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The Financial Activity Index

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THE FINANCIAL ACTIVITY INDEX*

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ABSTRACT

The financial activity index (FAIX) introduced in this paper is a selection of financial indicators that borrow from prior literature on early bubble warnings and are particularly adept at explaining the bubble occurred in Japan starting in the 1980s. Our index comprises 10 financial indicators and is envisioned for use from two main perspectives. First, it is used for a multi-faceted analysis of overheating and overcooling of financial activity through individual indicators in each segment. Second, it is used to monitor from a macroeconomic perspective the dynamics of bubble creation and destruction through an aggregation of the indicators. The index, with these characteristics, should be an effective tool for detecting the accumulation of financial imbalances.

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I. INTRODUCTION

The common element of both the bursting of Japan's Heisei bubble in the 1990s and the collapse of Lehman Brothers in September 2008 was that prior to the crisis, there was an overheating of financial activity, including rising asset prices, expanded credit creation, and an increase in market funding. When overheated financial activity is dramatically rolled back, the subsequent period of low levels of financial intermediation can cause serious losses in both the financial and real economies. Based on this experience, central banks and financial regulators came to broadly share an understanding that constraining sharp swings in financial activity requires knowledge early on of financial overheating to implement preventative measures.

The idea of using financial indicators for early detection of such overheating and implementing measures to prevent a financial and economic crisis is present in much of the prior literature. For example, Minsky (1982) is the seminal work clarifying the substantial adverse impacts on the real economy of financial destabilization, and argues that excessive financial activity can be detected by observing certain financial indicators. More recently, Kaminsky and Reinhart (1999) look at a number of different financial indicators and show that when certain indicators reach a predetermined threshold, a financial crisis is about to occur in the near future. In addition, Kamada and Nasu (2011) devise the Financial Cycle Indexes, an early warning indicator of financial crises based on the traditional theory of business cycles, that combines multiple financial indicators and is tested against financial crises occurred in Japan in the past.

Our index comprises the 10 financial indicators, chosen from among nearly 100 indicators identified in prior literature as being effective in evaluating the degree of overheating in financial activity, that were particularly able to detect in advance the bubble developed in Japan in the 1980s. The financial activity analyzed in this paper includes not only the activity of financial institutions and financial markets, but also that of households and firms. During Japan's Heisei

bubble, for example, financial activity was overheated not only in the financial sector but also in the corporate and household sectors. Furthermore, bubbles and economic boom can take different forms each time they happen, even if their essence is the same. We take this possibility into account when choosing the multiple indicators for each sector. The index can also be used to detect the opposite of overheating, namely the overcooling of financial activity following a crisis or in a recession.

The indicators for the index in this paper are chosen with the bubble that formed in Japan in the 1980s in mind, but most of them are also used by other central banks as well as international institutions. Figure 1 compares the financial indicators examined by these other institutions with those selected for this paper. Of the 10 we use, nine are either the same as or similar to indicators used in reports on the financial system by other central banks and international institutions. Thus the components of the FAIX are widely recognized measures of financial activity.

In addition to being useful for gauging the extent to which a specific financial activity is overheated or overcooled based on the movement of individual indicators, the index is also used to assess the dynamics of overall financial activity from a macro perspective by looking at movement in the entire index. We present here two integrated approaches, our "heat map" to get a picture of the degree to which all of the individual indicators are too hot or too cold, and our "stretch chart," which shows the number of indicators showing overheating or overcooling. When overheating spreads across the financial activity of various sectors, financial activities for the entire economy are overheated and there could easily be a bubble or economic boom that leads to a financial-economic crisis. In addition, when a broad range of financial activity becomes overcooling, a major financial disruption is likely to occur. Many other central banks and international institutions have tried to assess the macroeconomic trend by aggregating individual indicators (see Figure 2 for examples of financial stress indices they have created).

A critical element when gauging whether financial activity is overheating or overcooling is the time span monitored. In this paper, we try to evaluate financial activity in various aspects by using three different time spans: long-term, medium-term, and short-term. Shortening the time span from long-term to medium-term and then to short-term corresponds roughly with shifting the focus from levels to changes.[1] Hence in addition to assessing the degree of financial overheating or overcooling, i.e., the level, we also assess the speed at which it is heating or cooling.

This paper is organized as follows. In Section II, we outline our criteria for selecting individual indicators, and then define financial overheating and overcooling. In Section III, we explain the individual indicators we selected. In Section IV we aggregate the indicators to show movement in the indicators as a whole and attempt to assess the level of financial activity for the broader economy. It is here that we make our assessment from three different viewpoints: long-term, medium-term, and short-term. In Section V, we present our conclusions. In the appendix, we confirm robustness of the index to real-time estimation problem.

II. CRITERIA FOR SELECTING INDICATORS

(1) Selection criteria

We apply the following two conditions when choosing variables to detect

[1] First, consider the case of setting a very short-term time span of one period. In this case, the extent of overheating each period is compared with that of the previous period. This is the same as looking at the change in heat from one period to the next. Now consider the case of setting a superlong time span of infinite horizon. This would amount to comparing the extent of overheating each period to infinitely long moving averages. A moving average can converge to a given level by lengthening the averaging period. In this case, therefore, looking at the deviation from a moving average is the same as looking at the level of overheating for each period. By the same token, changing the time span for assessing overheating from long-term to short-term corresponds to moving the focus of the assessment from the level to the change.

financial overheating. The first condition is that the indicator has theoretical underpinnings or is recognized as empirically useful in prior literature. For example, Minsky (1982) show that financial instability has large adverse impacts on the real economy via the overheating of financial activity. We have chosen the indicators that Minsky honed in on. It should be noted that we expect such substantiated indicators to explain not only the overheating of financial activity but also its overcooling.

