we examine the usefulness of candidate indicators from two perspectives: (a) whether the indicator can detect the overheating of financial activities in the Japan's Heisei bubble period, which occurred around the late 1980s and had a major impact on Japan's economy and financial activities; and (b) whether the indicator successfully minimizes various statistical errors involved in forecasting future events. In the examination, multiple possibilities are explored with respect to methods used for extracting trends from indicators and thresholds employed for assessing that the deviation of an indicator from its trend constitutes overheating. As a result of choosing the one indicator considered most useful in each category, two of the ten financial indicators comprising the existing FAIXs are abandoned, one is retained, three are revised in terms of trend extraction methods, and four are revised in terms of data processing methods. The 14 indicators, including these eight and six newly selected, now constitute the new FAIXs.

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1. Introduction

Based on past experience of financial crises, it is globally shared that it is critical to promptly detect an overheating of financial activity and to implement preventive measures against possible crises. For this reason, national policymakers and international organizations conduct research on early warning indicators in order to detect such overheating and prepare for possible crises.

Minsky (1982) was one of the early attempts to study early warning indicators of financial crises.[1] It analyzed a broad range of financial crises including the Great Depression. Subsequently, research on early warning indicators has been progressed mainly at international organizations, triggered by the frequent occurrences of financial and currency crises in emerging economies, such as those in Latin America and Asia.[2] Furthermore, research activities have become more active among policymakers in advanced economies following the global financial crisis in the latter half of the 2000s.[3]

The Bank of Japan also introduced its early warning system for financial imbalances, Financial Activity Indexes (FAIXs), based on the prevailing studies on early waning indicators for other countries (Ishikawa *et al*., 2012). This index comprises 10 indicators which are useful in assessing the conditions of financial activity. We are able to make a comprehensive assessment on the overheating and overcooling of financial activity by examining how far individual indicators deviate from their historical trends. The Bank of Japan uses FAIXs as one of tools to assess the stability of Japan's financial system in its semiannual *Financial System Report* (FSR).[4] We use a 3-year backward moving average as a trend. Financial activity is regarded as having become overheated if current indicator levels deviate from their trends by more than their upper thresholds, whereas financial activity is assessed as having overcooled if they deviate below their lower thresholds. The report indicates the overheating or overcooling assessment for individual indicators in a "heat map" format, where red shading shows the indicator in question is tilted toward overheating, blue indicates overcooling and green everything in between (Figure 1).

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[1] Minsky (1982) points out that overheating of financial activity can be detected by observing specific financial indicators.

[2] Kaminsky and Reinhart (1999) is one of the notable studies. They analyzed the currency and banking crises which occurred in the period between the 1970s and the 1990s, and examined how 16 economic indicators were sending signals of crises before they broke.

[3] Borio and Lowe (2002) is one of the empirical studies on early warning indicators using sample including advanced economies. Borio and Drehmann (2009) made further progress in this line of research by using more recent data. Both studies conclude that credit aggregates and asset prices can be useful leading indicators of financial crises.

[4] We started to use the FAIXs in Financial System Report in its April 2012 issue.

Further progress has been made in studies of early warning indicators conducted in a number of countries since we introduced FAIXs. The backdrop to this is the preparatory moves made by each national authorities and international organizations toward introducing the countercyclical capital buffer (CCB) under Basel III.[5] Once the CCB has been introduced, policymakers will need precise knowledge of the conditions of financial activity when they establish or alter their buffer levels. While the Basel Committee on Banking Supervision (BCBS) guidance for setting and operating the CCB explains that the common reference indicator for setting the buffer levels is the credit to GDP ratio gap, it also claims that it is important to assess the conditions of financial activity comprehensively based on various other indicators.[6]

In addition, based on early warning indicator analyses conducted thus far, some national authorities have recently analyzed and selected specific variables to be used as reference indicators for setting a countercyclical buffer level. For example, the Bank of England examined 18 indicators including the credit to GDP ratio gap and adopted them as CCB reference indicators. Many other countries have also found that various other indicators in addition to the credit to GDP ratio gap are useful for operating the CCB (Figure 2).

In some cases, indicators have been analyzed and selected through qualitative studies based on information available in, for example, prior literature, whereas in other cases a strict statistical verification process has been adopted.[7] To give an example of the latter case, Behn *et al*. (2013), who conducted a CCB reference guide study in the euro zone, evaluated the financial crisis prediction performance of a variety of indicators in terms of their ability to not only send signals in advance of financial crises, but also to minimize statistical errors in signaling. Behn *et al*. (2013) acknowledged that the various indicators including the credit to GDP ratio gap were effective predictors of financial crises, and concluded that indicators other than the credit to GDP ratio gap should also be referenced in operating the CCB.

In this paper, we revise our FAIXs based on the recent progress made overseas in studies and in utilizing early warning indicators. First, we sort the candidate indicators into categories corresponding to investment activities on the asset side and funding

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[5] The CCB is a capital buffer planned for introduction under Basel III for the purpose of securing a buffer against the buildup of system-wide financial risk due, for instance, to excess aggregate credit growth. It is to be set at the discretion of individual national authorities within the zero to 2.5% of their capital ratios.

[6] The BCBS guidance was based on the analysis conducted by Drehmann *et al*. (2010). They analyzed whether certain indicators, including the credit to GDP ratio gap, had sent appropriate signals prior to crises, including the recent global financial crisis. Based on their analyses, the authors concluded that the most appropriate early warning indicator to detect a financial crisis in advance was the credit to GDP ratio gap.

[7] An example of the former type of cases is the Bank of England (2014).

activities on the liability side of various economic entities such as financial institutions and firms. We also divide asset price indicators into two categories, stock price category and land price category. Then, in each category, we examine the usefulness of indicators from two perspectives: (a) whether the indicator can detect the overheating of financial activities in the Japan's Heisei bubble, which occurred around the late 1980s and had a major impact on Japan's economy and financial activities; and (b) whether the indicator successfully minimizes various statistical errors involved in forecasting future events.

As a result of the examination, two of the ten financial indicators comprising the existing FAIXs are abandoned, one is retained, three are revised in terms of trend extraction methods, and four are revised in terms of data processing methods. The 14 indicators, including these eight and six newly selected, now constitute the new FAIXs.

This paper is structured as follows. Section 2 discusses the indicator selection methodology and the selection results. Section 3 summarizes the distinctive features of each indicator selected. Section 4 compares old and new heat maps. Section 5 provides a summary and discussion points.

2. Indicator selection methodology and selection results

(1) Indicator selection methodology

The existing FAIXs comprise 10 indicators selected on the basis of the two following conditions: first, the indicator has been either theoretically endorsed by earlier studies or recognized both in Japan and overseas as empirically useful; and second, it detected the overheating of financial activity prior to major events, including the bursting of Japan's Heisei bubble and the Lehman shock.

While basically following the framework provided by the two conditions mentioned above, we employ a statistical approach in systematically selecting the indicators with clear objective criteria as much as possible. The selection of indicators is done in three steps (Figure 3). First, we collect the candidate indicators based on the previous studies. Second, we set up 14 categories such as investment activities by financial institutions and divide the potential indicators into each appropriate category. Third, we select the most appropriate indicator from each category by using statistical evaluation. The detailed selection process will be described as follows.

Step 1: Selection of candidate indicators

Step 1 involves selecting candidate indicators by reference to recent studies of early

warning indicators conducted in various countries in preparation for the introduction of the CCB, in addition to prior literature used when the existing FAIXs were developed. While the existing FAIXs were selected from 97 candidate indicators, 159 indicators are used as candidates for developing the current index (Figure 4). In order to enable statistical evaluation, the indicators considered are limited to those for which data for the period of the Heisei bubble are available.

In some cases, various processing methods are examined for the same data. For example, regarding total credit, year-on-year change of total credit and difference in year-on-year changes of total credit and GDP are considered in addition to the total credit to GDP ratio, which has been used for the existing FAIXs. Similarly, regarding land prices, we consider land prices to income ratio and land prices to GDP ratio, and year-on-year change in land price in addition to ratio of land prices to rent, which has also been used for the existing FAIXs.

Step 2: Categorization of indicators considered

In Step 2, we categorize the candidate indicators by the type of economic agent and the nature of the indicator. Recent analyses of early warning indicators conducted in each country demonstrate that it is important to have a perspective that various indicators capture different activities of different agents. For example, the Bank of England (2014), which discusses the CCB reference indicators in UK, set up three categories, (i) bank balance sheet stretch, (ii) non-bank balance sheet stretch, and (iii) conditions and terms in markets, and then examined reference indicators in each of the three categories. In studying indicators for determining the stability of the financial system in the U.S., Adrian *et al*. (2013) propose that four categories of data be collected and analyzed for monitoring the financial system: (i) systemically important financial institutions; (ii) shadow banking; (iii) asset markets; and (iv) non-financial businesses.[8]

In addition to classification by type of economic agent, it is also important to choose appropriate indicators based on each agent's activity in the asset and liability categories. First, on the assets side, a tendency to make investments involving large risks has been observed among economic agents when financial activity is overheated. Accordingly, it is essential to monitor indicators that show investment activities of each economic agent. In addition to understanding investment trends of economic agents, it is also important to figure out what funding activity is enabling such investment. A number of past

[8] As another example, the European Systemic Risk Board (ESRB) classifies a number of indicators into six categories, namely, inter-linkages and composite measures of systemic risk, macro risk, credit risk, funding and liquidity, market risk, and profitability and solvency, which are regularly updated in the ESRB's Risk Dashboard.

financial crises throughout the world have shown financial institutions, non-financial firms and households move toward highly risky investments while increasing their debts (Kindleberger, 2000). There is therefore a need to analyze indicators reflecting funding activity on the liabilities side.

Based on the above, we first categorize the candidate indicators into three sectors: (i) the financial institution sector; (ii) the financial market sector; and (iii) the private sector, and then divide those into investment activity on the asset side and funding activity on the liability side of each sector. Furthermore, we set up sub-sectors of the private sector; household, corporate and real estate sector, and sort out the candidate indicators into investment activity on the asset side and funding activity on the liability side of each sector. We set up such subsectors because previous financial crises around the world show us that in some cases, the household sector is significant, as in the subprime loan crisis, but in others, the corporate or real estate economy does so, as was the case in Japan's bubble period.

In addition to the above categorization based on type of economic agent and the nature of indicators, we employ two categories of asset prices: stock prices and real estate prices.

To summarize the above, there are 14 categories in all (Figure 5). The 159 indicators chosen in Step 1 are now sorted into these 14 categories, for each of which the single most useful indicator is selected through statistical evaluation, as described later. This means that the new Financial Activity Index will comprise 14 indicators.

Step 3: Selecting suitable indicators for each category

In Step 3, we choose the most suitable indicators from each category based on statistical evaluation. First, for the candidate indicators categorized in Step2, we calculate their trends and their gaps between their actual levels and their trends. Second, we conduct statistical evaluation for those gap indicators from two perspectives: (a) whether the indicator can detect the overheating of financial activities in the Japan's Heisei bubble; and (b) whether the indicator successfully minimize various statistical errors involved in forecasting future events. In the process of examination, we use various trend extraction methods and thresholds, above which we consider that indicators suggest overheating of financial activity. The following sub steps explain the details (Figure 3).

Step3, sub-step 1: Calculating trends and gap indicators

We need to capture the extent to which the latest values of the indicators deviate from

their trends in order to detect the degree of overheating or overcooling in financial activity based on the movement of those indicators. It is a general practice to analyze the movement of "gap indicators", the difference between the actual values and the trend values of indicators, in analyzing early warning indicators. For example, in the BCBS guidance for setting and operating the CCB, a large deviation of the actual value of the credit to GDP ratio above its trend is interpreted to signal overheating.

However, trends can be calculated in many ways. For example, three types of trend were examined in developing the existing FAIXs: the 3-year backward moving average, the 8-year backward moving average and the average over the entire sample period (Ishikawa *et al*. 2012). Meanwhile, the BCBS (2010) extracts the trend of the credit to GDP ratio based on a one-sided HP filter (using a smoothing factor $\lambda = 400{,}000$), and defines the gap between actual and trend values, i.e., the gap indicator, as the appropriate indicator for capturing financial cycles where cycle periods are longer than those of ordinary business cycles.[9]

Selecting an appropriate trend calculation method for each indicator is subject to empirical examination as such a judgment depends on a variety of factors including each indicator's time series characteristics. Accordingly, for each indicator considered in the current analysis, we prepare various gap indicators by applying several trend calculation methods, and then select the best gap variable as an early warning indicator for each category in statistical evaluation.

We use two candidate trend calculation methods: the 3-year backward moving average used in the FAIXs heat maps published in past issues of the *Financial System Report*, and the one-sided HP filter (with a smoothing parameter $\lambda = 400{,}000$). The one-sided HP filter is the trend extraction method which the BCBS adopted in its guidance for setting the CCB. We consider the 3-year backward moving average as an effective approach for calculating a trend to extract short-term fluctuations, whereas we consider

[9] A one-sided HP-filter is a trend extraction method which recursively apply an HP filter to the original series up to each period to calculate the trend values. On the other hand, a two-sided HP filter applies an HP filter to the entire sample of the original series to calculate trend values at all periods at once. For example, consider a series that starts from 2000:Q1 (the 1st quarter of year 2000), and suppose that we would like to calculate its trend for the period from 2005:Q1 to 2013:Q4. When a one-sided HP-filter is employed, the trend value at 2005:Q1 is first calculated by applying an HP filter to the data from 2000:Q1 to 2005:Q1. Next, the trend value at 2005:Q2 is calculated by applying an HP filter to the data from 2000:Q1 to 2005:Q2. In this manner, each period's trend value is calculated by applying an HP filter to the data from 2000:Q1 to that period. In this case, when new data for 2014:Q1 becomes available after some time pass and the trend value at that period is calculated, the past trend and gap values are not altered as long as the past data of the original series are not revised. On the other hand, when a two-sided HP-filter is employed, the trend is calculated by applying an HP filter to the entire sample of the series. When new data for 2014:Q1 becomes available, the trend is recalculated by applying an HP filter to the sample including that period, and thus the past trend values are replaced with new ones. Therefore, when this method is employed, trends and gap values are continually altered as data accumulate.

the 8-year backward moving average and the one-sided HP filter with large smoothing parameter as appropriate methods to capture medium- to long-term fluctuations. However, in addition to these two methods, we also decided to use the past average up to each point of time for some indicators exhibiting mean-reverting characteristic.[10]

One characteristic of the three trend extraction methods is that past trend values or gap values are not revised by adding new data for calculation. These approaches are chosen because, in making real-time judgments, we always need to analyze financial conditions using only data available at each point of time.

Based on the above, gap indicators are calculated by employing the different trend calculation methods. As a result, 321 series in total are subject to statistical assessment in the next step.

Step 3, sub-step2: Statistical evaluation of gap indicators

The indicators are evaluated based on the following two perspectives: (a) whether the indicator can detect the overheating of financial activities in the Japan's Heisei bubble; and (b) whether the indicator successfully minimize various statistical errors involved in forecasting future events.

(i) Statistical evaluation I: Screening by the existence or otherwise of signals indicating overheating

As the first step of statistical evaluation, we screen the candidate indicators by examining whether they can detect the overheating of the Heisei bubble.

The first criterion used for selecting indicators in the current revision of FAIXs is whether an indicator could detect the overheating of the Heisei bubble, which had a substantial impact on Japan's economic and financial activities.[11] Past studies suggest

[10] When calculating a past average, an approach similar to the one-sided HP filter is used. That is, an average is calculated using only the data available for the period up to the time of calculation, and is then used for determining a gap value. When this approach is employed, no past average values are changed when a set of additional data becomes available.

[11] In terms of utilizing a financial activity index as a reference guide for implementing macroprudential policy measures such as the CCB, one possible view is that indicators should issue appropriate signals not only of overheating prior to the occurrence of crises, but of overcooling as well, whereby the usefulness of the financial activity index is enhanced. In that case, however, indicators would on the one hand be required to play a role as a "leading index" to point to a crisis in advance, and on the other would also be expected to serve as "coincident indexes" in the post-crisis period to indicate whether or not a crisis is building. In the current analysis, we decided to apply selection criteria which focus on an indicator's "leading index" role based on the following concept: a financial activity index will perform more effectively when it is developed individually for a single purpose rather than being forced to perform multiple and different functions concurrently. Many existing studies have supported this approach. For example, Drehmann *et al.* (2010) points out that market information is more useful than the credit to GDP ratio gap in post-crisis periods, because market instability and financial institution crises accelerate

that the bursting of the Heisei bubble took place in 1991–1992.[12] Considering possible lags from the time when signals of overheating are recognized to the time when policy measures are taken or their effects are transmitted to financial system, indicators should issue such signals at least one year or ideally several years before the crisis. For this reason, we set the period in which a signal indicating overheating was supposed to be sent to 1987–1990.[13]

In order to detect the overheating of financial activities, we need to evaluate the indicator values in comparison to some upper thresholds. Since we do not know which levels of threshold would be appropriate a priori, we examine several threshold levels. In setting threshold levels in this paper, we calculate the root mean square of the sum of deviations between actual and trend values (expressed as σ in the equation shown below; hereinafter referred to as the root mean square, RMS) and study five cases, namely, 1 time, 1.25 times, 1.5 times, 1.75 times and 2 times RMS.

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(x_i - x_i^t\right)^2},$$

where x_i is the actual value of the indicator x at time i, and x_i^t stands for the trend value of the same indicator at the same point of time.

The first statistical evaluation criterion can be restated as whether each indicator actually issued an “overheating” signal by moving above the upper threshold in the “overheat indication period (1987-1990)” as set out above. Indicators which did not send any signal of “overheating” are discarded at this stage. Those which did are taken forward to the next step.

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quickly in such periods.

[12] In its Business Cycle Reference Dates, the Cabinet Office defines the peak as occurring in February 1991. Reinhart and Rogoff (2009) and Drehmann *et al.* (2010) assumed that Japan’s financial crisis occurred in 1992.

[13] In developing the existing FAIXs, the period of overheating was also set to 1987-1990 based on existing studies.

(ii) Statistical evaluation II: Evaluating statistical errors

When using indicators to make a financial activity assessment, it is ideal that warning signals be issued before an event, i.e., a financial crisis, takes place, and that no warning signals are dispatched when no such event is occurring. It is desirable that either *A* or *D* in the table below always be realized:

	Event	No event
Signal issued	Correct signal: *A*	Type II errors: *B*
No signal issued	Type I errors: *C*	Correct signal: *D*

Indicators, however, do not always send appropriate signals, and the occurrence of events and signals thereof could involve two types of errors. The first type, or "type I errors," is a case in which indicators fail to issue any signals of an event that is actually occurring. In the above table, *C* falls under this category, which can be described as a "risk of missing crises." In the second type, or "type II errors," indicators issue crisis signals despite no such event arising, to which the case of *B* in the above table corresponds. This represents a "risk of issuing false signals."

The threshold should be set at a relatively low level if one would like to to minimize the occurrence of "type I errors (= risk of missing crises)" so that signals are issued at a reasonably early stage. This will allow as many crisis signals as possible to be sent so that no crisis is overlooked as it occurs. Meanwhile, there is also a need to keep thresholds at a relatively high level to lower the frequency with which false signals are issued, thereby reducing "type II errors (= risk of issuing false signals)." Thus, trying to reduce "type I errors" will cause thresholds to be on the low side, and trying to reduce "type II errors" will cause thresholds to be on the high side. There is a trade-off between these two objectives (Figure 6).

In this paper, the period for which "type I errors" and "type II errors" are examined is 1980-2005, with the period from 2006 onward not being included in statistical verification. This is because there is not necessarily consensus as to the appropriateness of assuming the pre-Lehman shock period represents an overheating phase of financial activity in Japan.

In the literature, several statistical models are perceived as useful in evaluating indicators. Here we perform statistical evaluation using four such models as explained below. If the majority of the models select an indicator, that is taken as the best choice. If more than one indicator in the same category survives the statistical verification

process, a single indicator is ultimately selected based on a judgmental assessment.

Three of the four statistical models are based on the following loss function. The threshold level will be chosen to a value for which the loss is minimized. The loss function is basically the weighted average of probabilities of type I and type II errors. This method of selecting a threshold τ to minimize the loss function is called a policymaker's approach.[14]

$$L(\mu,\tau) \equiv \mu P T_1(\tau) + (1-\mu)(1-P)T_2(\tau),$$

$$P \equiv \frac{a+c}{a+b+c+d},\ T_1(\tau) \equiv \frac{c}{a+c},\ T_2(\tau) \equiv \frac{b}{b+d},$$

where, *a*, *b*, *c*, and *d* are the numbers of periods corresponding to event *A*, *B*, *C*, and *D*, μ is the weight parameter, $L(\mu,\tau)$ is the policymaker's loss under the weight μ and the threshold τ, P is the ratio of the number of periods in which a signal should be issued to the total number of periods, and $T_1(\tau)$ and $T_2(\tau)$ are the probabilities of type I errors and type II errors, respectively.

μ is a preference parameter indicating which type of errors, type I or type II, the policymaker attaches importance to, and is subjectively set by the policymaker. This paper uses three statistical models: "statistical model 1" where μ = 0.5, "statistical model 2" where μ = 0.7 and "statistical model 3" where μ = 0.9.[15]

Next, in statistical model 4, we select the threshold τ which will minimize the following "NS ratio" (noise-to-signal ratio; a ratio of false signals being issued to proper signals being issued) for each indicator. This is called the NS-ratio approach.

$$NS(\tau) \equiv \frac{b}{b+d} \Big/ \frac{a}{a+c}$$

However, one problem on the NS ratio approach is that using this approach often ends up in setting extremely high threshold values, and that this may materially increase the risk of missing crises, i.e., Type I errors.[16] Therefore, in this paper we follow the

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[14] There is another statistical criterion for choosing indicators. The details are discussed in appendix.