The second condition is that the indicator is able to detect the overheating of financial activity prior to the bursting of Japan's Heisei bubble. We follow Okina et al. (2001) and define the Heisei bubble boom here as lasting from 1987 to 1990, and therefore an indicator must be able to detect the overheating of financial activity prior to 1990 in order to satisfy this condition. We note that some financial market data do not even exist during the Heisei bubble. In this case our selection criterion is that the indicator is able to detect financial overheating prior to Lehman shock (marked by the failure of Lehman Brothers) in 2008.

There is of course a big difference between the Heisei bubble and the Lehman shock in the extent to which domestic financial intermediation became overheated in the run up to the crisis. The Heisei bubble was homegrown in Japan, and financial activity was overheated throughout Japan's economy prior to the bubble bursting. The Lehman shock was a crisis that began in the US and Europe and spread globally, and financial overheating was not broadly present in Japan leading up to the crisis. Nevertheless, with finance having become globalized at a dizzying pace, it would probably be to argue that Japan's financial markets also became overheated in some aspects on the ripple effects of the credit bubble emanating in Europe and the US. With this in mind, we think the Lehman shock is also an event of use for selecting indicators.[2] We

[2] In our analysis, a secondary crisis that occurs in the middle of a large crisis is not included in our second condition for choosing indicators. For example, we did not use the financial system instability that occurred after the Heisei bubble burst as a selection criteria.

note that we do not choose indicators based on their ability to detect financial overcooling.

We chose indicators using the two conditions, but given the possibility that bubbles can develop in various forms, one could argue that all of the indicators that meet the first condition (supported in prior literature) should be used. There were nearly 100 indicators that did so, however (see Supplementary Figure 1), and it would not be realistic to track all of them in detail. We have therefore limited the indicators we track to those that also meet our second condition of being measurable from the Heisei bubble, which has had a serious impact on Japan for a long time (or measurable from Lehman shock).

(2) Defining financial overheating and overcooling

A specific financial activity is overheated when it deviates substantially above its trend, i.e., the stable level of activity shown empirically. This overheated condition is not sustainable, and when it unwinds, the overheating is likely to result in a deep overcooling of both the financial and real economies. In contrast, a specific financial activity is overcooled when it deviates substantially below its trend. This underactive state makes financial and real economic activity inefficient and is likely to cause losses in the sense of benefits foregone.

There is no quantitative consensus, however, on how to determine which conditions merit the overheated or overcooled labels. In some cases, as described in Reinhart and Rogoff (2008) and Haldane (2010), a large increase in an indicator is vaguely defined as an overheating of financial activity without defining any specific criteria for that judgment. Such an approach will inevitably be criticized as arbitrary, however. Kaminsky and Reinhart (1999) assess the level of financial activity by looking at its levels in the crisis relative to "tranquil" times. This does not eliminate the need for arbitrary numbers to

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We think that a major crisis and overcooling occurs after financial intermediations overheat and pass threshold levels. Consequently, even if a crisis reoccurs subsequently, we consider that to be a result of the same overheating episode.

determine whether there is overheating, however.

Meyer and Bomfim (2011) automatically deem financial activity as overheated on a one standard deviation increase in an indicator. This means calling an overheated situation when the deviation from the trend results in a gap of a size that only occurs with a probability of 16%. Following Meyer and Bomfim (2011), we detect overheating when an indicator's deviation from the trend exceeds +1 standard deviation.[3] Likewise, we detect overcooling when an indicator's deviation from the trend exceeds -1 standard deviation.

III. CHARACTERISTICS OF EACH INDICATOR

Using the criteria noted in the previous section, we chose a total of 10 indicators. Of those, nine detect financial overheating prior to the collapse of the Heisei bubble (all but the ratio of short-term marketable securities outstanding to liabilities for corporations without data in that period), and two (stock prices and ratio of short-term marketable securities outstanding to liabilities for corporations) detect financial overheating leading up to the Lehman shock. Only one indicator, stock prices, detects both the Heisei bubble and the Lehman shock. Looking at the number of indicators in each sector, the financial institutions sector has three, the corporate and household sector has three, the financial market sector has two, and other sectors has two. We describe below,

[3] Be aware of two types of errors that can occur when using individual indicators to assess overheating or overcooling. One of these (a Type I error) is that a crisis does not occur even when an indicator signals overheating or overcooling. The other one (a Type II error) is that a crisis does occur when an indicator does not signal overheating or overcooling. For example, Kannan et al. (2009) minimize the impacts from these two types of errors by defining the overheating threshold at a level that minimizes the noise-to-signal ratio. Since our analysis only uses data from Japan, we are unable to use the same method because it would result in an insufficient sample size. Instead, we propose here a method of detecting the occurrence of subsequent crises by selecting indicators that meet two conditions: they are widely recognized in the prior literature as useful in detecting bubbles and financial-economic crises, and multiple indicators show an overheated condition at the same time.

following the literature, why these 10 indicators are able to explain both the overheating of financial activity during a bubble or economic boom and the subsequent overcooling, and then show the actual path of each indicator in Japan.