[15] Behn *et al.* (2012) is a working paper investigating appropriate indicators for ECB's CCB reference. They use the preference parameter with μ = 0.9, which emphasizes the importance of type I errors (=risk of missing crises), taking account of a large cost likely to be incurred as a result of missing crises. In this paper, we use three μ values: (i) 0.5, where type I and type II errors are evaluated equally; (ii) 0.7, where type I errors are emphasized; and (iii) 0.9, where type I errors are strongly emphasized as in the ECB analysis. By employing this approach, we try to avoid, as much as possible, the danger of selecting a biased group of indicators by assuming a particular value for the subjective preference parameter.

[16] This problem is cited in the literature, including papers by Oka (2003) and Ito and Orii (2006). In analyses using financial crisis data, the NS ratio often becomes a monotonically decreasing function of

"modified noise-to-signal ratio approach" adopted by Drehmann *et al.* (2010). Specifically, we focus solely on indicators which issue signals in more than two-thirds of the overheat indication period. We then select one of these indicators which has the lowest NS-ratio.

Having discussed the indicator selection process, let us now explain how the above process is implemented in practice in terms of specific indicators. As an example, we look at indicators which represent funding activity in the private sector. We first use statistical model 1, then choose the total credit to GDP ratio as the first candidate indicator. The loss function values of this indicator in each combination of the two trend types (the 3-year backward moving average and the one-sided HP filter) and the five thresholds (1 time, 1.25 times, 1.5 times, 1.75 times and 2 times RMS), i.e., 10 combinations in all, are then calculated. From these calculation results, the lowest loss function value and the relevant trend extraction method and threshold are then recorded. The year-on-year growth rate of total credit is then taken as the second candidate indicator. Again, the loss function values in all the combinations of the two trend types and the five thresholds are calculated, and the lowest loss function value and the relevant trend extraction method and threshold are recorded. The same calculations are performed for all other indicators in the same category. The indicator with the smallest loss function value (and the relevant trend extraction method and threshold) is selected as the optimal indicator in statistical model 1 for that particular category. The same process is repeated for statistical models 2, 3 and 4, with the optimal indicator being selected for each of them. The indicator (and the relevant trend extraction method and threshold) selected by the majority of the four models is the best indicator for the category in question.

(2) Selection results

The selection results are shown in Figure 7. For each category, the indicators selected by the four statistical models are shown with the trend extraction methods and thresholds.

For example, in the category of financial institutions and investment activity, two out of four models choose *DI of lending attitudes of financial institutions* with trend of past average and threshold of one time RMS. One model chooses *ROA from net interest income of banks* with trend of one-sided HP filter and threshold of one time RMS. No indicators are chosen for the last statistical model. Since two out of the four models choose *DI of lending attitudes of financial institutions*, the indicator (and the relevant

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the threshold (τ) in an appropriate range, and the optimal interior solution cannot be obtained in many such cases. For this reason, the policymaker's approach has been adopted in some recent analyses. See, for example, Babecky *et al*. (2012) and Sarlin (2013).

trend extraction method and threshold mentioned above) is the best for this category. In the category of private sector and funding activity, all the models choose *total credit to GDP ratio*. Two out of the four models choose the indicator with trend of one-sided HP filter and threshold of one time RMS, one with trend of 3-year moving average and threshold of 1.25 times RMS, and one with trend of 3-year moving average and threshold of one time RMS. Therefore, *total credit to GDP ratio* with trend of one-sided HP filter and threshold of one time RMS is selected as the best in this category. Same procedure is applied for other categories and the best indicators are chosen.

The selected 14 indicators are shown in Figure 8.

3. Characteristics of each indicator

In the manner described above, we examined 321 variables, using different trend extraction methods, and we choose optimal indicators based on two statistical criteria: (a) whether the variables issue signals of the overheating of the Heisei bubble, and (b) whether statistical errors are minimized. As a result, two of the 10 previously selected indicators were abandoned, one was retained, three were retained with different trend extraction methods, four with different processing methods applying to the original data series, and six new indicators were added (Figure 8). Thus, the number of indicators comprising FAIXs was increased from 10 to 14 by the revision. More than one indicator was left as a candidate in the category of land prices and that of corporate investment activity. The selections of indicators in these categories are discussed in detail in the following section.

We now summarize the characteristics of the indicators selected above, classifying them into five groups: (1) indicators to be abandoned; (2) an indicator to be retained and used in the same way; (3) indicators to be retained with different trend extraction methods; (4) indicators to be retained with different processing methods applying to the original data series; and (5) newly adopted indicators.

(1) Indicators to be abandoned

(i) Ratio of firms' CP outstanding to their liabilities

In periods leading to financial crises in overseas economies, firms have tended to become more reliant on financing from short-term funding markets in an effort to increase their assets to expand their business (Minsky, 1982). The ratio of firms' CP outstanding to their liabilities was chosen as one of the indicators in FAIXs, as in addition to such overseas cases, its actual value immediately before the Lehman shock

indicated a move toward overheating (Figure 9). This indicator, however, has contain following problems. First, because no data are available for the Heisei bubble period, no back-testing can be done to establish whether it issued appropriate signals before the crisis in Japan. Second, it did indicate an overheating tendency before the Lehman shock, but it continued to do so up to around the early 2009, i.e., in the post-Lehman shock period as well. In particular, we need to take account of the fact that firms actively issued CP immediately after the Lehman shock to secure their on-hand liquidity, and that this can hardly be interpreted as an overheating of financial activity. Consequently, we believe it is appropriate to exclude this indicator from FAIXs.

(ii) Spread between expected equity yields and government bond yields

The spread between expected equity yields and government bond yields is the difference between expected earnings per share divided by the share price and the long-term interest rate, as shown in Equation (1). From this equation, and based on the share price determining equation shown in Equation (2), the spread between expected equity yields and government bond yields is equivalent to the risk premium for equity investment less the growth rate of expected earnings per share, as shown in Equation (3).

$$\text{Spread between expected equity yields and government bond yields} = \frac{E}{P} - i \quad (1)$$

$$\text{Share price } (P) = \frac{E}{i - g + RP} \quad (2)$$

$$\text{Spread between expected equity yields and government bond yields} = \frac{E}{P} - i = RP - g \quad (3)$$

Here, P is the share price, E is expected earnings per share, i is the long-term interest rate, g is the growth rate of expected earnings per share and RP is the risk premium.

It is apparent that this indicator trended upward from the early-1990s (Figure 10). Based on the above equation (3), this can be interpreted as indicating the growth rate of expected earnings per share (g) trended downward. Cyclical changes around such a trend can be described as showing the short-term cyclical fluctuations in the risk premium and the growth rate of expected earnings per share.

Since the starting period of the sample of this indicator is the first quarter of 1991, we cannot implement statistical examination for signals of the overheating of the Heisei bubble. Therefore, we decided to abandon this indicator.[17]

[17] We examined spread between actual equity yields and government bond yields, which uses actual, not expected earnings per share. That indictor was included in the category of stock price. As a result of the statistical examination, this indicator was not chosen.

(2) Indicator to be retained and used in the same way

The indicator which will be retained and used, applying the same calculation method and threshold, is "equity weighting in institutional investors' portfolios." This was selected as the best indicator in the category of investment activity in the financial market. We examined other indicators, such as those relating to the investment activities of overseas investors and various interest rates. However, we selected this indicator, inheriting from the existing index, on the basis of its statistical usefulness. This indicator signaled overheating in most of the Heisei bubble period, and thus can be expected to capture investment activity in stock markets well (Figure 11).

(3) Indicators with different trend extraction methods

(i) DI of lending attitudes of financial institutions

In the existing FAIXs, the 3-year backward moving average was used as a trend extraction method, and deviations of actual indicator values from the trend were used as gap values of the indicator. As a result of the current examination, the gap indicator is now calculated using the past average as the trend. The threshold is one time RMS. In the Heisei bubble period, the actual values of this indicator did not signal "overheating" despite its high level, because the trend closely followed movements in the actual values of the indicator (Figure 12(1)). In contrast, the new indicator based on the past average has signaled overheating in the same period (Figure 12(2)). Financial institutions' lending attitude is a statistic which should be considered to have a mean-reverting nature, as the lending attitude is not supposed to fluctuate much in the long run. The current investigation resulted in selecting a gap indicator of this nature.

(ii) Total Credit to GDP ratio

In the existing FAIXs, past 3-year moving averages were calculated as trends, and deviations of actual values from these trends were used as gap values of indicators. This was also the case with the total credit to GDP ratio. In the current examination, in addition to the existing method, we examined another way to extract trends, i.e., the one-sided HP filter, which is an approach adopted by the BCBS in its guidance for CCB decisions, and other data processing methods (such as year-on-year growth rate and deflating nominal data to real values) as well. As a result, we adopted the total credit to GDP ratio with a trend extracted by the one-sided HP filter, which is used in the BCBS guidance.[18] The threshold is one time RMS. No major differences were observed for

[18] We also examined the performance of DSR (Debt Service Ratio), which is one of the useful indicators to capture the private funding activity. However, the results supported the adoption of the total credit to

both indicators, and the differences in the judgments concerning overheating or overcooling between the existing and new indicators were minimal. In terms of minimizing statistical errors, however, the current indicator demonstrated better results (Figure 13).

(iii) Stock prices

As the indicator for stock prices, the existing FAIXs adopted an indicator of the deviation of actual stock prices (TOPIX) from their 3-year backward moving average. In the current examination, we examined several additional candidate indicators, including stock price normalized by GDP and the spread between actual equity yields and government bond yields, and examined a method of extracting trends using the one-sided HP filter. Based on the statistical examination, we again selected stock prices (TOPIX) as a variable, but chose the one-sided HP filter as a trend extraction method and a threshold of 1.5 times RMS (Figure 14). The new threshold value chosen on the basis of minimizing statistical errors is larger than that of the existing indicator.

(4) Indicators to be retained with different processing methods applying to the original data series

(i) Money multiplier (ratio of M2 to the monetary base) and M2

Early studies demonstrated that the money multiplier was a variable indicating financial intermediation activity by financial institutions (Kaminsky and Reinhart, 1999). In comparison with monetary base representing fundamental economic liquidity, the amount of money (M2) increases significantly when credit creation by financial institutions becomes active as they extend loans aggressively.

The money multiplier was also included in the candidate indicators of the current examination. As a result of the statistical examination, however, we chose the M2 growth rate, with the trend extracted using the one-sided HP filter and the threshold of one time RMS. The actual movement of the M2 growth rate indicates overheating in the Heisei bubble period and overcooling in the subsequent period (Figure 15).

In addition to its statistical inferiority, another problem with the money multiplier is that its nature can change depending on what kind of monetary policy measures are implemented. When a central bank shifts its policy focus from traditional short-term interest rate operations to non-traditional base money operations such as quantitative easing, the nature of monetary base changes from being an endogenous variable to an

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GDP ratio. We are grateful to Mr. Mathias Drehmann of BIS for kindly providing the data of DSR for the examination.

exogenous variable (or, a "policy variable"). For example, in Japan, monetary base increased significantly and as a result the money multiplier decreased substantially when quantitative easing or quantitative and qualitative monetary easing has been implemented (Figure 15). However, such a large decrease in the money multiplier does not mean that the financial intermediation and credit creation of financial institutions contracted materially at that time.

(ii) Land prices

In the existing FIAXs, a gross rent multiplier (= ratio of land prices to rent; land prices are all use categories in the Tokyo area) was used as an indicator for land prices. In this examination, we also included land prices normalized by GDP or other income-related variables or deflated by the consumer price index, in the candidate indicators. At the same time, we examined land prices not only in the Tokyo area, but also in six major cities (including the Tokyo area) and land price variables for different use categories, such as commercial and residential.

As a result of the statistical examination, several indicators were selected in each statistical model category: the land price to GDP ratio (land price of six major cities/all use categories average); the real land prices (land price of six major cities/all use categories average); and the real land prices (land price of six major cities/commercial use category).[19] We choose the land prices to GDP ratio (land price of six major cities/all use categories average) based on the following judgments: first, it covers a wide range of land usages and cities; and second, it is normalized by the size of economy. The trend is calculated using the 3-year backward moving average, and the threshold is one time RMS. It was found that both the existing and newly selected indicators issued an overheating signal in the Heisei bubble period in a similar manner, and that their movements in other periods were also nearly identical (Figure 16).

(iii) Business fixed investment to GDP ratio

The index representing firms' investment activity used in the existing FAIXs is the ratio of firms' investments to operating profits, where firms' investments comprise fixed investments, inventory investments and security investments (Figure 17(1)). In the current examination, we also investigated other definitions for the numerator, such as firms' investments excluding security investments, which are largely influenced by stock price fluctuations, or fixed investments alone. We also investigated the case with GDP as a denominator variable.

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[19] The 'real' variables are deflated by the Consumer Price Index.

Based on statistical examination, two indicators were selected: the ratio of firms' investments including security investments to GDP and the ratio of firms' fixed investments to GDP. We choose the ratio of firm's fixed investment to GDP based on the following judgments: first, it is more appropriate to focus on fixed investments rather than investments affected by fluctuations in market price of stocks when we try to capture changes in non-financial firms' investment stances; second, stock price movements themselves are assessed in another category of the new FAIXs. Taking these points into account, the fixed investments to GDP ratio was selected as the indicator in this category (Figure 17(2)). The trend is extracted using the one-sided HP filter and the threshold is one time RMS.

(iv) Household loans to GDP ratio

As an indicator for assessing the size of household debts, the existing FAIXs employ the ratio of debts to on-hand liquidity that comprises demand deposits and cash. However, comparing household debts with household income is a possible alternative to measure the size of such debts. Indeed, the debt-to-income ratio (DTI) is often used as an indicator to measure the indebtedness of borrowers. For this reason, in this exercise we examined several other variables for the denominator, such as disposable income, compensation of employees, GDP and financial assets. We also include for consideration the growth rate of debts themselves as a candidate indicator. Based on the statistical assessments on these variables, we choose the household loans to GDP ratio, with the trend extracted using the 3-year backward moving average and the threshold being 1.25 times RMS. Comparing the performance of both the existing and new indicators, the new indicator appears to capture more precisely the overheating in the Heisei bubble period (Figure 18).

(5) Newly adopted indicators

Based on the categories mentioned earlier, we investigated the usefulness of a wide range of candidate indicators which were not subject to consideration in the past. As a result, six indicators were newly adopted.

(i) Stock purchases on margin to sales on margin ratio

This indicator was selected from the category of funding activity in financial markets. Its trend is extracted using the 3-year backward moving average, and the threshold is one time RMS. In overheated stock markets, margin trading tends to increase with the aim of capital gains, whereas short selling becomes more prevalent when stock prices

trend downward.[20] Against this backdrop, we included the ratio of stock purchases on margin to sales on margin in the candidate indicators. This indicator shows overheating in the Heisei bubble period (Figure 19), as well as around 2000, when the so-called IT bubble took place.

(ii) Private investment to GDP ratio

This indicator was selected from the category of investment activity in the private non-financial sector (households and businesses). Private investment includes firms' fixed and inventory investments and households' housing investments and consumer durables expenditure.[21] The trend is extracted using the 3-year backward moving average, and the threshold is one time RMS. Financial institutions adopt a more relaxed lending attitude when financial activity is overheating, and then financing becomes easier for entities in the private non-financial sector, such as businesses and households. Moreover, financial overheating tends to encourage optimistic expectations of future profits and incomes, which then accelerate corporate and household investment activities. It is the private investment to GDP ratio that captures these tendencies. It indicates an overheating of financial activity in the Heisei bubble period (Figure 20). In addition to the above comprehensive definition, we investigated other candidates for the ratio's numerator, i.e., other types of investment, such as security investments and fixed capital investments (the sum of fixed investments and housing investments). However, the private investment to GDP ratio was selected as a result of statistical examination.

(iii) Household investment to disposable income ratio

This indicator was selected from the category of investment activity of household. Household investments include housing investments and consumer durable goods consumptions. The indicator's trend is extracted using the 3-year backward moving average, and the threshold is one time RMS. As mentioned earlier, household investment activity tends to be accelerated by lax lending attitudes among financial institutions, and optimistic assumptions regarding future incomes fostered during a financial boom. This indicator captures this tendency, and it issued an overheating signal in the Heisei bubble period (Figure 21). Other candidates considered include housing investments, security investments and financial assets. We also investigated other variables including GDP as the denominator. The household investment to disposable income ratio was ultimately selected based on statistical examination.

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[20] Galbraith (1990) points out that margin trading was actively conducted in the uptrend in stock markets in the U.S. prior to the Great Depression.

[21] We do not include investments in lands due to data availability.

(iv) Corporate credit to GDP ratio

This indicator was chosen from the category of funding activity of corporate sector. The trend is extracted using the 3-year backward moving average, and the threshold is one time RMS. In an overheating phase of financial activity, businesses tend to accelerate their investment activity and to rely on borrowings to fund their investments, prompted by a relaxed lending attitude among financial institutions and optimistic expectations of future profits. Authorities in a increasing number of countries monitor the state of business credit, and some of them are examining this variable as one of the reference indicators for CCB decisions. This indicator issued a signal indicating overheating in the Heisei bubble period (Figure 22). In this category, we also investigated several other indicators such as corporate credit growth rate, corporate credit to GDP ratio, and changes in corporate credit to GDP ratio. In addition, possibilities of using operating profits or on-hand liquidity are explored in this examination.

(v) Real estate firm investment to GDP ratio

This indicator was selected from the category of investment activity of real estate sector. The real estate firms' investments include fixed investments, land investments and inventory investments. The trend is extracted using the one-sided HP filter, and the threshold is one time RMS. In real estate booms, realty firms tend to engage themselves in active developments of commercial facilities and office buildings, thereby increasing their real asset investments. Accordingly, a shift in realty firms' investments can be an early warning indicator. Indeed in Japan, this indicator sent a signal suggesting a certain level of overheating in the Heisei bubble period around the latter half of 1980s (Figure 23). Similarly, it issued a signal implying overheating in realty firms' investments in around the mid of the 2000s, when a real estate boom by newly established realty firms was said to be emerging. We investigated different numerators such as a combination of realty firms' real investments and their security investments, and different denominators including sales and operating profits in addition to GDP.

(vi) Real estate loans to GDP ratio

This indicator was selected from the category of funding activity of real estate sector. The trend is extracted using the one-sided HP filter, and the threshold is one time RMS. Overheating of the real estate sector has been a source of financial crises in bubble episodes experienced in a number of countries (Galbraith, 1990; Kindleberger, 2000). Similarly, one phenomenon observed in the Japan's Heisei bubble was that real estate firms' outstanding loans increased substantially as real estate prices rose. There are two reasons for this: first, when speculative real estate transactions become common, driven

by price increase in real estate, firms' funding requirements for such deals increase; and second, because real estate serves as collateral for loans, the limits for such loans will be raised as their collateral value rises along with an increase in its price. Kiyotaki and Moore (1997) found that changes in the volume of credit due to variations in values of collateralized real estate have a major impact on economic fluctuations, and named this phenomenon the "credit cycle." Thus, loans to real estate firms tend to increase substantially when financial activity becomes overheated. Tracing movements in the level of loans to real estate firms in Japan, it is indeed obvious that a signal indicating a overheating started to be issued in the mid of the 1980s and continued to be sent until early 1990s, i.e., just before the collapse of the bubble economy (Figure 24). In addition to loans to real estate firms, we examined total debts including funds raised in the market as the numerator variable. Furthermore, real estate firms' operating profits were examined as a denominator variable.

4. New heat map

Based on the above examination, we abandon two indicators, retain one, revise three with different trend extraction methods, revise four with different processing methods applying to the original data series, and adopt six new indicators. Therefore, the new FAIXs consist of 14 indicators. A new heat map based on the new configuration of indicators is shown in Figure 25. Compared with the existing FAIXs, while both versions exhibit the same feature of indicating overheating during the Heisei bubble period, the new version contains a larger number of indicators which issue signals suggesting overheating of the bubble. The episode available for testing performance of the indicators in detecting a bubble is basically limited to the Heisei bubble. Despite this limitation, however, we believe that the upgraded and expanded FAIXs will be more useful from the perspective of closely monitoring early warning indicators in order to avoid emergence of the same type of bubbles as the Heisei bubble, which have a major negative impact on financial activity and the real economy in Japan.

Verifying the new index's performance just prior to the Lehman shock, which is not a part of the statistical examination described in the previous sections, the indicator for real estate firms' investment alone indicates overheating. At that time, active real estate investments in urban areas were observed in Japan, and several bankruptcies of young real estate firms were filed in the post-Lehman shock economic downturn. Nevertheless, the situation did not develop into a major episode of financial system turmoil. We consider that the new FAIXs correctly capture such situations, and that this supports the usefulness of the new index, while acknowledging that much implication cannot be

drawn from this one episode.

Two indicators, namely, the household loans to GDP ratio and the corporate credit to GDP ratio, indicated overheating immediately after the Lehman shock. This is due to a substantial drop in GDP, the denominator, within a short period of time after the Lehman shock. Thus, an unusual move in a denominator variable can cause major fluctuations in the ratio, which can trigger a signal. The BCBS's CCB guidance points to the risk that such a move may cause the credit to GDP ratio indicator to issue an overheating signal in a serious economic downswing period (BCBS, 2010). Thus there is a need to carefully observe the denominator variables themselves as well when making judgments on the movement of indicators normalized by variables such as GDP.