(1) Indicators for financial institutions

i) *DI of financial institutions' lending attitudes*

According to Rajan (1994), Dell'ariccia and Marquez (2006), and Berger and Udell (2004), a relaxation of banks' lending attitude is induced by an easing of bank credit standards[4] and increase in loans that really should not have been extended, leading to an overheating of real economic activity. In this case, there is likely to be a substantial deterioration in the quality of credit,[5] and when an adverse shock to the economy occurs, corporate default rates sharply increase. In response, the banks excessively tighten their credit standards. Once financing dries up, the lack of credit starts to constrain activity in the real economy, resulting in lost opportunities.

Figure 3 shows the DI of financial institutions' lending attitudes. This indicator rose by one standard deviation during the Heisei bubble boom, signaling that financial intermediation was overheated. It also declined by one standard deviation following the bankruptcy of Sanyo Securities in 1997, indicating that lending had overcooled. Its recent levels indicate neither overheating nor overcooling.

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[4] Factors that lead to a relaxing of lending standards include a short-term view of bank's credit management as shown in Rajan (1994), the easing of information asymmetries between banks as shown in Dell'ariccia and Marquez (2006), and the loss of institutional memory during the collapse of previous booms as shown in Berger and Udell (2004). In addition, Lown and Morgan (2006) explain the expansion of credit on the supply side as an easing of bank credit standards.

[5] The literature on this includes Rajan (1994), Dell'ariccia and Marquez (2006), and Berger and Udell (2004).

ii) ***Ratio of total credit to GDP***

Numerous papers, including Gavin and Hausmann (1996), Kaminsky and Reinhart (1999), Eichengreen and Arteta (2000), and Borio and Lowe (2002), find a relationship between banking crises and a surge in bank credit as a fraction of the real economy. The literature explains this expansion of credit in terms of the supply side as being brought by an easing of bank credit standards.[6] The loosening of credit standards reduces credit quality, and banks' credit costs increase (provisions for loan loss reserves and nonperforming loan disposals increase) when an economic shock hits the banks. Then, the banks tighten their credit standards, resulting in a sharp contraction of credits. The overcooling of credit activity constrains activity in the real economy. Credit expansion can be explained in terms of the demand side by the increased demand for funds brought by an investment boom.[7] Of course, investment booms do not last forever, and when loans subsequently turn bad, activities in the real economy slow down. Thus, demand and supply feed off each other to cause an excessive increase in credit, which leads to a bubble and economic boom, and then eventually to a pronounced overcooling of credit activity under financial-economic crisis.[8]

When measuring growth in credit relative to the real economy, the ratio of total credit to GDP is often used.[9,10] Figure 4 shows the ratio of total credit to

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[6] The literature on this includes Rajan (1994), Dell'ariccia and Marquez (2006), Berger and Udell (2004), and Lown and Morgan (2006).

[7] One example is Gourinchas et al. (2001), which argue that the inflow of funds from overseas triggered by financial liberalization causes a domestic investment boom, which in turn invites an expansion of credit.

[8] For some empirical research in this regard, see Demirgüç-Kunt and Detragiache (1997), Asea and Blomberg(1998), Berger and Udell (2004), Lown and Morgan (2006), and IMF (2011b). This indicator is also used by the Bank of Japan (2011) and the Basel Committee on Banking Supervision (2010) to express the build-up of financial imbalances and as a warning signal for a banking crisis.

[9] Drehmann, et al. (2010) and IMF (2011b) find the ratio of total credit to GDP to be useful for detecting overheated financial activity.

GDP. This indicator rose by more than one standard deviation during the Heisei bubble boom, indicating that credit activity was overheated. The primary reason for this, we think, is that banks became more aggressive in extending loans as land investment increased.[11] Its recent levels indicate neither overheating nor overcooling.

iii) ***Equity weighting in institutional investors' portfolios***[12]

Reinhart and Rogoff (2008), Meyer and Bomfim (2011), and Blanchard (1997) show that financial-economic crises are often preceded by an overheated stock market and large increase in stock prices. This suggests that prior to a crisis, the equity weighting in institutional investors' portfolios is likely to increase. In addition, Sharpe (1964) and Campbell et al. (2001) show that stock prices are highly sensitive to macroeconomic shocks,[13] implying sharp drop in the event of an adverse shock to the economy.[14] Consequently, an excessive rise in equity

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[10] In addition to reports from the BIS and IMF, the financial stability reports from a number of countries (Japan, Canada, the EU, and Hong Kong) quantify the degree of overheating based on the deviation of the ratio of total credit to GDP from its long-term trend. In many cases, a variable trend based on an HP filter (with a smoothing parameter of 400,000) is used as the long-term trend. As we do with the other variables, however, in our analysis we assess the level directly.

[11] Okina et al. (2001) cites long-term monetary easing as another factor.

[12] The institutional investor means insurance companies, pension funds, and securities investment trusts.

[13] The CAPM from Sharpe (1964) uses the sensitivity (beta) of an asset's excess return to the market portfolio's excess return to represent risk. This is because the higher an asset's beta (the riskier the asset), the more its price reacts to changes in the value of the market portfolio caused by a macroeconomic shock. In addition, Campbell et al. (2001) show that stock price volatility increases during recessions when stock prices are falling using US stock market data. Kyle and Xiong (2001) show that the increase in investor risk avoidance brought by falling asset prices amplifies the downward shock to asset prices via portfolio rebalancing (wealth effects).

[14] Basel II rules also treat stock investments as higher risk than normal credit. When calculating credit risk assets, loans to nonfinancial corporations are given a maximum risk weight of 150%, while stock holdings (except in the bank account and for strategic holdings) are assigned a minimum risk weight of 200%. For details, see Basel Committee on

weightings within securities portfolios increases vulnerability of the financial condition of institutional investors and raises the probability of a financial-economic crisis. If a crisis occurs at that point, institutional investors become more risk-averse, including a dramatic unwinding of positions and an excessive reduction of financial activity. Under these conditions, the allocation of funds through the stock market freezes up, and economic activity is greatly hindered.

Figure 5 shows the equity weighting in institutional investors' portfolios. This indicator rose by more than one standard deviation during the Heisei bubble boom, indicating overheated financial activity, caused by institutional investors more aggressively investing in stocks. It has recently declined by more than one standard deviation, indicating the overcooling of stock investing by institutional investors.

(2) Indicators for corporate and household

i) *Ratio of business investments to operating profits*

Minsky (1982) argues that if firms ride the bubble and increase their borrowings,[15] the amount of their business investments financed externally rises excessively, resulting in huge debt payments which weaken the firm's financial condition and increase the likelihood of financial destabilization. If an adverse economic shock occurs under these conditions, corporate creditworthiness weakens as a result of deteriorating profits, causing overcooling of external funding activity. This causes firms to reduce their investments and production activities, including slows down of real economic activity. When actually using this indicator, we follow Minsky (1982) and capture firms' reliance on external financing for business investment using the ratio of business investments to operating profits.

Banking Supervision (2006).

[15] Okina et al. (2001) report that business investment grew excessively during the Heisei bubble boom.

Figure 6 shows the ratio of business investments to operating profits. This indicator rose by more than one standard deviation during the Heisei bubble boom, indicating that firms' external financing activity was overheated. This indicator declined by more than one standard deviation from the 2002 until 2005 and also following the Lehman shock, indicating overcooling in firms' external financing activity. Its recent levels indicate neither overheating nor overcooling.

ii) ***Ratio of firms' short-term marketable securities outstanding to their liabilities***

Minsky (1982) argues that when expected profits increase during a bubble, firms become reliant on commercial paper and other short-term funding markets in order to expand their business. This increases market refinance risk, and financially weakens the firm. Thus, an excessive increase in the ratio of firms' short-term marketable securities outstanding to their liabilities increases the likelihood that a financial-economic crisis occurs. During the dramatic unwinding of positions following the crisis, an increase in bankruptcies and declining creditworthiness makes it difficult for firms to obtain external financing. When it becomes difficult to get short-term funding from the market, corporate activity is constrained, which in turn dampens activity in the real economy. Meanwhile, interest costs associated with such alternative funding measures as medium- and long-term corporate bonds and bank loans also increase, creating a further drag on real economic activity.

Figure 7 shows the ratio of firms' short-term marketable securities outstanding to their liabilities.[16] This indicator rose by more than one standard

[16] Minsky (1982) defines short-term marketable securities as the sum of CP and banker acceptances. Japan does not keep data on bankers' acceptances, however, and therefore when applying this indicator to Japanese data, we count only commercial paper as short-term marketable securities. For total liabilities, we use financial liabilities (excluding stock and other equity stakes). The sample period begins in Q3 1998, because the CP issuance market was completely liberalized in June 1998.

deviation prior to the Lehman shock.[17] We attribute this to firms' increased short-term funding using CP offering a rate of interest lower than long-term bank loans. This indicator declined by more than one standard deviation around 2000 and again from 2005 until 2007, indicating overcooling in firms' short-term market funding activity. Its recent levels indicate neither overheating nor overcooling.

iii) ***Households' debt-to-cash ratio***

Minsky (1982) shows that households' debt-to-cash ratio is a useful indicator of households' ability to repay debt. If asset prices rise during a speculative boom, constraints on household borrowing are eased, and the ratio of debt to on-hand liquidity (demand deposits + cash) rises. This results in households' ability to repay becoming vulnerable to a cash flow shock. When incomes worsen during the post-crisis unwinding, household borrowings shrink. In addition, amid uneasiness over employment, households have increased incentives to hoard on-hand liquidity, which constrains households' spendings and causes real economic activity to stagnate.

Figure 8 shows the households' debt-to-cash ratio.[18] This indicator rose by substantially more than one standard deviation during the Heisei bubble boom, indicating that households' borrowing activities were overheated. Since 2002, this indicator has declined by more than one standard deviation, showing a overcooling of households' borrowing activities and an increase in their cash holdings relative to debt.[19]

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[17] Be aware that the increase in the Bank of Japan's CP operations raised the indicator from Q4 2008.

[18] When applying this indicator to Japan, we follow Minsky (1982) and use financial liabilities from the Flow of Funds Accounts Statistics as a proxy variable for liabilities paid in cash.

[19] The Financial System Report (2011) from the BOJ finds that the increase in deposits can be attributed to the rapid aging of Japan's population.

(3) Indicators for financial markets

i) *Stock prices*

Reinhart and Rogoff (2008) use historical data to show that stock prices present a useful warning signal for a financial crisis.[20] Meyer and Bomfim (2011) also find stock prices a useful indicator for warning of an asset bubble. This view is supported by economic theory. Blanchard (1997), for example, shows that a large rise in stock prices is caused by overestimation of enterprise values and the divergence of stock prices from enterprise values brought by speculative investments. When the speculative boom ends, the stock prices drop to a level commensurate with enterprise values or to a level below those, and this has the potential to trigger a serious recession. An excessive decline in stock prices causes a retreat from investing in stocks and inhibits the flow of funds into corporations, thereby slowing down activity in the real economy.

Figure 9 shows the stock prices. This indicator rose by more than one standard deviation during the Heisei bubble boom, indicating that stock investing was overheated. It also rose by more than one standard deviation prior to the Lehman shock. Its recent levels indicate neither overheating nor overcooling.