A comparison of the new and old heat maps shows that the "stock purchase on margin to sales on margin ratio" in the new heat map indicates an overheating of financial activity. In contrast, "stock prices" in the existing heat map do so. The "stock price" indicator is adopted in both versions. However, a higher threshold value has been set for this indicator in the new index based on the statistical examination, and as a result no indication of overheating is issued in the new heat map.

5. Summary and points to be noted

(1) Summary

This paper discusses the revision of FAIXs taking into account recent analyses of early warning indicators and examples of reference guides for the CCB in other countries. Prior to carrying out the selection process, indicators were divided into two categories -- indicators representing investment activity and those representing funding activity -- for each type of economic agent, such as financial institutions and businesses. In addition, asset prices were sorted into two categories: stock prices and land prices. 14 indicator categories were then established in all. In the course of selecting a single indicator for each category, we examined the usefulness of individual indicators from the two perspectives: (a) whether they can capture the overheating of the Heisei bubble period, which had a major impact on economic and financial activities in Japan, and (b) whether statistical errors of various types can be minimized. We also used various trend extraction methods and several threshold values. As a result of these examinations, two of the 10 indicators comprising the existing FAIXs are abandoned, one is retained, three are revised with different trend extraction methods, and four with different processing methods applying to the original data series. The 14 indicators, including these eight and the newly chosen six, now constitute the new FAIXs.

(2) Points to be noted

The following points need to be noted when analyzing financial activity situations using the new FAIXs.

First, it is important to have comprehensive judgments on financial conditions.[22] It would be convenient if we could make a judgment on financial conditions totally based on a limited number of indicators. However, we need sufficient lengths of time series data in order to construct early warning system based on the past overheating and overcooling episodes of financial activities.[23] When financial activities become overheated, newly developed financial transactions and products can emerge in order to avoid existing regulations. In this case, it is difficult to capture such a movement by using existing statistics. We saw such an example of "shadow banking activities" in the recent global financial crisis. As such, we may run a risk to overlook newly developed financial imbalances if we only concentrate on the existing statistics. While it is important to upgrade statistical analysis, we need to make efforts to capture any newly developed potential risks by acquiring various information regarding financial institutions' activities and financial market developments. In this regard, information on financial institutions' activities obtained through on site examinations and off site monitoring/hearing is very useful when we assess "financial overheating and overcooling."[24] Some changes in risk-taking attitudes among financial institutions are likely to threaten the stability of the financial system in future. Such changes may not be reflected in macro statistics, but may be clarified through direct contact with financial institutions, such as hearings. Thus, there is a need to make comprehensive judgments on financial system situations based on a wide range of information, including those items mentioned above.

Second, we need to remain vigilant over interactions of various sorts. The indicators analyzed in this paper basically focus on individual economic agents and the market developments which these indicators respectively cover. However, the recent global financial crisis has demonstrated the need to gain a precise understanding of the

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[22] The CCB guidance by BCBS (2010) also emphasized importance of judgment for the assessment of financial conditions.

[23] In this paper, we only investigate indicators available in the past providing signals of the overheating in the Heisei bubble period. It is possible that newly available data be useful indicators to detect the overheating of the bubble economy at early stage in future.

[24] *Financial System Report* of the Bank of Japan comprehensively assesses the state of financial intermediation and risks in financial system in Japan. In the process of the assessment, we rely on qualitative information obtained through on site examinations and off site monitoring/hearing as well as quantitative results of our analyses on a number of types of risks borne by Japanese financial institutions.

interrelationships at play between key factors in a financial crisis, such as feedback loop between financial sector and the real economy, transaction relations between financial institutions, and the status of various risk transfers. For this reason, other approaches have also started to be taken by authorities in many countries: macro stress testing, which takes account of a variety of interactions, and risk monitoring, which utilizes financial institutions' transaction data.[25] It is necessary to continue conducting studies in this field, including the adoption of these new analytical methods, so that any kind of risks which may emerge in the future can be dealt with as effectively as possible.

Third, we need to be mindful of the significance attached to trend values. Our concern in the current analysis has been whether a "gap indicator," which captures deviations of actual values from trend values, has issued appropriate signals in an episode of financial activity overheating, and whether associated statistical errors have been minimized. A trend value itself, therefore, is not given the meaning of "an equilibrium value which would have been realized had it not been for a bubble or a financial imbalance." Indeed, land price movements demonstrate this point: actual land prices, which rose significantly in the Heisei bubble period, largely declined after the bubble, and their trend values also display similar fluctuations with some time lags (Figure 16). This clearly indicates that trend values in the bubble period cannot be interpreted as showing "had-it-not-been-for-a-bubble levels." How asset prices or credit volumes deviate from a "level which should have occurred" in an episode of financial overheating is a subject that must be analyzed separately using tools such as theoretical models.

[25] *Financial System Report* of the Bank of Japan assesses the resilience of Japan's financial system against macro risks by conducting macro stress testing using the Financial Macro-econometric Model, which models the interrelationship between the financial system and the real economy. In the testing, we quantitatively analyze the effects on the financial system of a significant economic downturn and a substantial rise in interest rates.

Appendix: Statistical criterion for choosing indicators

In this appendix, we explain a statistical criterion for choosing indicators which has been used recently. That is receiver operating characteristics curve (ROC curve).[26]

1. ROC curve

ROC curve is the relationship between the rate of “true positive” and that of “false positive” for different values of the threshold. The rate of true positive is the probability of dispatching correct signals when event occurs (i.e., 1 minus probability of type I errors). The rate of false positive is the probability of dispatching false signals when no event occurs (i.e., probability of type II errors). If the threshold is set at a lower level, more signals tend to be dispatched and events are easily signaled. However, in that case, there is a high risk of type II error. If the threshold is set at a higher level, fewer signals are dispatched and events are not easily signaled. In that case, risk of type II error is low. Therefore, there is a positive relationship between the rates of true positive and false positive. Three typical forms of ROC curve are depicted in Figure 26.

First, suppose that an indicator is perfect in the sense that, with the optimal threshold, it can signal future events accurately without type II error. The ROC curve in this case is depicted in Figure 26(1). The upper-left point (0,1) corresponds to the outcome with the optimal threshold. If the threshold is lowered from the optimal level, the true positive rate decreases while the false positive rate does not change from zero. Thus the point corresponding to the outcome moves downwards on the vertical part of the curve. On contrary, if the threshold is raised from the optimal level, the false positive rate increases while the true positive rate does not change from one. Therefore, the corresponding point moves in the right direction on the horizontal part of the curve.

Next, consider an indicator which is completely uninformative (Figure 26(2)). For example, starting from the origin (which corresponds to the outcome with an extremely high threshold), if the threshold is lowered, the rates of true positive and false positive increase by the same amount. Therefore, the point corresponding to the outcome moves in the upper-right direction on the ROC curve, which is, in this case, a straight line with an angle of 45 degrees. In this case, we have signals, but prediction power of the indicator is 'fifty-fifty' under any value of thresholds. That is, using the indicator is equivalent to tossing a coin, and in this sense, the indicator contains no information.

[26] This analysis is originally from studies of radar where characteristics of radar signal receivers were examined.

Most of indicators to be used for early warning system are those between the above extreme cases. A typical ROC curve is shown in Figure 26(3). In this case, starting from the origin, if the threshold is lowered, the true positive rate increases more than the false positive rate does. Thus the point corresponding to the outcome moves in the upper-right direction on the curve, which is located above the 45-degree line. In this case, if the threshold is set at an appropriate level, the indicator can correctly predict events with a probability higher than 50%. Therefore, using the indicator is better than tossing a coin.

2. Relationship between the policy makers' approach and ROC curve

The curve in Figure 26(3) is ROC curve, the relationship between the rates of true positive and false positive for different values of the threshold. The policymakers will decide which point of ROC curve is optimal with the corresponding threshold when they use indicators for anticipation of a future event. If policymakers attach more attention to the risk they overlook the event, they would like to have lower threshold levels and capture the event as much as possible. In this case, however, they need to accept higher incidents of type II errors. This situation is point A in Figure 27(1). If policymakers have tendency to avoid type II error, they will set higher threshold levels. This situation is point B in Figure 27(1).

The policymakers' approach we employ in this paper for choosing appropriate indicators and thresholds is equivalent to ROC curve approach with optimal combination of true positive and false positive (Figure 27(2)). In the main text, we examined the usefulness of indicators directly calculating values of loss functions, taking into account various combinations of preference parameters.[27]

3. Example of ROC curve

We show an example of ROC curve using an indicator we used in the main text. 2 cases for the total credit to GDP ratio are depicted in Figure 27(3), one with one-sided HP filter trend case and the other with 3-year backward moving average. Both curves are positioned above 45 degree line and thought to be useful indicators. Comparing these two, one with one-sided HP filter trend is positioned higher and thought to be a better indicator.

[27] In addition, there is the analytical method for measuring the area under ROC. Drehmann (2014) points out that the credit to GDP ratio is the best indicator according to this criterion.

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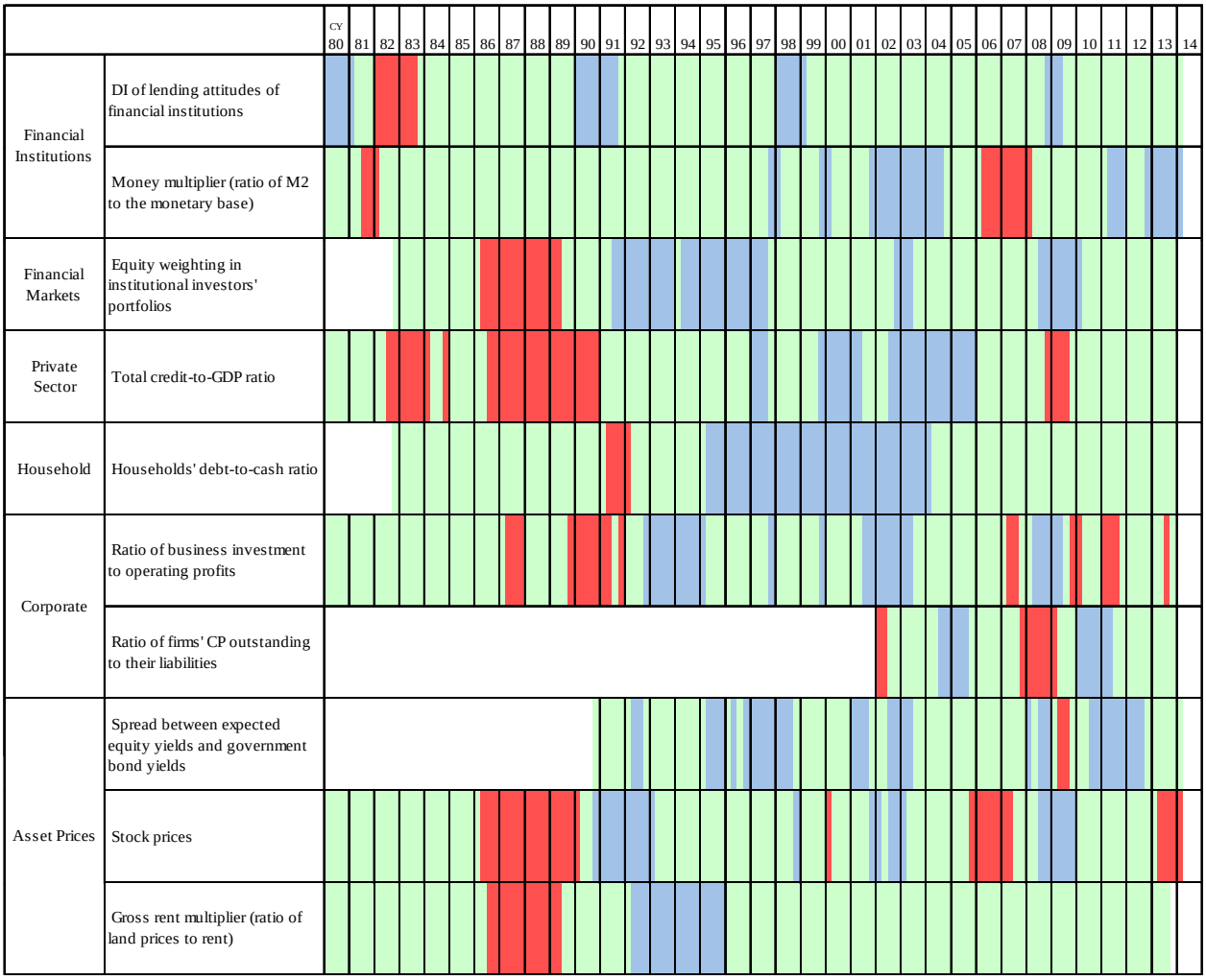
(Figure 1)

Existing FAIXs and its heat map



Notes: 1. The latest data for DI of lending attitude of financial institutions, stock prices and spread between expected equity yields and government bond yields are as of the January-March quarter of 2014. Those for money multiplier (ratio of M2 to monetary base) are as of the January-February of 2014. Those for gross rent multiplier (ratio of land prices to rent) are as of the July-September quarter of 2013. Those for other indicators are as of the October-December quarter of 2013.

2. The red portion (the most deeply shaded) shows a rise of indicator by more than the upper threshold, the blue portion (the second deeply shaded) shows a decline by more than the lower threshold, and the green portion (the most lightly shaded) shows everything in between (periods without data shown as white).

3. DI represents diffusion index.

Sources: Bloomberg; Cabinet Office, "National accounts"; Japan Post Holdings, "The former Japan Post statistical data"; Japan Real Estate Institute, "Urban land price index"; Ministry of Finance, "Financial statements statistics of corporations by industry, quarterly"; Ministry of Internal Affairs and Communications, "Consumer price index"; Ministry of Postal Services, "Annual statistical report of postal services," "Annual statistical report of postal service administrations"; Thomson Reuters; BOJ, "Flow of funds accounts," "Monetary base," "Money stock," "Tankan."

(Figure 2)

Key indicators for countercyclical capital buffer

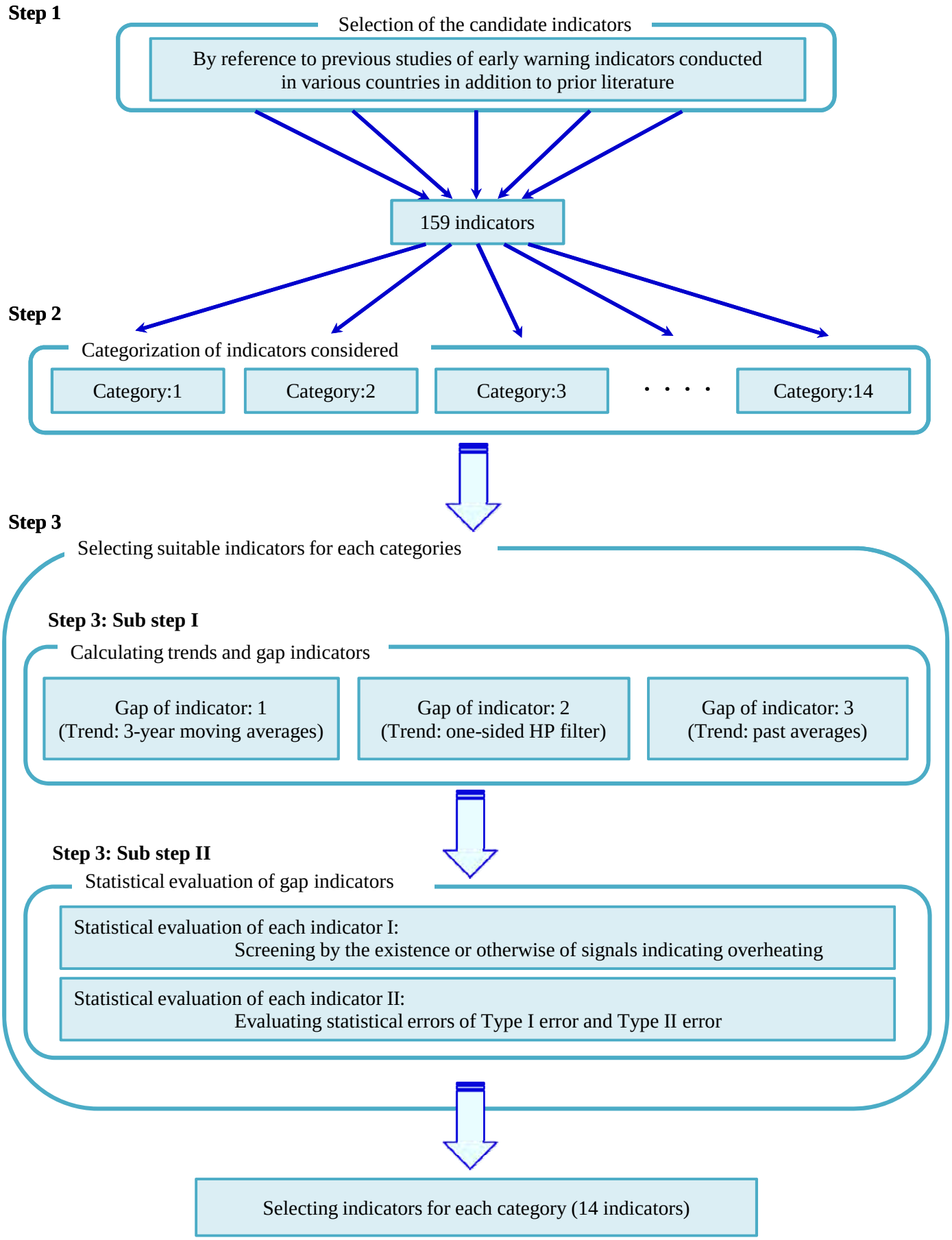
	Indicators
United Kingdom	Bank balance sheet stretch (9 indicators) — Capital ratio (Basel II core Tier 1, Basel III common equity Tier 1), Leverage ratio (Simple, Basel III initial proposal), Average risk weights, Return on assets before tax, Loan to deposit ratio, Short-term wholesale funding ratio (of which excluding repo funding), Overseas exposures indicator, CDS premia, Bank equity measures (price to book ratio, market-based leverage ratio) Non-bank balance sheet stretch (5 indicators) — Credit-to-GDP (ratio, Gap), Private non-financial sector credit growth, Net foreign asset position to GDP, Gross external debt to GDP, Current account balance to GDP Conditions and terms in markets (4 indicators) — Long-term real interest rate, VIX, Global corporate bond spreads, Spreads on new UK lending (household, corporate)
Denmark	Credit-to-GDP ratio, Leverage ratio, Interest margins, The banks' price-to-book ratio, Losses and write-downs as a ratio of total lending, Average market value, Development in real stock prices, Lending to households / GDP, Development in real housing prices, etc.
Norway	Credit-to-GDP ratio, House prices-to-income ratio, Real commercial property prices, Wholesale funding ratio.
Canada	Credit-to-GDP ratio, House prices, Yield spreads on corporate bonds, etc.
Sweden	Credit-to-GDP ratio, Financial stress index, Implied risk-premiums, Household debts to disposable income, etc.
United States	Ratio of credit to gross domestic product, Options implied volatility, Indices based on credit default swap spreads, etc.
Iceland	Credit-to-GDP ratio, Equity prices, Housing prices, Commercial and industrial real estate prices, Current account balance.
Switzerland	Mortgage volume indicators, Real estate price indicators, General economic condition indicators.

Note: 1. For the shaded area, indicators are mentioned in the rules of CCB that they will be used in the process of setting and changing CCB levels. However, about Switzerland, the reference indicators for the sectoral capital requirement is used. For other countries, indicators are examined in regular report of FSR whether they are appropriate as CCB reference indicators.

Sources: Published accounts of each country.

(Figure 3)

Selection process of new indicators



(Figure 4-1)

Candidate indicators (1)

Sector		Indicator
Financial Institutions	1	DI of lending attitudes of financial institutions
	2	DI of lending attitudes of financial institutions (Large firms)
	3	DI of lending attitudes of financial institutions (Small firms)
	4	ROA from net interest income of banks
	5	Current income ROA of banks
	6	ROA from operating profits of banks
	7	Net income ROA of banks
	8	Current income ROE of banks
	9	ROE from operating profits of banks
	10	Net income ROE of banks
	11	Real loan rate
	12	Money multiplier (ratio of M2 to the monetary base)
	13	Deposits to M2 ratio
	14	Real deposit outstanding
	15	(Cash + Required reserves) / Total assets
	16	Financial assets to financial debt ratio
	17	Demand deposit to total liabilities ratio of depository corporations
	18	Loan to deposit ratio of depository corporations
	19	Loan to deposit ratio of banks
	20	Leverage ratio (Shares and other equities / Assets)
	21	Depository corporations loans to equity ratio
	22	Financial institutions credit to GDP ratio
	23	Growth rate of financial institutions credit
	24	Non-bank credit to GDP ratio
	25	Total liabilities to net assets ratio of banks
	26	Total assets to total liabilities ratio of banks
	27	Total assets to net assets ratio of banks
	28	Ratio of market funding to total liabilities of depository corporations
	29	M2 to GDP ratio
	30	Growth rate of M2
	31	Real M1
Financial Markets	32	Volatility of excess bank stock return
	33	Equity weighting in institutional investors' portfolios
	34	Share of overseas investors in stock market
	35	Loan rate to deposit rate spread
	36	Growth rate of nominal GDP − Loan rate
	37	Growth rate of nominal GDP − Deposit interest rate
	38	Long-term / Short-term interest rate spread
	39	Short-term interest rate
	40	Long-term interest rate
	41	Real long-term interest rate
	42	Growth rate of real long-term interest rate

Sector		Indicator
Financial Markets	43	Volatility of exchange rate
	44	Government bond yield volatility
	45	Stock purchases on margin to sales on margin ratio
	46	Stock purchases on margin to TOPIX ratio
	47	(Stock purchases on margin + Sales on margin) / TOPIX
	48	(Stock purchases on margin − Sales on margin) / TOPIX
Private Sector	49	Private investment to GDP ratio
	50	Private security investment to GDP ratio
	51	Private investment (including security investment) to GDP ratio
	52	Growth rate of private investment
	53	Private fixed investment to GDP ratio
	54	Private fixed investment (excluding inventory investment) to GDP ratio
	55	DSR (Debt service to income ratio)
	56	Current balance
	57	Current balance to GDP ratio
	58	Total credit-to-GDP ratio
	59	Growth rate of real total credit
	60	Growth rate of total credit
	61	Quarter-on-quarter rate of change in total credit
	62	Growth rate of total credit − Growth rate of nominal GDP
	63	Quarter-on-quarter change in total credit to GDP ratio
Household	64	Household investment to disposable income ratio
	65	Household security investment to disposable income ratio
	66	Household investment (including security investment) to disposable income ratio
	67	Household security investment to GDP ratio
	68	Household investment to GDP ratio
	69	Household investment (including security investment) to GDP ratio
	70	Housing investment to GDP ratio
	71	Housing investment to disposable income ratio
	72	Household financial risk asset to total financial asset ratio
	73	Household financial assets to GDP ratio
	74	Saving rate
	75	Household loans to GDP ratio
	76	Growth rate of household loans
	77	Households' debt-to-cash ratio
	78	Household credit to disposable income ratio
	79	Growth rate of ratio of household credit to disposable income
	80	Household credit to GDP ratio
	81	Household credit to financial asset ratio
	82	Household credit to compensation of employee ratio
	83	Household credit to cash and deposits ratio

(Figure 4-2)

Candidate indicators (2)

Sector		Indicator
Corporate	84	Ratio of business investment to operating profits
	85	Ratio of business investment to operating profits (Large firms)
	86	Business investment (including security investment) to GDP ratio
	87	Business investment to GDP ratio
	88	Business investment to operating profits ratio
	89	Business fixed investment to GDP ratio
	90	Business fixed investment to operating profits ratio
	91	Business security investment to operating profits ratio
	92	Business security investment to GDP ratio
	93	Business fixed investment to internal cash flow ratio
	94	Interest coverage ratio
	95	Current income ROA
	96	Current income ROE
	97	Corporate short-term loans to total debt ratio
	98	Corporate credit (including public firm) to cash ratio
	99	Corporate credit (including public firm) to demand deposit ratio
	100	Corporate credit (including public firm) to sales ratio
	101	Corporate credit (including public firm) to GDP ratio
	102	Corporate credit to GDP ratio
	103	Growth rate of corporate credit
	104	Corporate credit to internal cash flow ratio
	105	Corporate credit to operating profits ratio
	106	Corporate leverage ratio (Debt / Asset)
	107	Corporate leverage ratio (Debt / Net asset)
Real Estate	108	Real estate firm investment (including security investment) to sales ratio
	109	Real estate firm investment (including security investment) to operating profits ratio
	110	Real estate firm investment (including security investment) to GDP ratio
	111	Real estate firm investment to sales ratio
	112	Real estate firm investment to operating profits ratio
	113	Real estate firm investment to GDP ratio
	114	Real estate firm security investment to sales ratio
	115	Real estate firm security investment to operating profits ratio
	116	Real estate firm security investment to GDP ratio
	117	Ratio of real estate loans to GDP
	118	Ratio of real estate loans to operating profits
	119	Leverage ratio of real estate
	120	Real estate loans of financial institutions to GDP ratio
	121	Real estate credit to GDP ratio
Asset Prices	122	Stock prices (TOPIX)
	123	Stock prices to GDP ratio
	124	Real stock prices
	125	PBR

Sector		Indicator
Asset Prices	126	Spread between equity yields and government bond yields
	127	Equity yields (Operating profits / TOPIX)
	128	RER (TOPIX / Operating profits)
	129	Forward-looking PER
	130	Backward-looking equity risk premium
	131	Forward-looking equity risk premium
	132	Current stock price of financial institutions to book value ratio
	133	Stock prices of banks to GDP ratio
	134	PBR of Banks
	135	Stock prices of real estate to GDP ratio
	136	Excess yields of real estate
	137	Real estate stock yields
	138	Real land prices of six large city areas
	139	Growth rate of real land prices of six large city areas
	140	Land prices of Tokyo areas to GDP ratio
	141	Land prices of six large city areas to GDP ratio
	142	Gross rent multiplier (ratio of land prices of Tokyo areas to rent)
	143	Gross rent multiplier (ratio of land prices of six large city areas to rent)
	144	Real commercial property prices of Tokyo areas
	145	Real commercial property prices of six large city areas
	146	Commercial property prices of Tokyo areas to GDP ratio
	147	Commercial property prices of six large city areas to GDP ratio
	148	Commercial property prices of Tokyo areas to operating profits ratio
	149	Commercial property prices of six large city areas to operating profits ratio
	150	Real industrial property prices of Tokyo areas
	151	Real industrial property prices of six large city areas
	152	Real house prices of Tokyo areas
	153	Real house prices of six large city areas
	154	Growth rate of real house prices of Tokyo areas
	155	Growth rate of real house prices of six large city areas
	156	House prices of Tokyo areas to rent ratio
	157	House prices of six large city areas to rent ratio
	158	House prices of Tokyo area to income ratio
	159	CSPI of real estate

Note: The 'real' variables are deflated by the Consumer Price Index.

(Figure 5)

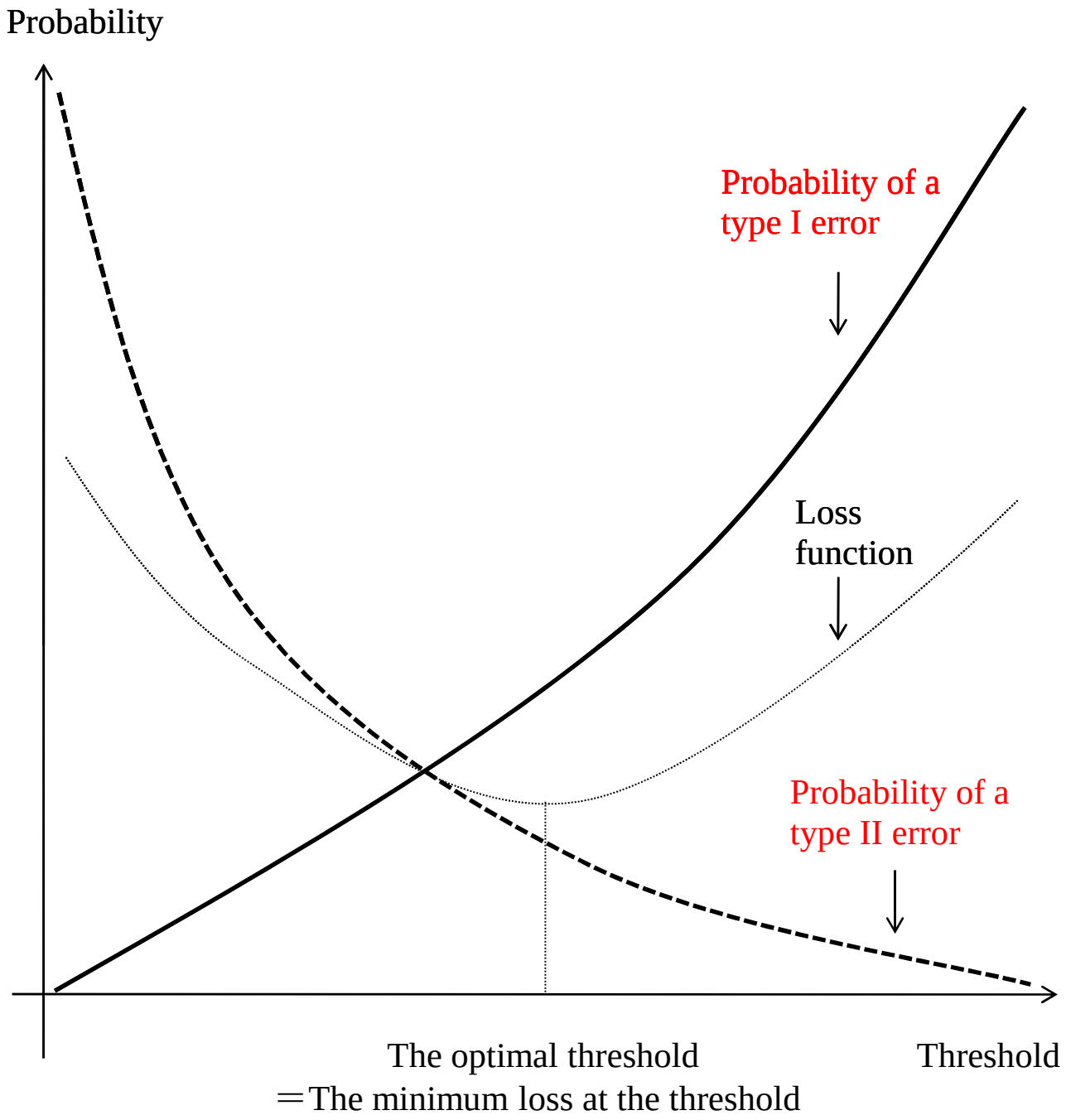
Category of the indicator

	Asset side: Investment Activity	Debt side: Funding Activity
Financial Institutions	Category : 1	Category : 2
Financial Markets	Category : 3	Category : 4
Private Sector	Category : 5	Category : 6
household	Category : 7	Category : 8
Corporate	Category : 9	Category : 10
Real Estate	Category : 11	Category : 12

	Stock Price	Land Price
Asset Prices	Category : 13	Category : 14

(Figure 6)

Type I error and type II error



(Figure 7)

Selecting indicators of each models

Category		Model	Indicator selected	Trends	Threshold
Financial institutions	Investment Activity	1.μ = 0.5	DI of lending attitudes of financial institutions	past average	1σ
		2.μ = 0.7	DI of lending attitudes of financial institutions	past average	1σ
		3.μ = 0.9	ROA from net interest income of banks	one-sided HP filter	1σ
		4.NS ratio	N.A.		
	Funding Activity	1.μ = 0.5	Growth rate of M2	one-sided HP filter	1σ
		2.μ = 0.7	Growth rate of M2	one-sided HP filter	1σ
		3.μ = 0.9	Non-bank credit to GDP ratio	3-year moving averages	1σ
		4.NS ratio	Growth rate of M2	one-sided HP filter	1σ
Financial markets	Investment Activity	1.μ = 0.5	Equity weighting in institutional investors' portfolios	3-year moving averages	1σ
		2.μ = 0.7	Equity weighting in institutional investors' portfolios	3-year moving averages	1σ
		3.μ = 0.9	Equity weighting in institutional investors' portfolios	3-year moving averages	1σ
		4.NS ratio	N.A.		
	Funding Activity	1.μ = 0.5	Stock purchases on margin to sales on margin ratio	one-sided HP filter	1.25σ
		2.μ = 0.7	Stock purchases on margin to sales on margin ratio	3-year moving averages	1σ
		3.μ = 0.9	Stock purchases on margin to sales on margin ratio	3-year moving averages	1σ
		4.NS ratio	N.A.		
Private sector	Investment Activity	1.μ = 0.5	Private investment to GDP ratio	3-year moving averages	1σ
		2.μ = 0.7	Private investment to GDP ratio	one-sided HP filter	1.5σ
		3.μ = 0.9	Private investment to GDP ratio	one-sided HP filter	1σ
		4.NS ratio	Private investment to GDP ratio	3-year moving averages	1σ
	Funding Activity	1.μ = 0.5	Total credit-to-GDP ratio	one-sided HP filter	1σ
		2.μ = 0.7	Total credit-to-GDP ratio	3-year moving averages	1.25σ
		3.μ = 0.9	Total credit-to-GDP ratio	3-year moving averages	1σ
		4.NS ratio	Total credit-to-GDP ratio	one-sided HP filter	1σ
Household	Investment Activity	1.μ = 0.5	Household investment to disposable income	3-year moving averages	1σ
		2.μ = 0.7	Household investment to disposable income	one-sided HP filter	1.5σ
		3.μ = 0.9	Household investment to disposable income	one-sided HP filter	1σ
		4.NS ratio	Household investment to disposable income	3-year moving averages	1σ
	Funding Activity	1.μ = 0.5	Household loans to GDP ratio	3-year moving averages	1.25σ
		2.μ = 0.7	Household loans to GDP ratio	3-year moving averages	1.25σ
		3.μ = 0.9	Household loans to GDP ratio	3-year moving averages	1.25σ
		4.NS ratio	Household loans to GDP ratio	one-sided HP filter	1.5σ
Corporate	Investment Activity	1.μ = 0.5	Business fixed investment to GDP ratio	one-sided HP filter	1σ
		2.μ = 0.7	Business investment to GDP ratio	one-sided HP filter	1σ
		3.μ = 0.9	Business investment to GDP ratio	one-sided HP filter	1σ
		4.NS ratio	Business fixed investment to GDP ratio	one-sided HP filter	1σ
	Funding Activity	1.μ = 0.5	Corporate credit to GDP ratio	3-year moving averages	1σ
		2.μ = 0.7	Corporate credit to GDP ratio	3-year moving averages	1σ
		3.μ = 0.9	Corporate credit to GDP ratio	3-year moving averages	1σ
		4.NS ratio	Corporate credit to GDP ratio	3-year moving averages	1.25σ
Real estate	Investment Activity	1.μ = 0.5	Real estate firm investment to GDP ratio	one-sided HP filter	1σ
		2.μ = 0.7	Real estate firm investment to GDP ratio	one-sided HP filter	1σ
		3.μ = 0.9	Real estate firm investment to GDP ratio	one-sided HP filter	1σ
		4.NS ratio	N.A.		
	Funding Activity	1.μ = 0.5	Ratio of real estate loans to GDP	one-sided HP filter	1σ
		2.μ = 0.7	Ratio of real estate loans to GDP	one-sided HP filter	1σ
		3.μ = 0.9	Ratio of real estate loans to GDP	one-sided HP filter	1σ
		4.NS ratio	Ratio of real estate loans to GDP	one-sided HP filter	1.75σ
Asset prices	Stock price	1.μ = 0.5	Stock prices	one-sided HP filter	1.5σ
		2.μ = 0.7	Stock prices	one-sided HP filter	1.5σ
		3.μ = 0.9	Stock prices	one-sided HP filter	1.5σ
		4.NS ratio	Stock prices	one-sided HP filter	1.5σ
	Land price	1.μ = 0.5	Land prices to GDP ratio	3-year moving averages	1σ
		2.μ = 0.7	Land prices to GDP ratio	3-year moving averages	1σ
		3.μ = 0.9	Land prices to GDP ratio	3-year moving averages	1σ
		4.NS ratio	A large number of indicators		

Notes: 1. Shaded indicators are one of the indicator of new FAIXs.

2. σ is a unit that represents the root mean square of deviation between actual and trend values.

(Figure 8)

Comparison between existing FAIXs and new FAIXs

(1) The existing indicators

	Existing Indicators	
	Investment Activity	Funding Activity
Financial Institutions	DI of lending attitudes of financial institutions < 3-year moving averages, 1σ >	Money multiplier < 3-year moving averages, 1σ >
Financial Markets	Equity weighting in institutional investors' portfolios < 3-year moving averages, 1σ >	
Private Sector		Total credit-to-GDP ratio < 3-year moving averages, 1σ >
Household		Households' debt-to-cash ratio < 3-year moving averages, 1σ >
Corporate	Ratio of business investment to operating profits < 3-year moving averages, 1σ >	Ratio of firms' CP outstanding to their liabilities < 3-year moving averages, 1σ >

	Stock Price	Land Price
Asset Prices	Stock prices < 3-year moving averages, 1σ > Spread between expected equity yields and government bond yields < 3-year moving averages, 1σ >	Gross rent multiplier < 3-year moving averages, 1σ >

(2) Indicators of the new version

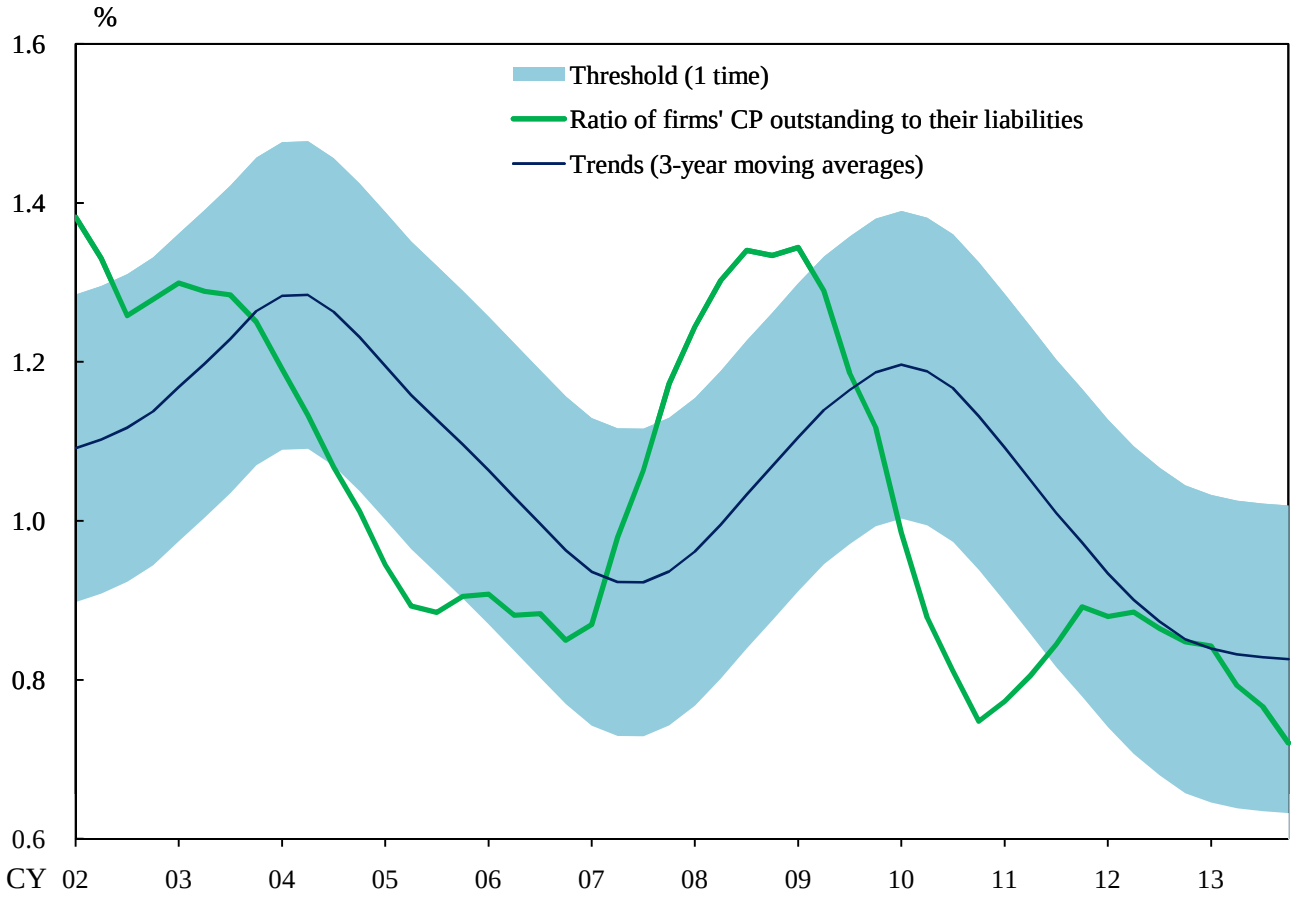
	New indicators	
	Investment Activity	Funding Activity
Financial Institutions	* DI of lending attitudes of financial institutions < **past averages**, 1σ >	• **Growth rate of M2** < **one-sided HP filter**, 1σ >
Financial Markets	‡ Equity weighting in institutional investors' portfolios < 3-year moving averages, 1σ >	† **Stock purchases on margin to sales on margin ratio** < 3-year moving averages, 1σ >
Private Sector	† **Private investment to GDP ratio** < 3-year moving averages, 1σ >	* Total credit-to-GDP ratio < **one-sided HP filter**, 1σ >
Household	† **Household investment to disposable income ratio** < 3-year moving averages, 1σ >	• **Household loans to GDP ratio** < 3-year moving averages, **1.25**σ >
Corporate	• **Business fixed investment to GDP ratio** < **one-sided HP filter**, 1σ >	† **Corporate credit to GDP ratio** < 3-year moving averages, 1σ >
Real Estate	† **Real estate firm investment to GDP ratio** < **one-sided HP filter**, 1σ >	† **Ratio of real estate loans to GDP** < **one-sided HP filter**, 1σ >

	Stock Price	Land Price
Asset Prices	* Stock prices < **one-sided HP filter**, **1.5**σ >	• **Land prices to GDP ratio** < 3-year moving averages, 1σ >

Notes: 1. The underlined items show the points of modification. Trends and thresholds for each indicator are in parentheses.
2. The symbol represent the following; ‡ : unmodified, *: methods for extracting trends and thresholds modified, •: data processing methods modified, †: newly adopted.
3. σ is a unit that represents the root mean square of deviation between actual and trend values.