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

Meyer and Bomfim (2011) find empirical evidence for using the spread between the inverse of the forward-looking P/E ratios (expected equity yield) and the government bond yields as an indicator of overheated trading in risk asset markets. This indicator expresses the safety of stock holdings relative to government bonds, and indicates the degree of optimism (risk tolerance) in the market. Accordingly, when the indicator turns negative, there is a high

[20] Haldane (2010) uses cumulative excess returns on stocks (the difference in cumulative returns between financial stocks and a whole market index) during the global financial crisis to analyze whether the stock market was appropriately valuing the increased productivity of the financial sector resulting from the development of financial instruments.

probability that a bubble has developed.[21] After the crisis, the market becomes excessively risk-averse, investments in risk assets decline, and activity in the real economy stagnates.

Figure 10 shows the Spread between expected equity yields and government bond yields (the difference between the inverse of the forward-looking P/E ratio and the 10-year JGB yield) on an inverted scale. This indicator rose by more than one standard deviation in 1988, during the Heisei bubble boom, indicating an overheating of investments in risk assets (stocks) relative to investments in safe assets. It has declined by more than one standard deviation often since 2003, indicating a reduction in investments in risk assets (stocks) relative to safe assets.

(4) Indicators for other sectors

i) *Gross rent multiplier (ratio of land prices to rent)*[22]

Both Reinhart and Rogoff (2008) and Meyer and Bomfim (2008) argue that empirical evidence shows real estate prices to be a useful indicator for warning of an asset bubble.[23,24] They note that there are two mechanisms enhancing real estate transactions behind an excessive rise in real estate prices. The first is a feedback loop whereby the increase in collateral values brought by rising real estate prices relaxes constraints on borrowings, which in turn causes collateral

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[21] There is nothing new about the idea that excessive market optimism causes both trading prices and trading volume to move too high and leads to the formulation of a bubble (see, for example, Blanchard (1997)).

[22] This follows the gross rent multiplier in Wendt and Wong (1965).

[23] Reinhart and Rogoff (2008) use real housing prices as an indicator. In contrast, Meyer and Bomfim (2011), as well as the IMF and FSB (2010) construct a warning index using the ratio of both real and nominal housing prices to rent.

[24] There is also an argument to be made that a rise in land prices by itself is a bubble. Against this logic, an index was created using land prices in Tokyo area, which tend to increase prior to other land prices.

values to rise further thanks to the consequent economic expansion.[25] The second is another feedback loop in which the increase in real estate prices leads to investment in those assets, which in turn causes real estate prices to rise further.[26] These feedback loops can quickly be put into reverse by an adverse shock, however. Regardless of which mechanism is at work, a large drop in real estate prices results in a slowdown of financial and economic activity.

Figure 11 shows the gross rent multiplier. This indicator rose by more than one standard deviation in 1987 during the Heisei bubble boom, showing an overheating of real estate transactions. This indicator peaked at an all-time high in 1990, and has been declining during the long period since then. Its recent levels indicate neither overheating nor overcooling.

ii) ***Money multiplier (ratio of M2 to the monetary base)***

Calvo and Mendoza (1996), Kaminsky and Reinhart (1999), and Okina et al. (2001) focus on how an expansion of the money supply has been associated with banking crises and Japan's Heisei bubble. Kaminsky and Reinhart (1999), in particular, propose monitoring the money multiplier as one way to detect the overheating of financial intermediation activity.[27] This is because excess credit creation can be attributed to liquidity demand brought by too much monetary easing and excessive spending. In addition, when positions are unwound after the crisis, the money multiplier drops excessively, causing financial intermediation activity to overcool.

Figure 12 shows the money multiplier. This indicator rose by more than one standard deviation during the Heisei bubble boom, indicating that financial

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[25] For details, see Kiyotaki and Moore (1997).

[26] Allen and Gale (2000) insist that investors being able to go default have an incentive to invest funds borrowed from banks into risk assets, and this incentive accelerates the rise in asset prices (the risk-shifting problem), resulting in a major increase in the price of real estate and other risk assets, which in turn causes banks to greatly expand their lending.

[27] For example, Calvo (1996), Calvo and Mendoza (1996), and Kaminsky and Reinhart (1999) use foreign exchange reserves to normalize M2.

intermediation activity was overheated. It also declined by more than one standard deviation from 2002, indicating a overcooling of financial intermediation activity.[28]

IV. Overall assessment of financial activities in Japan

The index is one potential benchmark for assessing the degree of financial overheating from a macroeconomic perspective. Doing so would require using the individual indicators introduced in the previous section to make an overall assessment of macro financial activity. In this paper we propose two different approaches to aggregation, one using a heat map to see the extent of overheating/overcooling of all of the individual indicators at once, and the other using a stretch chart, which counts the number of indicators that show overheating and the number that show overcooling. The heat map is aimed at clarifying which sectors of the macroeconomy are overheated and which are overcooled. The stretch chart looks at the extent to which financial overheating or overcooling has spread through the entire economy. When overheating is widely observed across the financial activity of various sectors, financial activities for the entire economy are overheated and there could easily be a bubble or economic boom that leads to a financial-economic crisis. Likewise, when a broad swath of financial activity becomes overcooled, the macro economy is likely to be in a major financial disruption.

To provide warning of a bubble or economic boom, it is important to assess overheating or overcooling over both an intermediate and short time span, in addition to looking at financial activity over a long time span. In addition, when considering a policy response, it is important to observe the direction of change and the speed at which the economy's temperature is rising or falling. The

[28] Changes in base money are greatly affected by the BOJ's policy response. For example, the money multiplier is likely to have declined substantially under a policy of quantitative easing, and this must be kept in mind when interpreting results.

reason for this is that policies can be implemented in response to the direction, and prevent a subsequent overheating or overcooling. In this regard, it must be remembered that shortening the time span from long-term to medium-term and then to short-term corresponds roughly with changing the focus from levels to changes. Therefore, by making the assessment based on different time spans, it effectively becomes possible to assess both the financial temperature and its direction of change.

(1) Assessments from a long-term perspective

Figure 13, named as a heat map, shows for each one of the individual indicators at which point they are overheated and at which point they are overcooled from Q1 1980 until Q3 2011. The horizontal axis shows the direction of the time series, the red portion (the most deeply shaded) shows a rise of indicator by more than one standard deviation, the blue portion (the second most deeply shaded) shows a decline by more than one standard deviation, and the green portion (the most lightly shaded) shows everything in between (periods without data shown as white). The map shows that financial overheating from the mid- to the late-1980s started with financial institutions and other sectors, and then spread to financial markets and the corporate and household sectors. Right before the collapse of the Heisei bubble, financial activity was overheated in all sectors of the Japanese economy. Note that leading up to the Lehman shock, the financial market-related indicators, namely stock prices and the ratio of short-term marketable securities outstanding to liabilities, showed overheating. Every sector had an indicator that showed financial activity overcooling from 2000.

Figure 14 is a stretch chart showing the number of financial indicators within the index indicating overheating or overcooling.[29] The vertical axis represents the time series, with the number of indicators showing overheating

[29] When using an indicator as a warning of a bubble or economic boom, it is necessary to confirm the degree of real-time estimation problem. See the Appendix regarding the robustness of the index to real-time estimation problem.

on the right side and the number showing overcooling on the left. The number of indicators showing overheating started increasing in the mid-1980s, rising to seven and eight by the early 1990s, right before the bubble collapsed, suggesting that financial activity was overheated throughout the economy. The number of overheat signals averaged 6.5 during the Heisei bubble boom (1987 to 1990), and then started declining in 1992 after the bubble collapsed, reaching zero at the end of the 1990s, by which point there was no overheated financial activity in any sector of the economy. In the early 2000s, one indicator signaled overheating. Prior to the Lehman shock, two of the market-related indicators showed overheated financial activity, albeit not at the same time, indicating that financial activity was overheated in certain sectors of the economy. There has been no such indication of overheating recently.

The number of indicators showing overcooling began rising in the late-1990s, and reached a maximum of six in the mid-2000s. Then, the number started declining, dropping to two immediately prior to the Lehman shock. The number of overcooling signals resumed rising after Lehman's shock, and rose as high as five. Recently, financial activity has undergone a broad overcooling. Given that it takes time for an individual indicator to diverge substantially on the upside after having done so on the downside, the number of overcooled indicators can be interpreted as breathing room until financial activity starts overheating. This suggests that there is ample leeway before the broader economy starts to overheat in the future.

(2) Assessments from a short- to medium-term perspective

In this paper, we calculate a deviation of each indicator from the three-year moving average to ascertain the level of financial activity over a short time span, and calculate that from the eight-year moving average to do so over an intermediate time span.[30] This allows us to see whether there has really been a

[30] Assessing indicator based on its divergence from the variable trend of 8-year average evaluates change relative to the 6-12-year Juglar cycle. We do not report on indicators that do not have a data period that exceeds five years. In addition, assessing indicator based on

sharp change toward either overheating or overcooling beyond short- to medium-term fluctuations,[31] and to speculate as to the direction of financial activity over the short- to medium-term.

Figure 15 shows a heat map, and Figure 16 a stretch chart, assessing the degree to which there is too much or too little financial activity over a medium-length time span. Both seem to capture financial overheating and overcooling at an earlier stage than do Figures 13 and 14, specifically for the development of the Heisei bubble in the 1980s, its collapse in the 1990s, the financial system instability in the late 1990s, and the boom leading up to the Lehman shock in 2008. The medium-term graphs (Figures 15 and 16), however, show that overcooling signals have largely disappeared recently, which does not seem right. Given the difficult business environment for financial institutions, the stronger degree of overcooling shown in the long-term graphs (Figures 13 and 14) seems to be closer to reality.

Figure 17 is a heat map and Figure 18 is a stretch chart, showing the extent to which activity was too high or too low over a short time span. These graphs appear to capture the direction of movement a bit earlier than do the medium-term graphs (Figures 15 and 16), although the difference is not that much. On the other hand, because individual indicators are more sensitive to moves in both directions, they showed an overheating for a larger number of indicators, particularly prior to the Lehman shock, and also detected more overcooling after the crisis. Thus, the different time spans have their strengths and

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its divergence from the variable trend of 3-year average evaluates change relative to the 3-4-year Kitchin cycle.

[31] Our level assessment of index thus far does not take account of structural changes in the economy. One would naturally expect the economic structure to be constantly changing over the long term, however. For example, much of the prior literature on the ratio of total credit to GDP ratio evaluate it based on its divergence from the trend to omits the impact from structural changes (such as financial deepening and the implementation of Basel rules). Our method here of grading financial activity based on divergence from its 3-year or 8-year average is one way to remove this trend and thereby take into account structural changes in the economy.

weaknesses, making it desirable to leverage the strengths of each when assessing the financial temperature.