(Figure 9)

Ratio of firms' CP outstanding to their liabilities

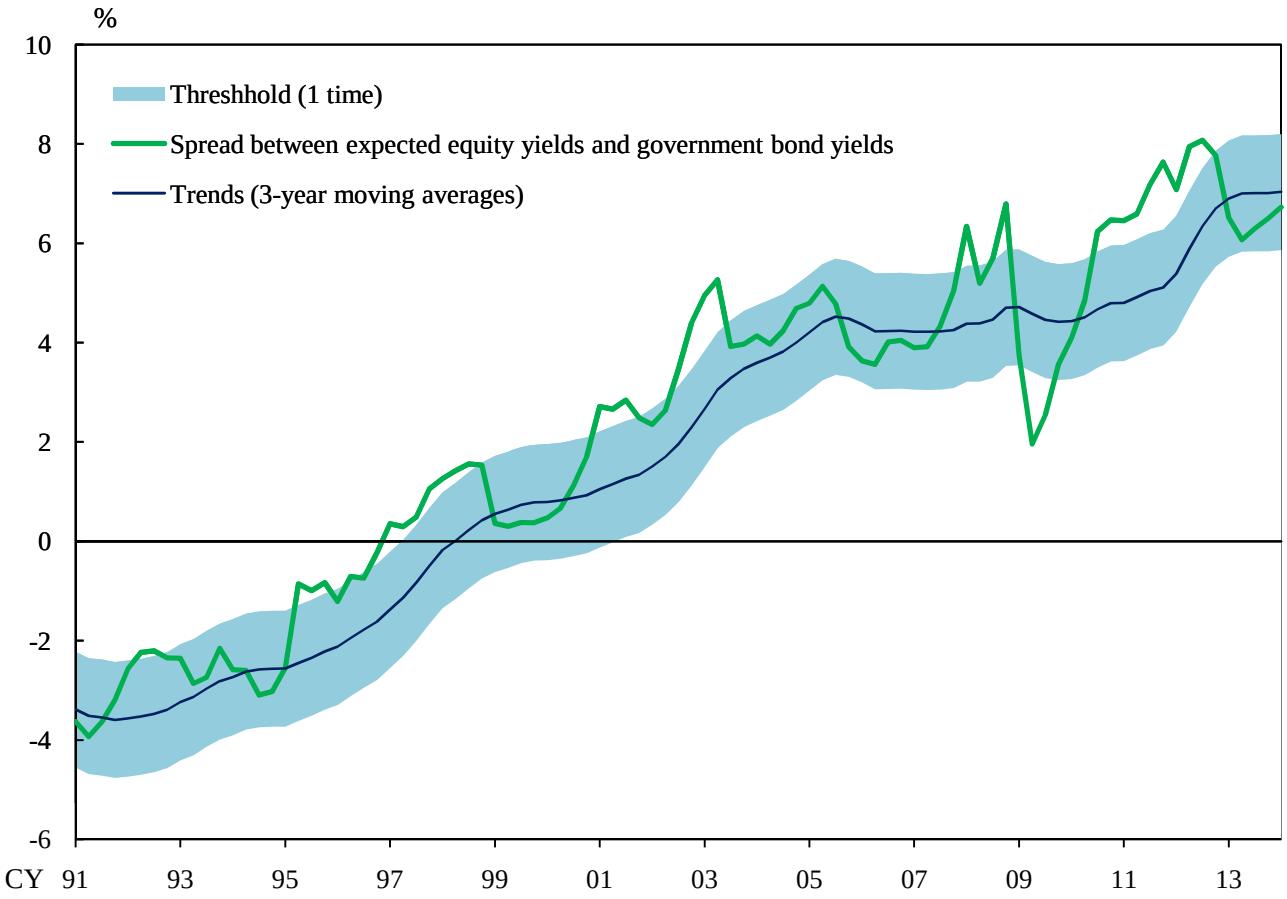


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by the non-financial corporations' commercial papers outstanding / their financial liabilities (excluding shares and other equities) × 100.
3. The sample period begins in Q3 1998, because the CP issuance market was completely liberalized by abandonment of finance-related notifications and memoranda by Ministry of Finance in June 1998.
4. The non-financial corporations' commercial papers outstanding and their financial liabilities (excluding shares and other equities) are measured as a four-quarter moving average.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Source: Bank of Japan, "Flow of Funds Accounts."

(Figure 10)

Spread between expected equity yields and government bond yields

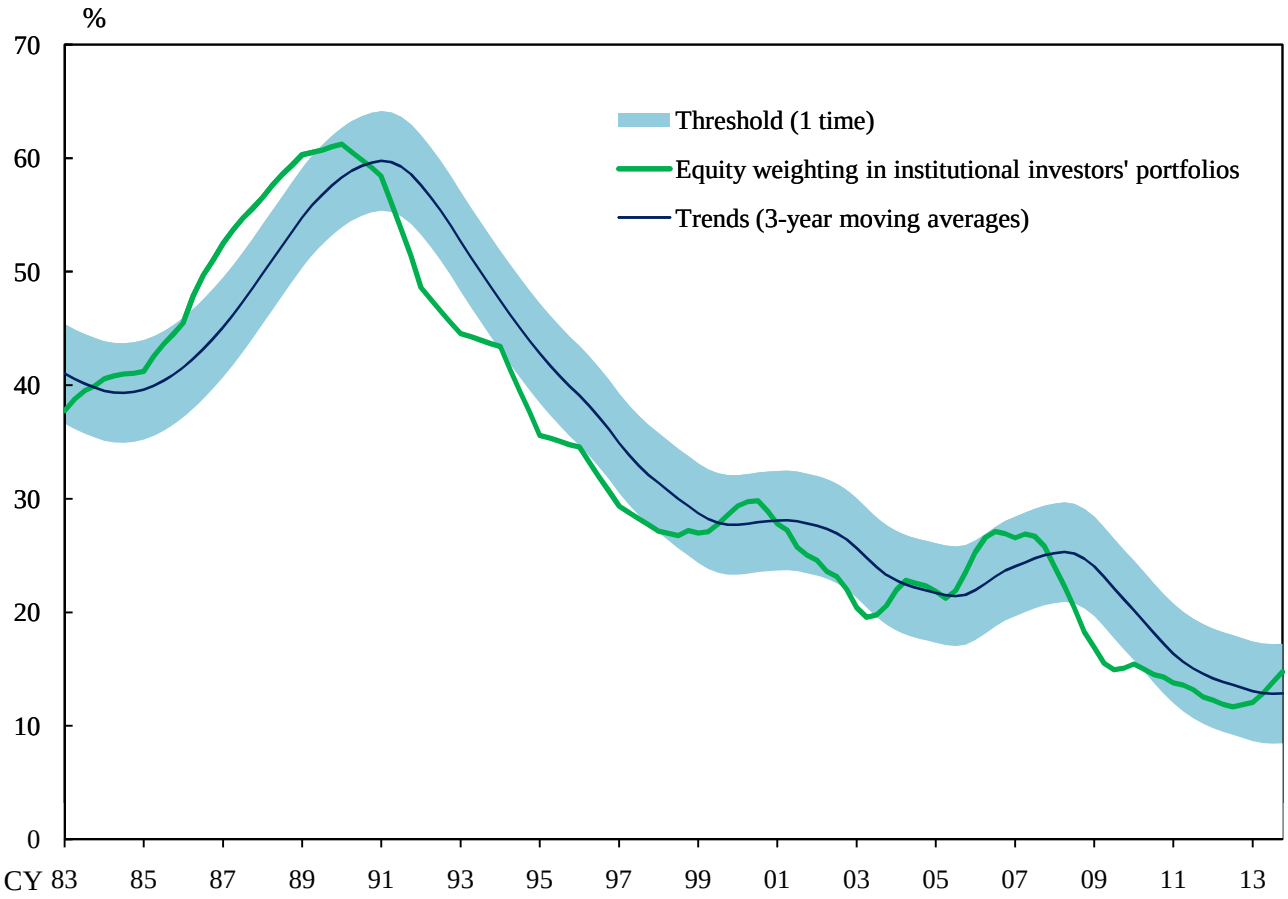


Notes: 1. The latest data are as of the January-March quarter of 2014.
2. The indicator is given by expected equity yields - 10-year JGB yields. Expected equity yield is defined as an inverse of the one year forward-looking PER of TOPIX.
3. The financial activity is overheated if the indicator fall below the shaded area and overcooled if the indicator exceeds the shaded area.

Sources: Bloomberg; Thomson Reuters.

(Figure 11)

Equity weighting in institutional investors' portfolios



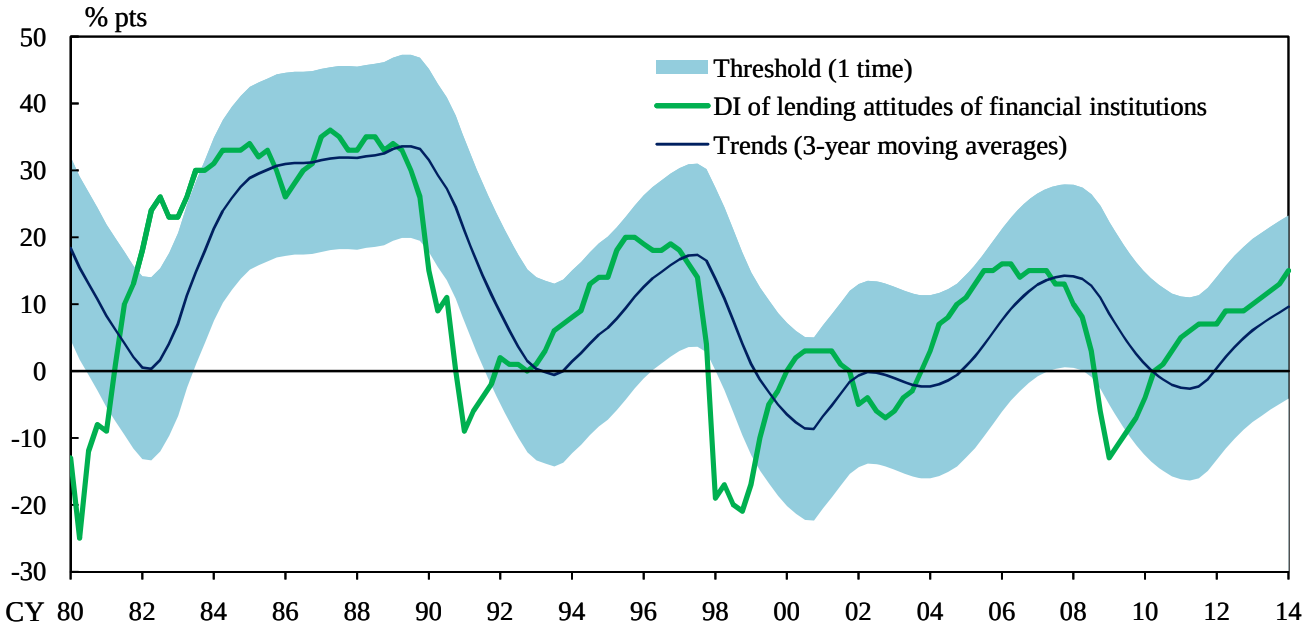
Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by the outstanding amount of institutional investors' equity investment / the outstanding amount of their total security investment × 100. Institutional investors is defined as the insurance sector, the pension funds sector and the securities investment trusts sector.
3. The outstanding amount of equity investment and that of total security investment from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the old basis data in those periods.
4. The outstanding amount of equity investment and that of total security investment are measured as a four-quarter moving average.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Source: Bank of Japan, "Flow of Funds Accounts."

(Figure 12)

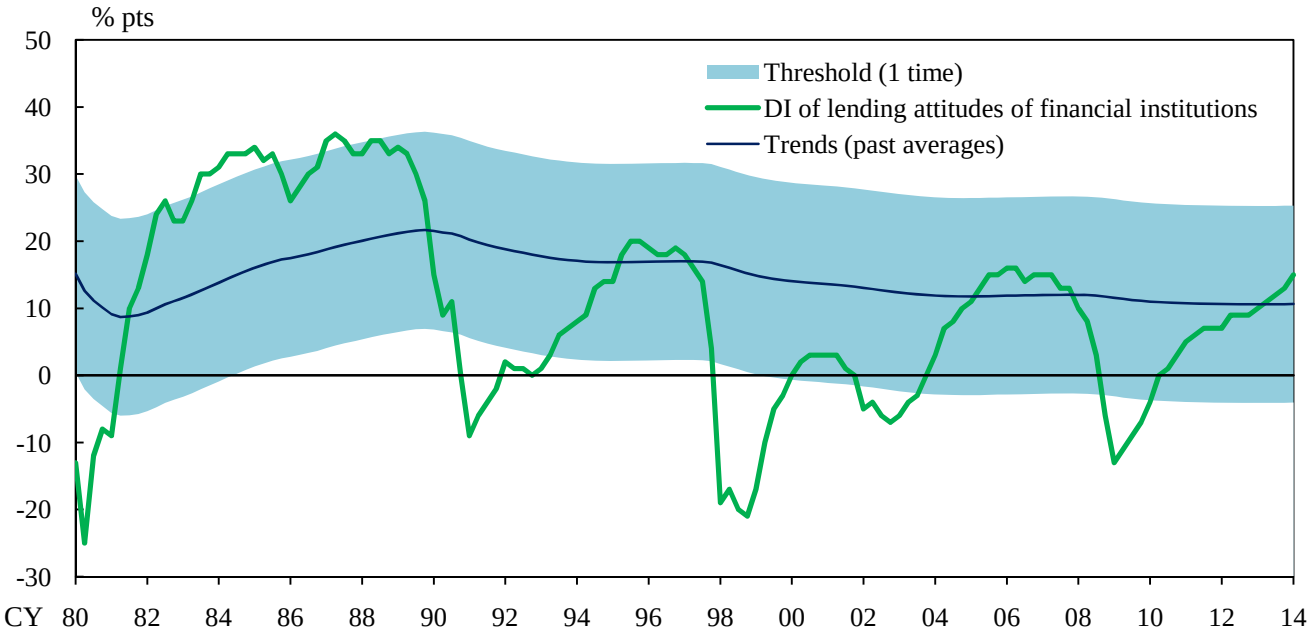
DI of lending attitudes of financial institutions

(1) The existing Indicator



Notes: 1. The latest data are as of the January-March quarter of 2014.
2. Diffusion index of "Accommodative" minus "Severe".
3. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator



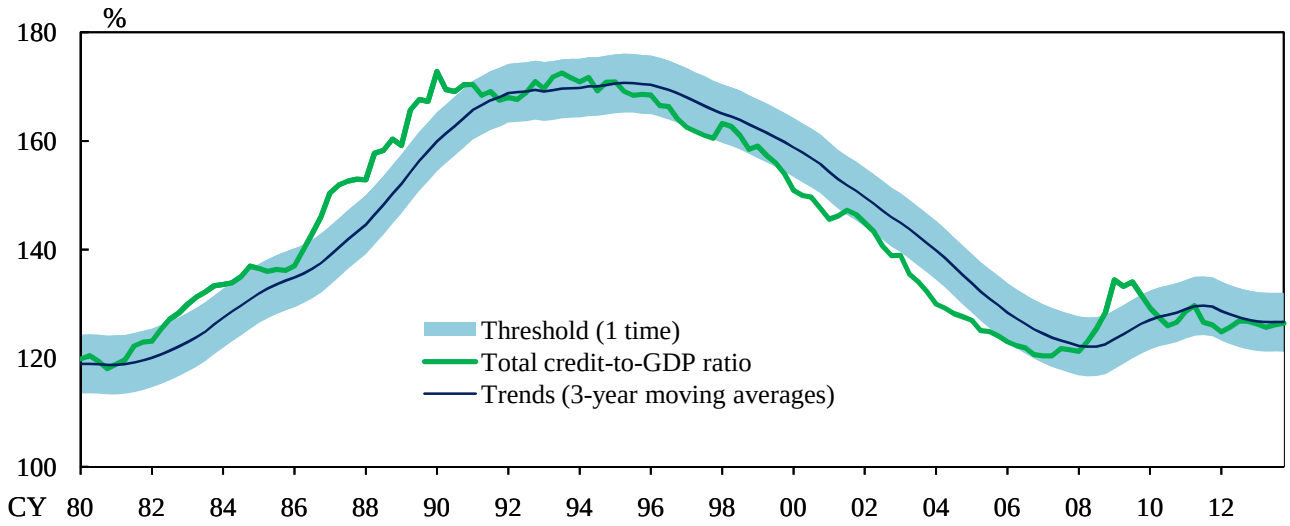
Note: 1. For details, see above Notes.

Source: Bank of Japan, "Tankan."

(Figure 13)

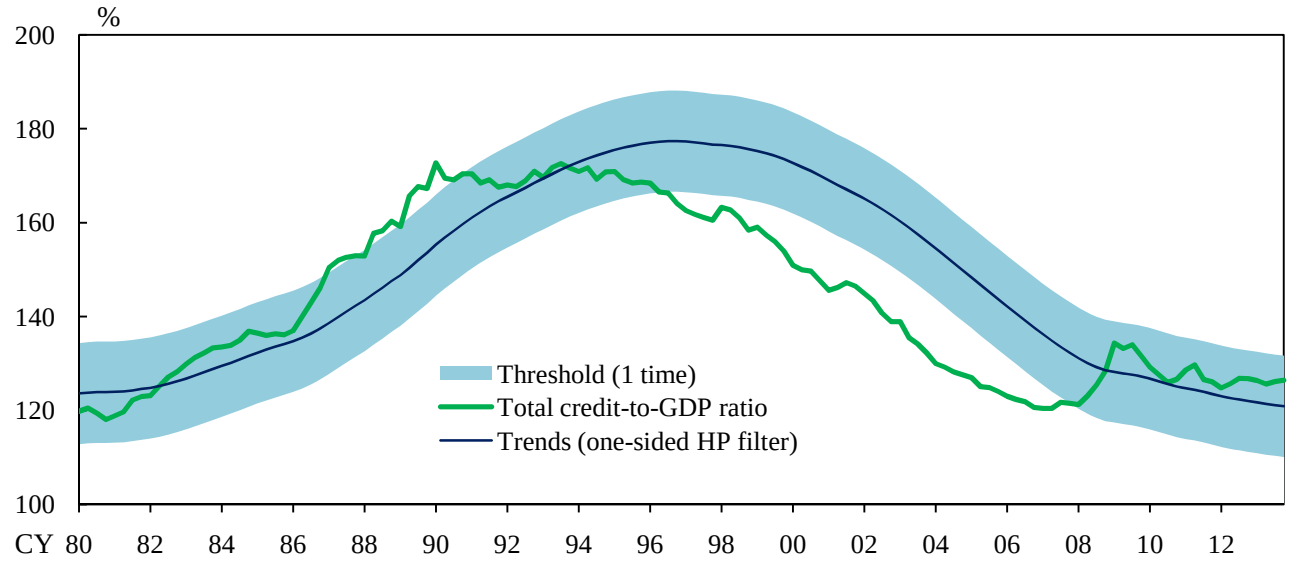
Total credit-to-GDP ratio

(1) The existing indicator



Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by total credit / nominal GDP × 100. Total credit is defined as the sum of the outstanding amount of loan by private financial institutions to non-financial sector (excluding general government) and the outstanding amount of securities investment by private financial institutions.
3. Total credits from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the old basis data in those periods. Total credits before Q4 1979 are calculated applying year-on-year rates of changes of 1968 SNA basis data in those periods. Nominal GDP from Q1 1980 to Q4 1993 are calculated applying quarter-on-quarter rates of changes of CY2000 basis data in those periods. Nominal GDP before Q4 1979 are calculated applying quarter-on-quarter rates of changes of 1968 SNA basis data in those periods.
4. Total credits are measured as a four-quarter moving average.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator



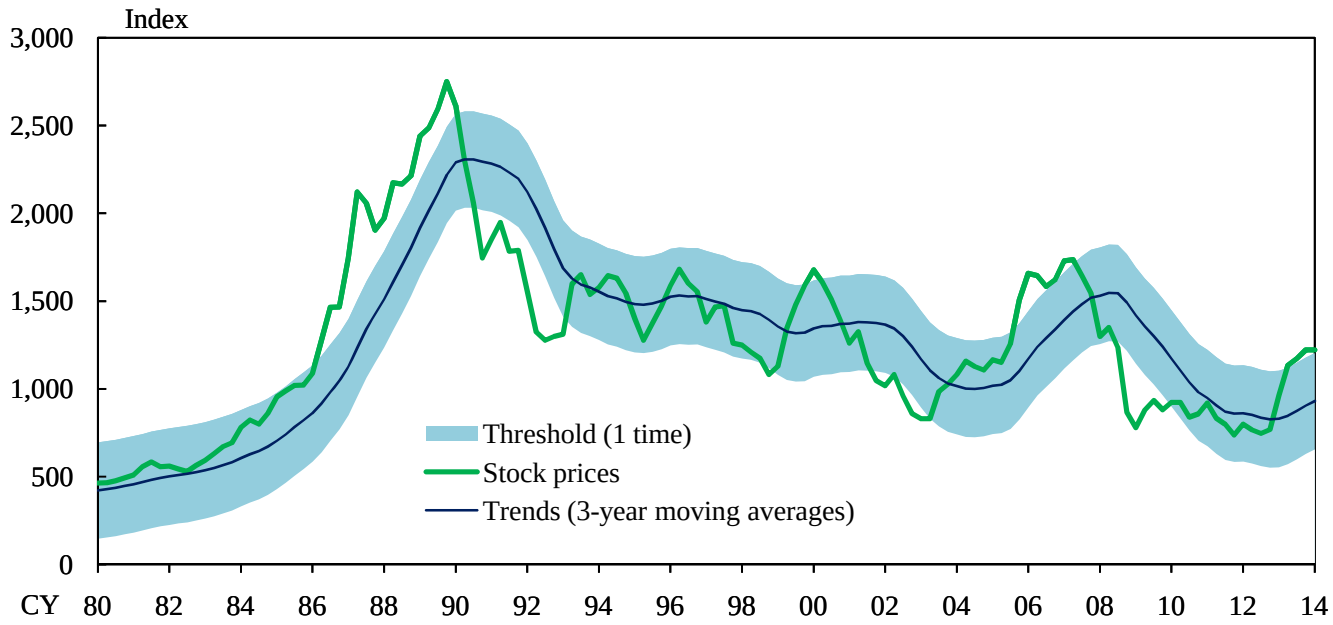
Note: 1. For details, see above Notes.