V. CONCLUSIONS

The FAIX selects multiple financial indicators in order to get a broader picture of the degree to which financial activity is overheated or overcooled. Of the financial indicators found to provide a useful warning of bubbles and economic boom in the former studies, we chose for our index those that detected overheating in a broad range of sectors during the Heisei bubble boom as well as those that detected overheating in certain sectors of financial activity leading up to the Lehman shock.

With many indicators signaling overheating during the Heisei bubble boom, an overall assessment based on the index suggests that overheating spread from financial institutions and other sectors to financial markets, firms, and households. For Lehmen shock, however, financial overheating was limited to certain sectors of the broader economy. Since 2000, financial activity as a whole has been on the cool side, with no sign of enough overactivity to create a bubble.

Take note, however, that this overall assessment was made on the assumption that each variable is weighted equally. A different overall assessment could possibly result if certain indicators were assigned greater importance than others. It would also be possible to arrive at a different overall assessment by changing the time span looked at for each variable.

We would like to conclude by noting two caveats to keep in mind when using the FAIX. First, there is no established method for measuring macro risk on the financial side. Accordingly, when looking for warnings of a bubble or financial-economic crisis, or when assessing the degree to which financial imbalances have built up, it is necessary to make a multi-faceted analysis using multiple indicators and indexes, including the index outlined in this report. Second, bubbles and economic boom follow a different path each time. Other

useful indicators are likely to be found, particularly when a new financial-economic crisis breaks out. Accordingly, it is important not to be satisfied with only the indicators we chose this time, but rather we constantly need to look for new indicators.

APPENDIX: ROBUSTNESS TO REAL-TIME ESTIMATION PROBLEM

For the index to provide a useful warning of the bubbles and economic boom that can lead to a financial-economic crisis, it is important that the sample period include at least one full cycle for event. If not, it is impossible to accurately determine the standard deviation when assessing overheating or overcooling. This is why we measure the degree of financial overheating and overcooling by calculating the standard deviation using all samples up to the recent past.

Conversely, when a cycle of an event is not included in the sample period, or when the sample size is insufficient, the index-based overheating/overcooling assessment may be different from that made after the sample is increased. This difference is the real-time estimation problem.[32] When using an indicator as a warning of a bubble or economic boom, the degree of real-time estimation problem is an important determinant of that indicator's usefulness. With this in mind, we check the past performance of the FAIX by assessing the degree of real-time estimation problem made at end-1990, right before the Heisei bubble collapse, and at end-2007, prior to the Lehmen shock, by comparing them with recent data.

Supplementary Figure 2 is a stretch chart showing overheating and overcooling constructed using samples taken up until end-1990, right before the bubble collapsed. In 1990, on average 88% of the indicators signaled overheating, which is hardly unchanged from the result of on average 86% using a sample taken up until Q3 2011.

Supplementary Figure 3 is a stretch chart constructed using a sample taken

[32] The real-time estimates problem stems from the revision of data, changes in the statistical characteristics (including standard deviation, mean, and trend) of the data as data is accumulated, and the lag of data release (for more on these arguments, see Orphanides and van Norden (2002) and Clark and Kozicki (2005)). The analysis in this paper is most affected by the second of these problems, i.e., changes in the standard deviation and mean from adding samples.

up until end-2007, just before the Lehmen shock. The number of the indicators with overheat signal in 2007 averaged 5%, the same as in a sample taken until Q3 2011, in part thanks to the increase in the sample period. With the sample that goes until end-2007, on average 33% of the indicators signaled overcooling in 2007. This contrasts with 25% signaling overcooling in the sample until Q3 2011, and thus the real-time assessment showed somewhat less stretched overcooling.

Therefore, there has not been a major real-time estimation problem for the index. In addition, because the length of the sample period has recently reached 120 quarters, we do not expect much change in the criteria for assessing overheating/overcooling from the recent ones, and real-time estimation problem will be minimal.

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(Figure 1)

Financial indicators examined by other central banks and international institutions

Sector	Indicator	ECB	Deutsche Bundesbank	Bank of Canada	Hong Kong Monetary Authority	BOE	Banque de France	Banca d'Italia	De Nederlandsche Bank	Swiss National Bank	IMF	BIS	FSOC
Financial Institutions	DI of financial institutions' lending attitudes	○	○						○			○	
	Ratio of total credit to GDP	○		○	○	○			○	Commercial real estate loans / GDP	○	○	
	Equity weighting in institutional investors' portfolios	The amount of equity investments				Risk appetite			The amount of equity investments				
Corporations / Households	Raio of business investments to operating profits	Interest payments / Operating surplus	Interest payments / Operating surplus			Interest payments / Operating surplus			Interest payments / Operating surplus				
	Ratio of firms' short-term marketable securities outstanding to their liabilities												
	Households' debt-to-cash ratio	○	Interest payments / Income	Interest payments / Income		Interest payments / Income							Interest payments / Income
Financial Markets	Stock prices	○	○	○	○	○	○	○	○	○	○	○	○
	Spread between expected equity yields and government bod yields	○			PER		PER		PER	PER	PER	PER	
Others	Gross rent multiplier (ratio of land prices to rent)	House prices / Rent	Real estate prices	House prices / Income	House prices / Income	Real estate prices / Rent		House prices / Rent	House prices		Residential real estate prices / Rent	Real property prices	Residential real estate prices / Rent
	Money multiplier (ratio of M2 to the monetary base)				M2								

Notes: *1.* ○ means the same indicator. Variable means a similar rathar than the same indicator.
2. Risk appetite (BOE) is calculated by equity weighting in institutional investors' portfolios and other variables.
3. This list is based on reports for financial system in the last four years.