Sources: Cabinet Office, "National accounts"; Bank of Japan, "Flow of Funds Accounts."

(Figure 14)

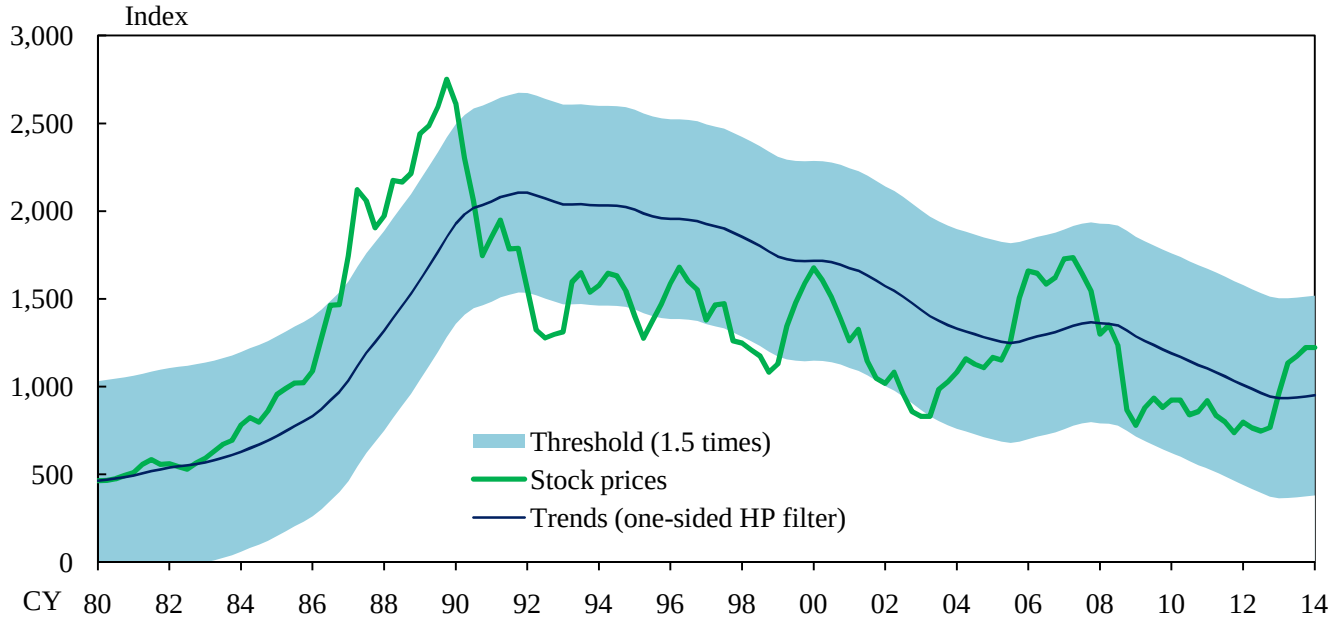
Stock price

(1) The existing indicator



Notes: 1. The latest data are as of the January-March quarter of 2014.
2. Stock prices are defined as TOPIX.
3. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator



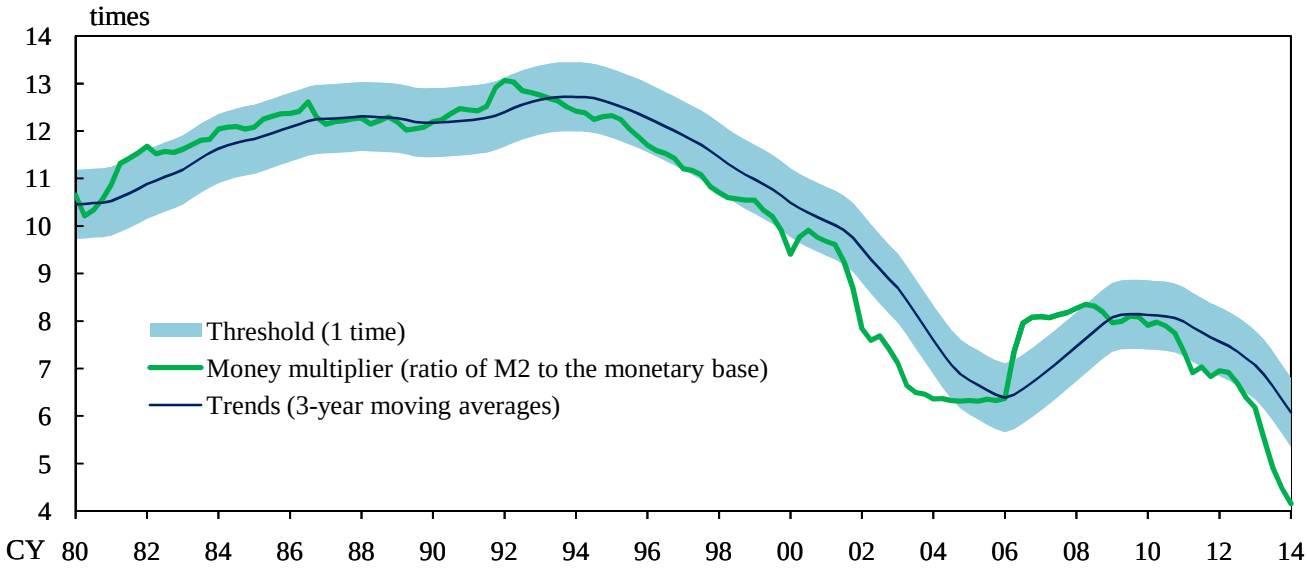
Note: 1. For details, see above Notes.

Source: Bloomberg.

(Figure 15)

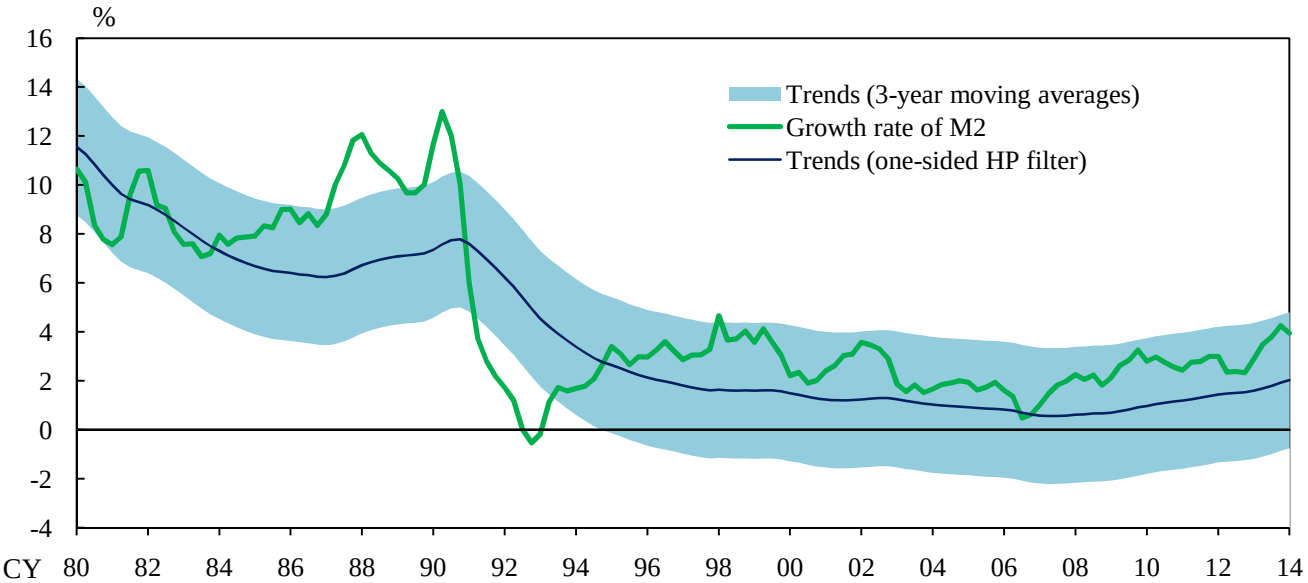
Money

(1) The existing indicator (Money multiplier)



Notes: 1. The latest data are as of the January-February of 2014.
2. The indicator is given by the average outstanding amount of M2 / the average outstanding amount of monetary base.
3. The M2s before Q1 2003 are calculated applying quarter-on-quarter rates of changes of the M2 + CD in those periods.
4. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator (Growth rate of M2)



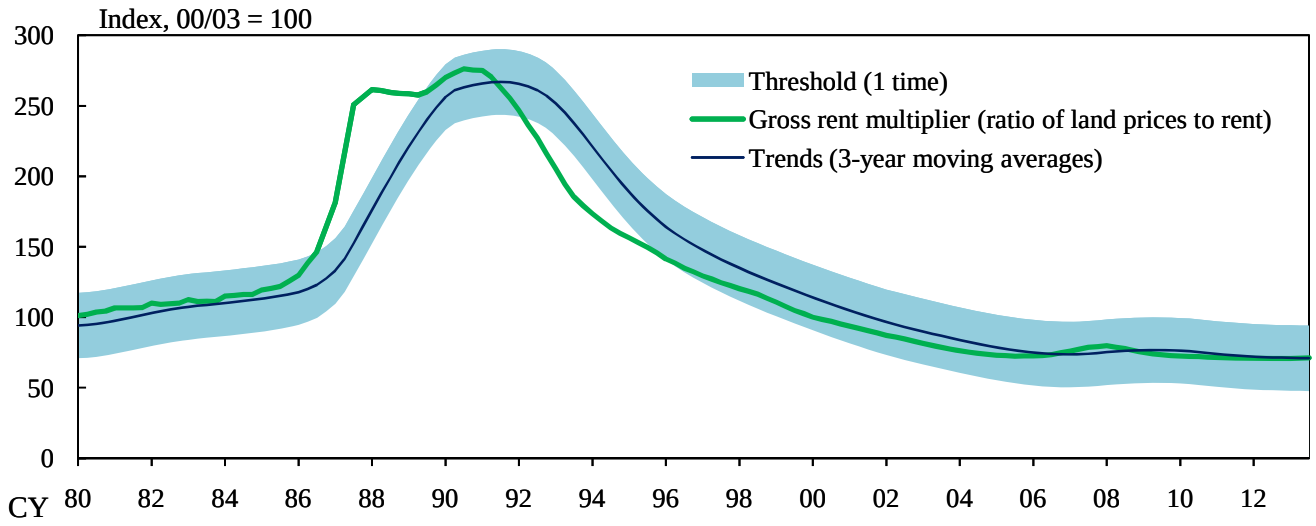
Notes: 1. The latest data are as of the January-February of 2014.
2. The indicator is given by the growth rate of the average outstanding amount of M2.
3. The M2s before Q1 2003 are calculated applying quarter-on-quarter rates of changes of the M2 + CD in those periods.
4. The financial activity is overheated when the indicator exceeds the shaded area and overcooled when the indicator below the shaded area.

Sources: BOJ, "Monetary base," "Money stock."

(Figure 16)

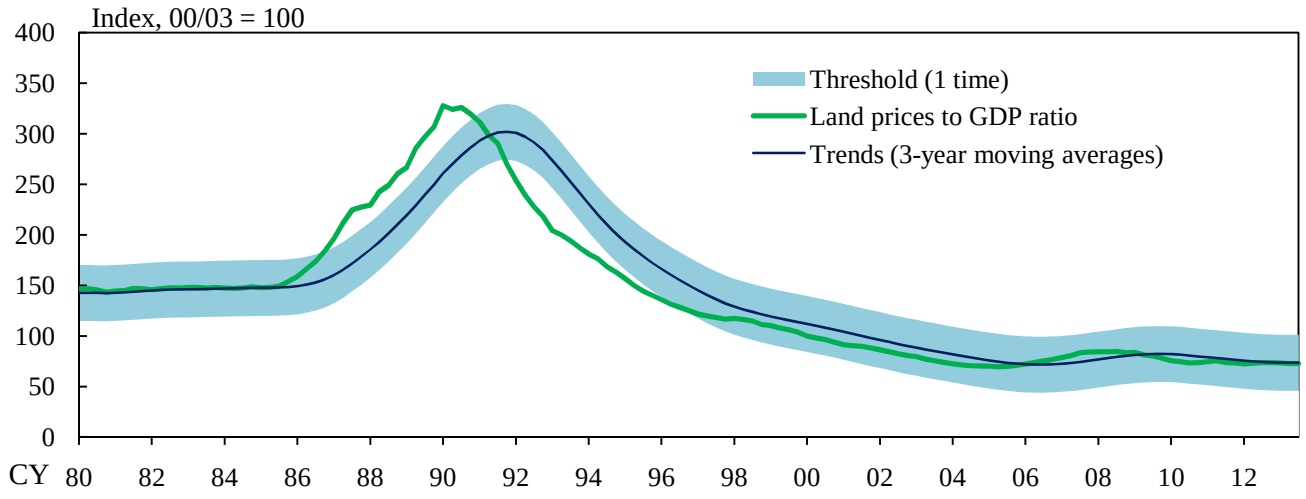
Land price

(1) The existing indicator (Gross rent multiplier)



Notes: 1. The latest data are as of the July-September quarter of 2013.
2. The indicator is given by urban land price index of Tokyo metropolitan area / consumer price index (rent) for Ku-area of Tokyo × 100.
3. The land prices before CY 1984 are calculated applying year-on-year rates of changes of the urban land price index of six large city areas in those periods.
4. The data of land prices for the intervening half year are linearly interpolated.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator (Land prices to GDP ratio)



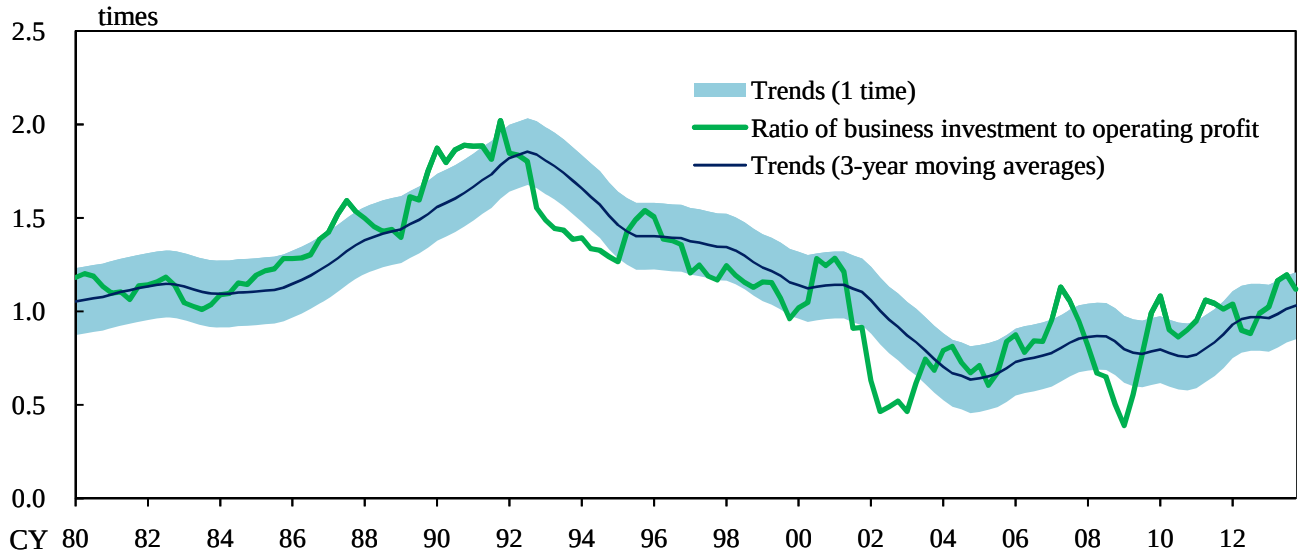
Notes: 1. The latest data are as of the July-September quarter of 2013.
2. The indicator is given by urban land price index of six large city areas / nominal GDP × 100.
3. Nominal GDP from Q1 1980 to Q4 1993 are calculated applying quarter-quarter rates of changes of CY2000 basis data in those periods. Nominal GDP before Q4 1979 are calculated applying quarter-on-quarter rates of changes of 1968 SNA basis data in those periods.
4. The data of land prices for the intervening half year are linearly interpolated.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National Accounts"; Japan Real Estate Institute, "Urban Land Price Index"; Ministry of Internal Affairs and Communications, "Consumer Price Index."

(Figure 17)

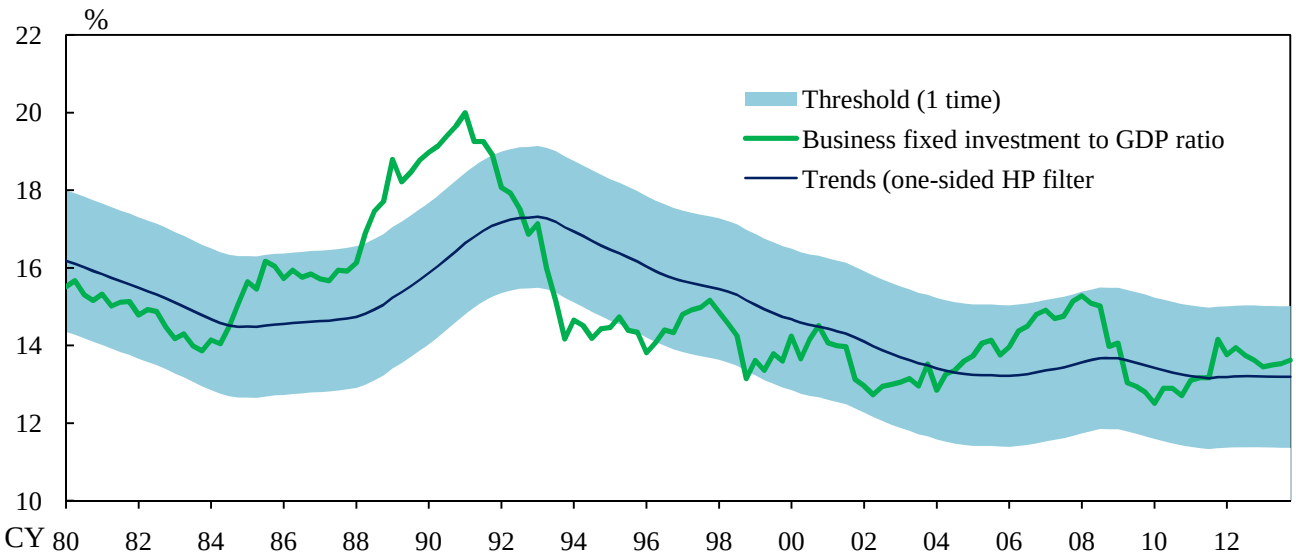
Business fixed investment to GDP ratio

(1) The existing Indicator (Ratio of business investment to operating profit)



Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by business investment / operating profits. Business investment is defined as the sum of fixed investment, inventory investment and security investment.
3. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator (Business fixed investment to GDP ratio)



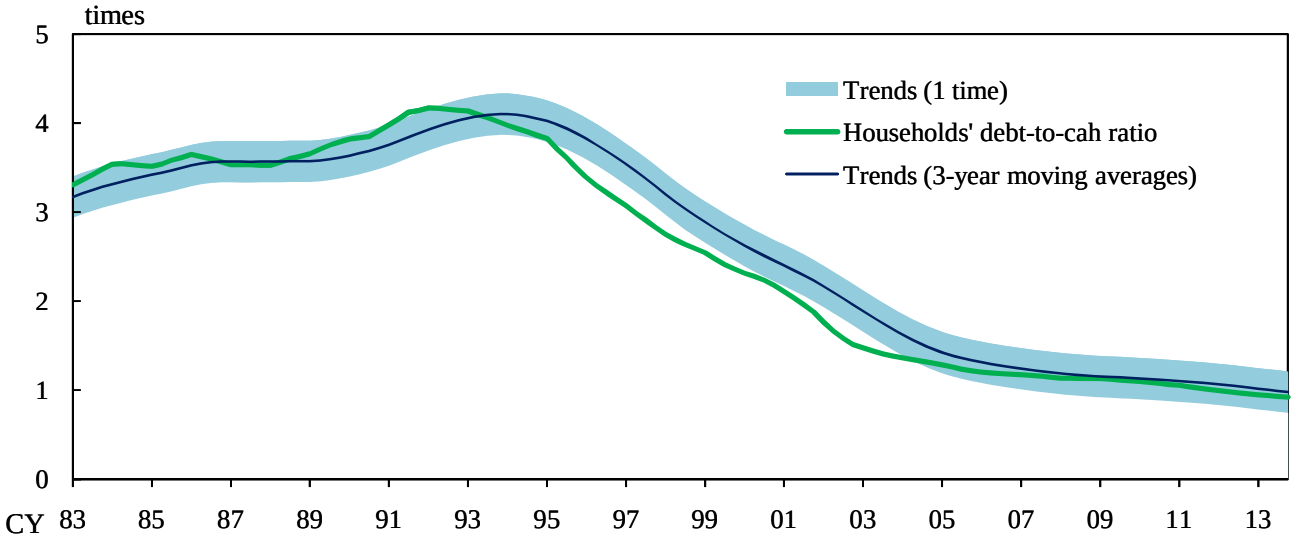
Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by business fixed investment / nominal GDP × 100.
3. Business fixed investment and nominal GDP from Q1 1980 to Q4 1993 are calculated applying quarter-on-quarter rates of changes of CY2000 basis data in those periods. Business fixed investment and nominal GDP before Q4 1979 are calculated applying quarter-on-quarter rates of changes of 1968 SNA basis data in those periods.
4. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National accounts"; Ministry of Finance, "Financial Statements Statistics of Corporations by Industry."

(Figure 18)

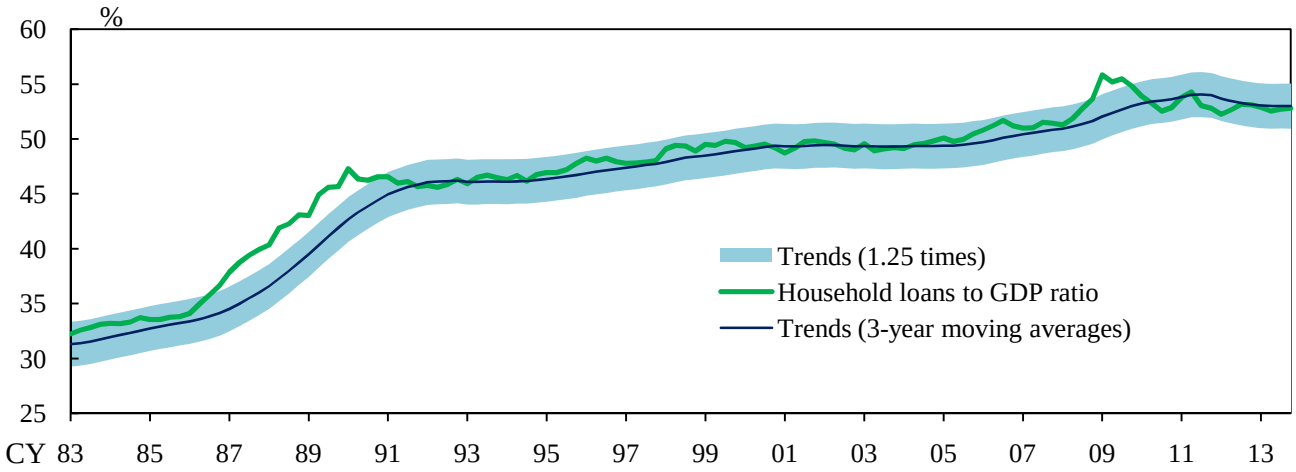
Household loans to GDP ratio

(1) The existing indicator (Households' debt-to-cash ratio)



Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by the households' financial liabilities outstanding / on-hand liquidity. The on-hand liquidity is defined as the sum of cash and demand deposits.
3. The financial liabilities, the cash and the demand deposits from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the annual data (fiscal year) in those periods.
4. The financial liabilities, the cash and the demand deposits are measured as a four-quarter moving averages.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

(2) New indicator (Household loans to GDP ratio)

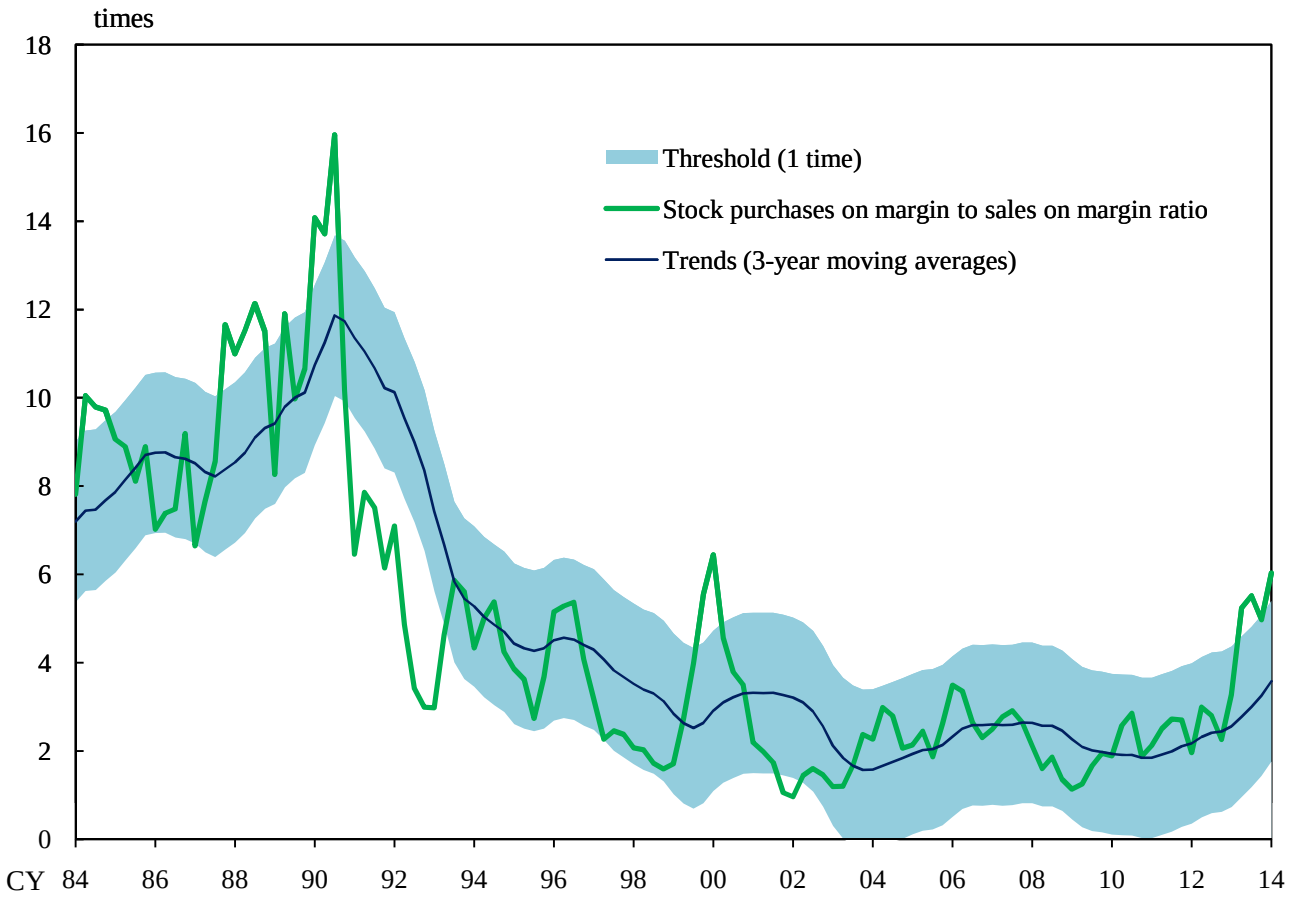


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by the household loans of commercial institutions / nominal GDP × 100.
3. The household loans of commercial institutions from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the annual data (fiscal year) in those periods.
4. The household loans of commercial institutions are measured as a four-quarter moving average.
5. For nominal GDP, see figure 13 Note 3.
6. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National accounts"; Bank of Japan, "Flow of Funds Accounts."

(Figure 19)

Stock purchases on margin to sales on margin ratio

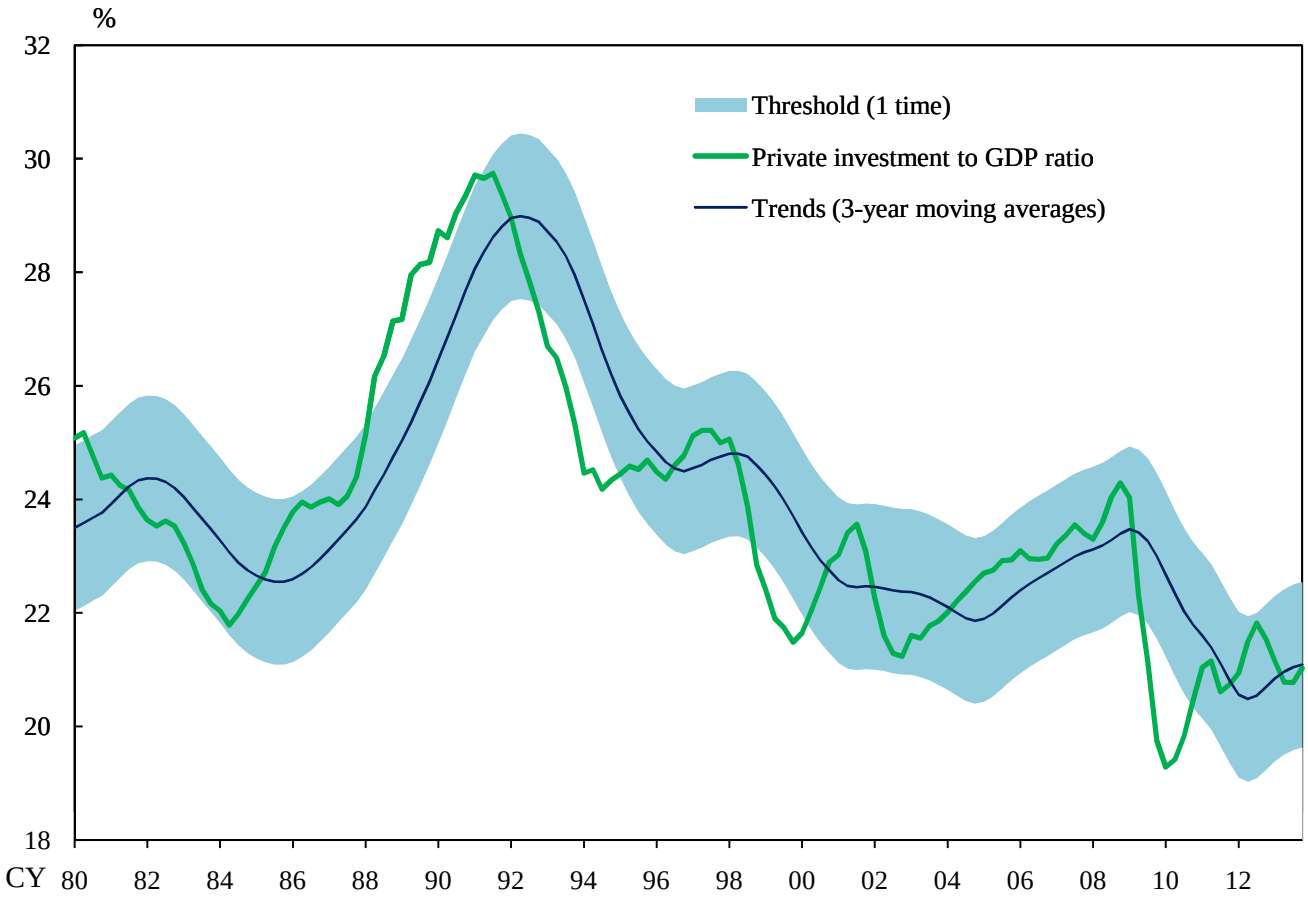


Notes: 1. The latest data are as of the January-March quarter of 2014.
2. The indicator is given by the stock outstanding purchases on margin / stock outstanding sales on margin.
3. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Source: Tokyo Stock Exchange, "Outstanding margin trading."

(Figure 20)

Private investment to GDP ratio

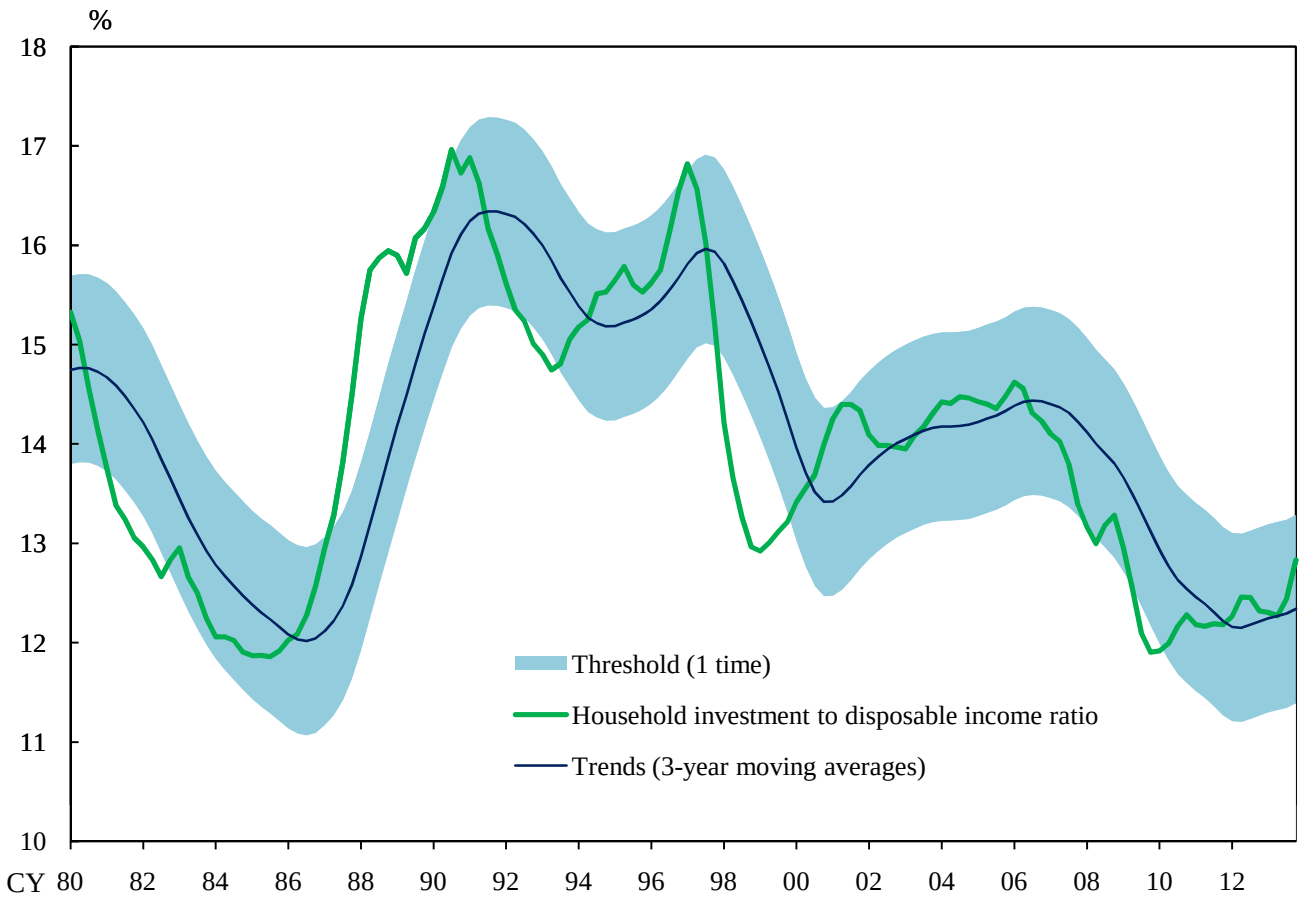


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by (business fixed investment + inventory investment + housing investment + durable goods consumption) / nominal GDP × 100.
3. Business fixed investment, inventory investment, housing investment, and durable goods consumption from Q1 1980 to Q4 1993 are calculated applying year-on-year rates of changes of CY2000 basis data in those periods. Those figures before Q4 1979 are calculated applying year-on-year rates of changes of 1968 SNA basis data in those periods.
4. For nominal GDP, see figure 13 Note 3.
5. Business fixed investment, inventory investment, housing investment and durable goods consumption are measured as a four-quarter moving average.
6. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Source: Cabinet Office, "National accounts."

(Figure 21)

Household investment to disposable income ratio

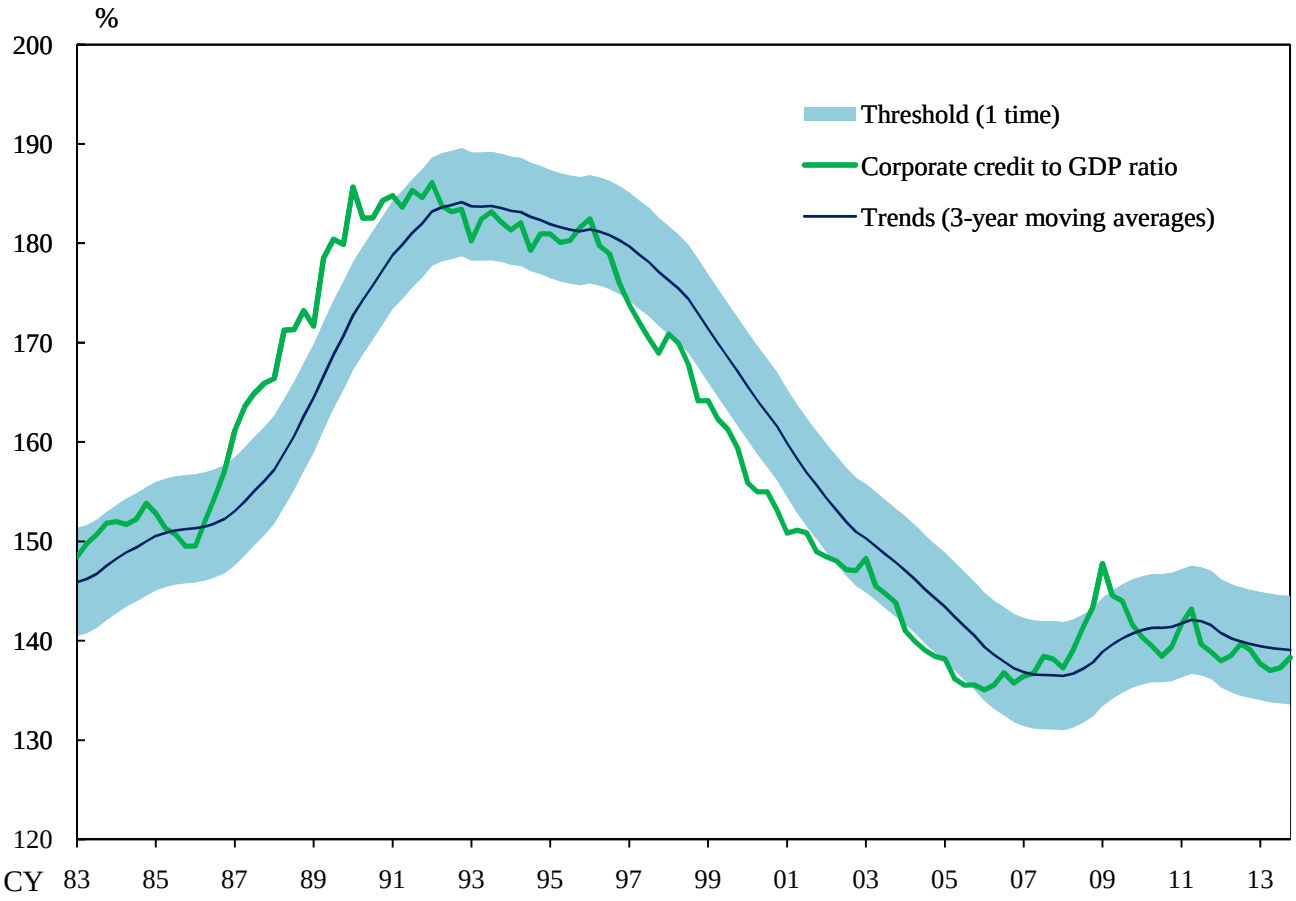


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by (housing investment + durable goods consumption) / disposable income × 100.
3. Housing investment, durable goods consumption, and disposable income from Q1 1980 to Q4 1993 are calculated applying year-on-year rates of changes of CY2000 basis data in those periods. Those figures before Q4 1979 are calculated applying year-on-year rates of changes of 1968 SNA basis data in those periods.
4. Disposable income from Q2 2013 to Q4 2013 are calculated applying year-on-year rates of changes of compensation of employee in those periods.
5. Housing investment, durable goods consumption, and disposable income are measured as a four-quarter moving average.
6. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Source: Cabinet Office, "National accounts."

(Figure 22)

Corporate credit to GDP ratio

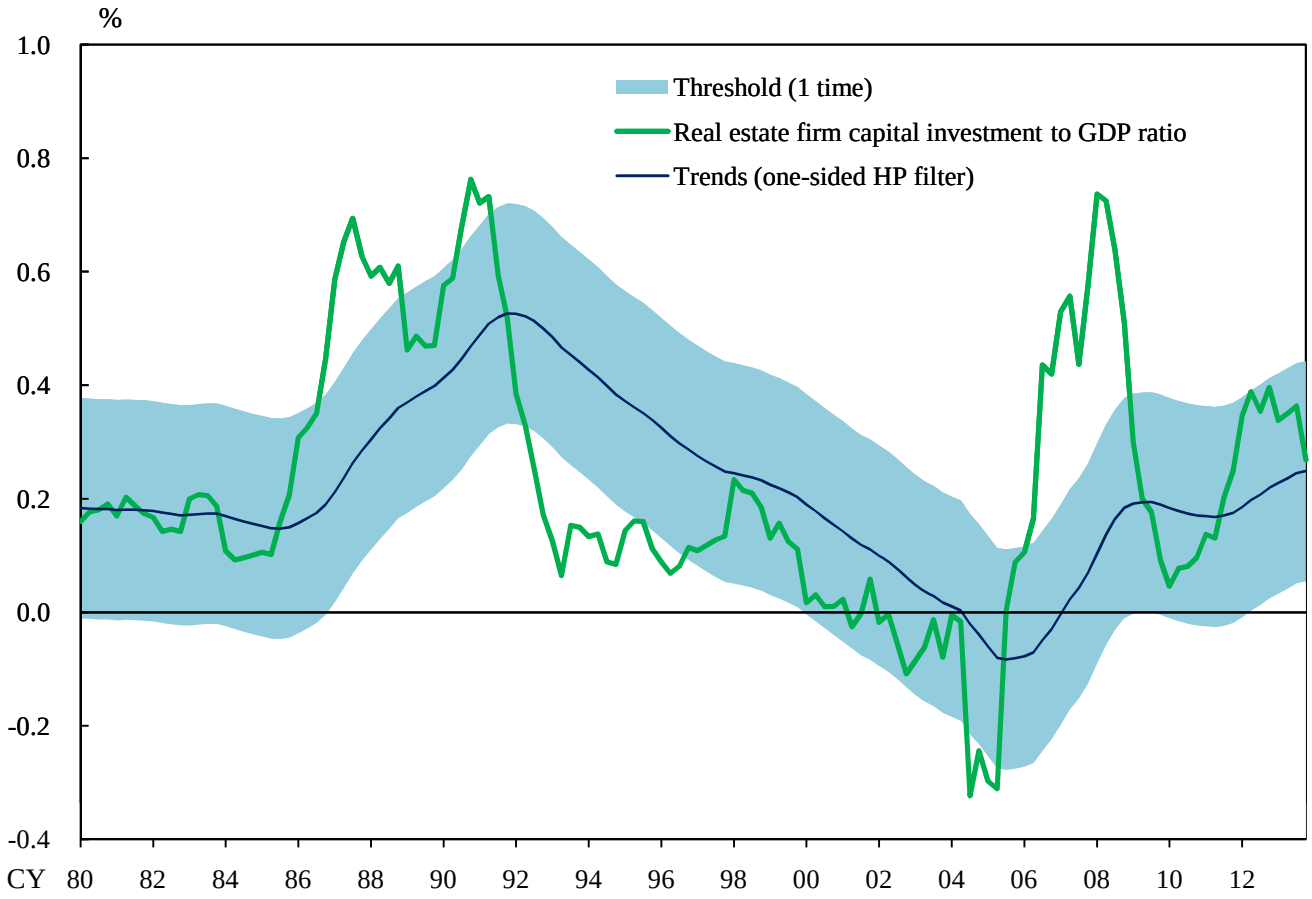


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by the commercial non-financial corporations' financial liabilities (excluding shares and other equities) / nominal GDP × 100.
3. The commercial non-financial corporations' financial liabilities from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the annual data (fiscal year) in those periods.
4. For nominal GDP, see figure 13 Note 3.
5. The commercial non-financial corporations' financial liabilities are measured as a four-quarter moving averages.
6. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National accounts"; Bank of Japan, "Flow of Funds Accounts."

(Figure 23)

Real estate firm investment to GDP ratio

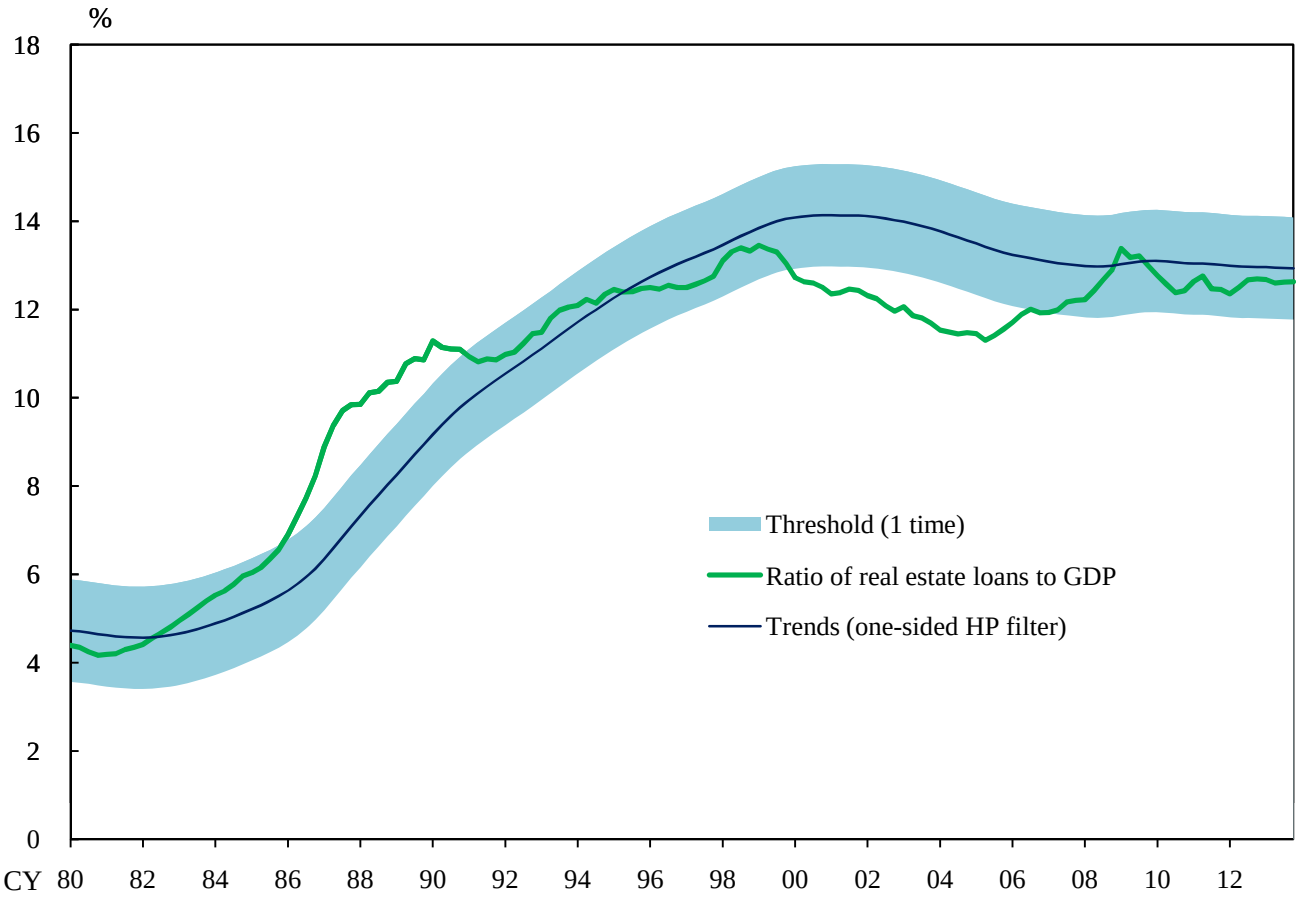


Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by (business fixed investment + land investment + inventory investment) / nominal GDP × 100. Large firms of real estate are counted.
3. Business fixed investment, land investment, and inventory investment are measured as a four-quarter moving average.
4. For nominal GDP, see figure 13 Note 3.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National accounts"; Ministry of Finance, "Financial Statements Statistics of Corporations by Industry."

(Figure 24)

Ratio of real estate loans to GDP



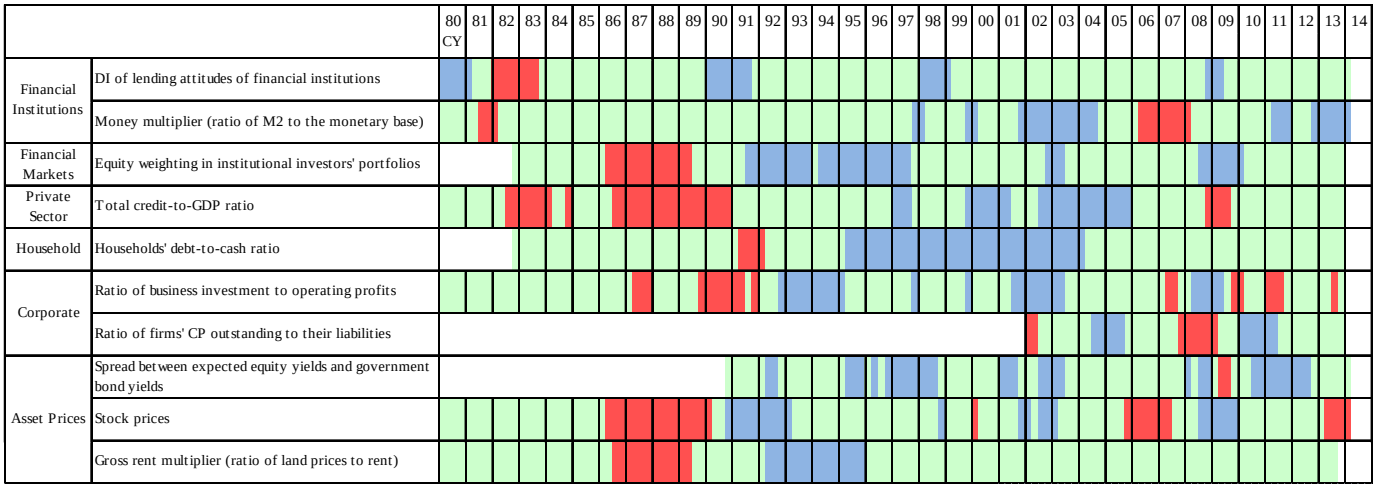
Notes: 1. The latest data are as of the October-December quarter of 2013.
2. The indicator is given by real estate loans of banks / nominal GDP × 100.
3. Real estate loans of banks are measured as a four-quarter moving average.
4. For nominal GDP, see figure 13 Note 3.
5. The financial activity is overheated if the indicator exceeds the shaded area and overcooled if the indicator fall below the shaded area.

Sources: Cabinet Office, "National accounts"; BOJ, "Loans and bills discounted by sector."

(Figure 25)

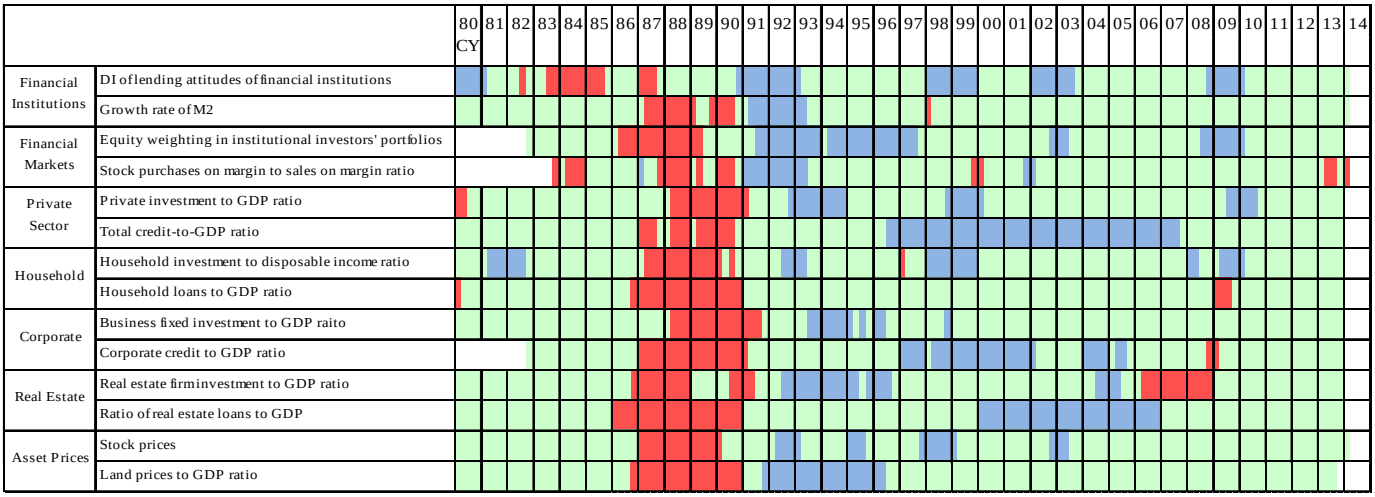
Heat Map of existing FAIXs and new FAIXs

(1) Existing FAIXs



Note: 1. See figure 1 Notes.

(2) New FAIXs



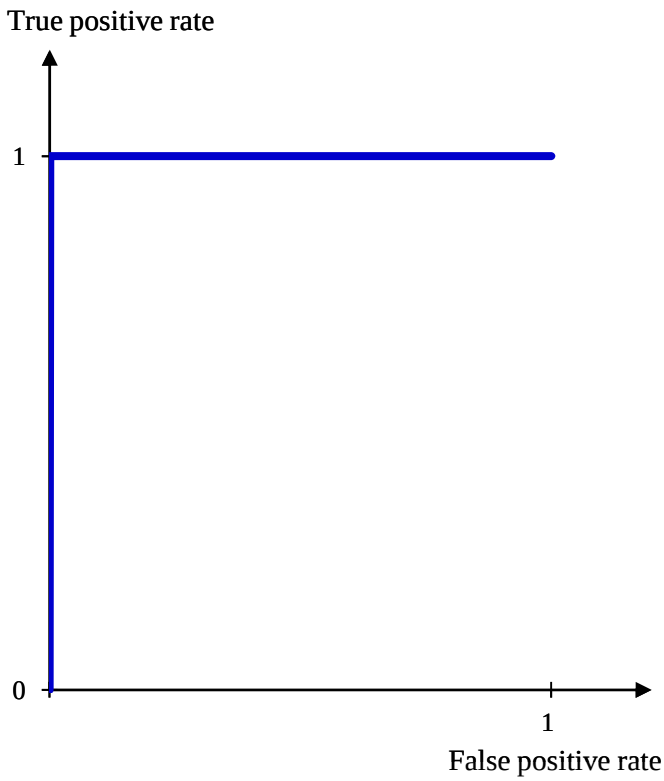
Notes: 1. The latest data for DI of lending attitudes of financial institutions, stock purchases on margin to sales on margin ratio, and stock prices are as of the January-March quarter of 2014. Those for growth rate of M2 are as of the January-February of 2014. Those for land prices to GDP ratio are as of the July-September quarter of 2013. Those for other indicators are as of the October-December quarter of 2013.
2. See figure 1 Note 2 and 3.

Sources: Bloomberg; Cabinet Office, "National accounts"; Japan Post Holdings, "The former Japan Post statistical data"; Japan Real Estate Institute, "Urban land price index"; Ministry of Finance, "Financial statements statistics of corporations by industry, quarterly"; Ministry of Internal Affairs and Communications, "Consumer price index"; Ministry of Postal Services, "Annual statistical report of postal services," "Annual statistical report of postal service administrations"; Thomson Reuters; Tokyo Stock Exchange, "Outstanding margin trading"; BOJ, "Flow of funds accounts," "Loans and bills discounted by sector," "Monetary base," "Money stock," "Tankan."

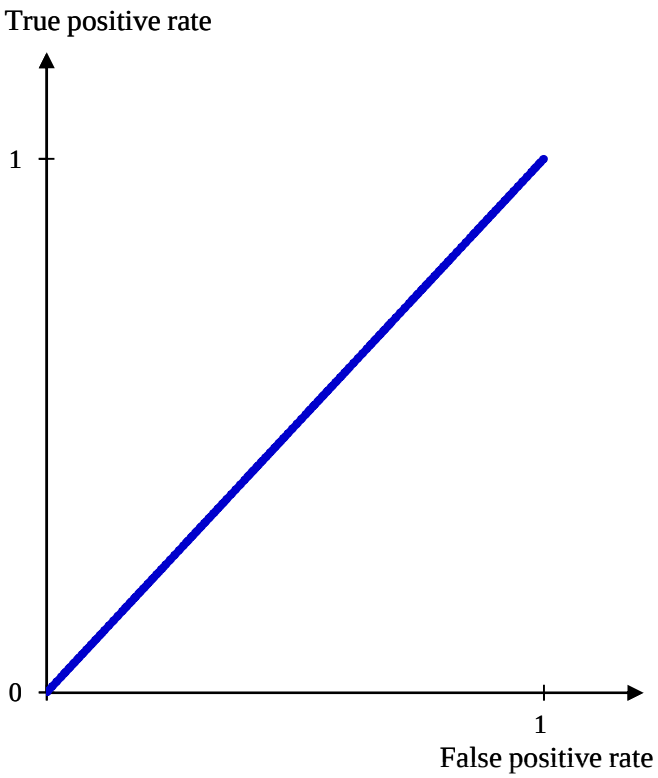
(Figure 26)

Receiver operating characteristics curve (1)

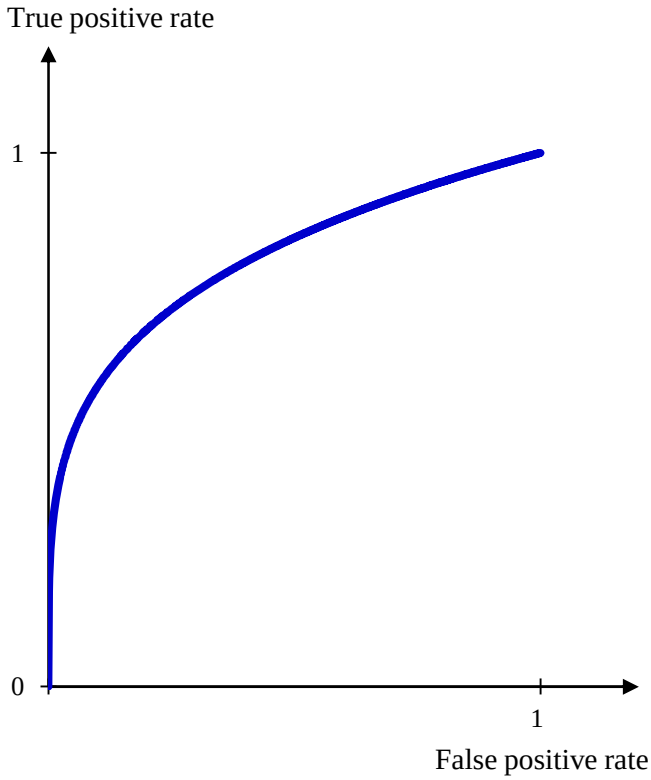
(1) Fully informative signal



(2) Uninformative signal



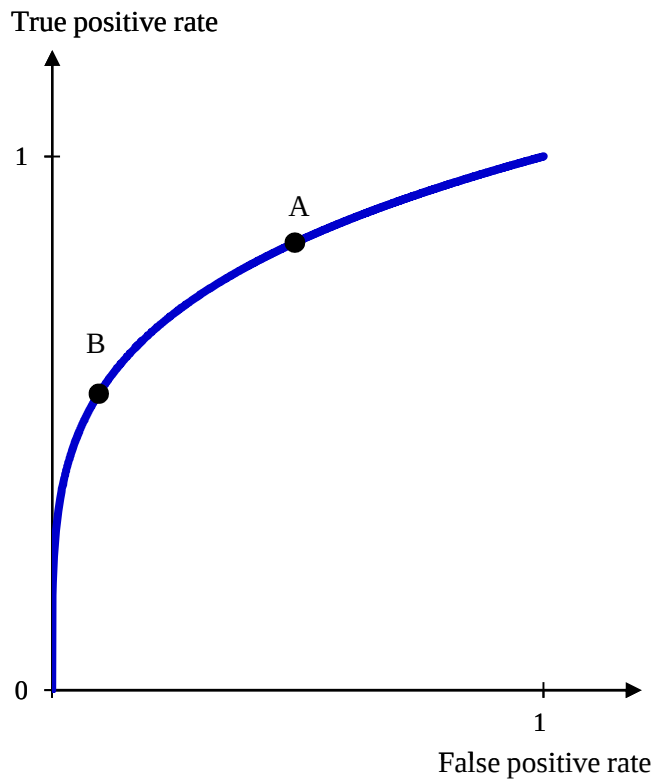
(3) Informative signal



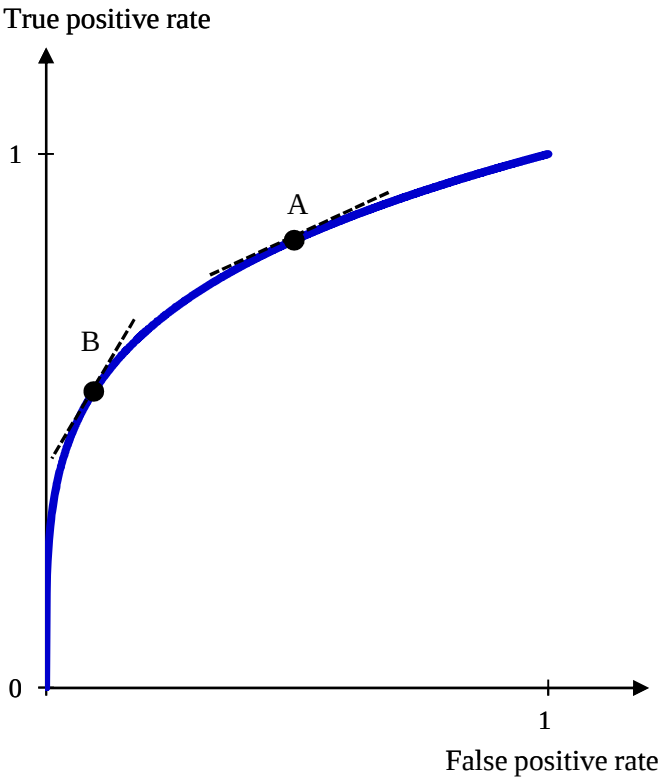
(Figure 27)

Receiver operating characteristics curve (2)

(1) Preference of policy maker



(2) Optimal point



(3) ROC curve of total credit to GDP ratio