Sources: Reports for financial system. For details, see reference.

(Figure 2)

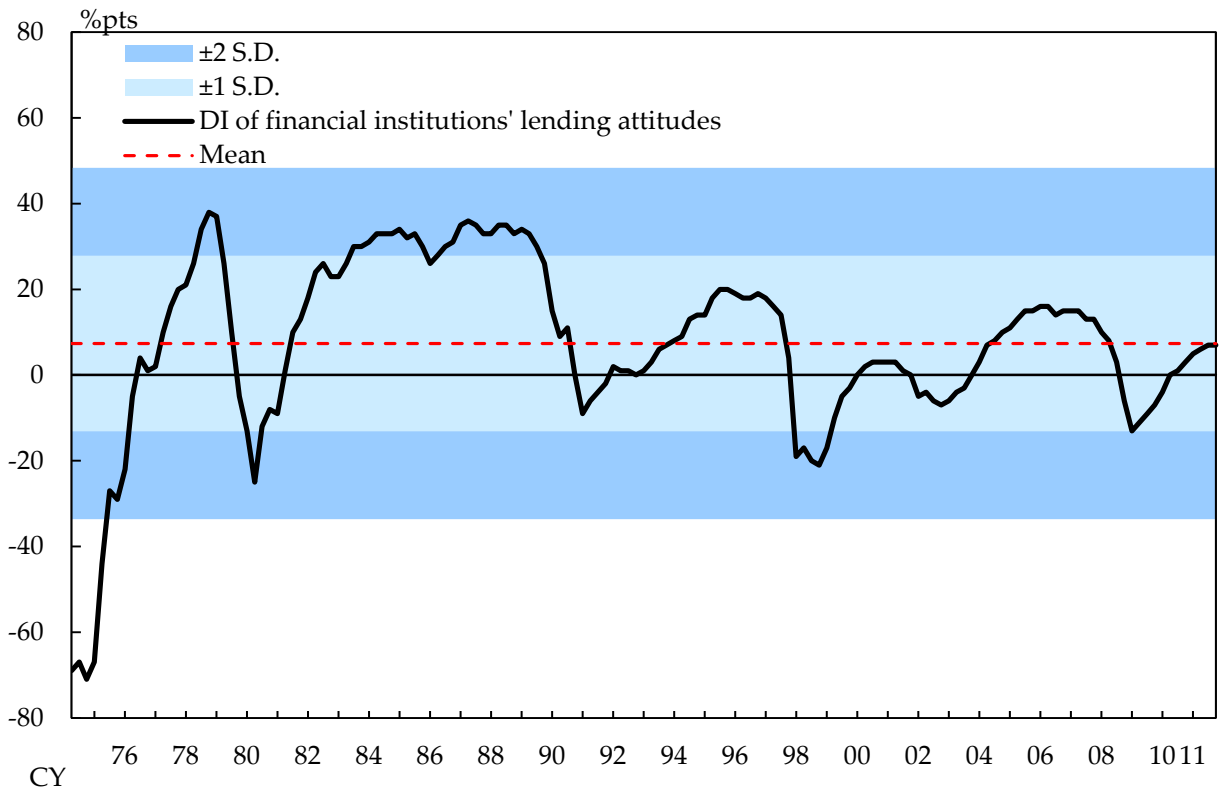
Financial stress indices of other central banks and international institutions

Entity	Indicator	Source	Summary
FRB	Cleveland Financial Stress Index (CFSI)	Oet et al. (2011)	Uses 11 indicators, including beta, bank bond spreads, liquidity spreads, and yield curve spreads, weighted by credit aggregates.
FRB	Systemic Assessment of Financial Environment Early warning system (SAFE EWS)	Oet et al. (2011)	Calculated using regression analysis based on returns, risk, liquidity, and indicators of structural imbalances.
FRB	Kansas City Financial Stress Index (KCFSI)	Hakkio and Keeton (2009)	Uses principal component analysis to create an index based on 11 variables, including the TED spread, bond spreads, stock price volatility, and the correlation between stock and Treasury returns.
ECB	Composite Indicator of Systemic Stress (CISS)	Holló et al. (2011)	Measures stress for five financial segments— money markets, bonds, stocks, the Forex market and financial intermediaries—from volatility, cumulative valuation losses, and risk spreads, using a weighting based on cross-correlations.
ECB	Macro-financial vulnerability index	Duca and Peltonen (2011)	Uses a logit model to create an index of such indicators as domestic and overseas GDP, credit-to-GDP ratio, P/E ratio, balance of payments, and outstanding government debt.
ECB	Credit risk deviation early warning indicator (CBI)	Schwaab et al. (2011)	Looks at the deviation between credit risk in the macro economy and the credit risk of financial institutions.
ECB	Financial stress indicator	Grimaldi (2010)	Uses a logit model to create an index of 16 indicators, including bond spreads, bank stock prices, the Euribor/EONIA spread, and stock price volatility.
ECB	Quasi "real time" early warning indicators	Alessi and Detken (2011)	Looks at a total of 18 indicators, including such real economy variables as GDP, consumption, and housing investment and such financial variables as CPI-deflated equity and housing prices, bond yields, interest rates, real effective exchange rates, M3, and credit.
ECB	Macro prudential indicators (MPI)	Mörttinen et al. (2005)	Looks at indicators related to profitability, balance sheet quality, capital adequacy, money demand, risk concentrations, market valuation of banks, financial fragility, asset prices, cyclical and monetary conditions, and interbank markets.
ECB	Early warnings system	Bussiere and Fratzscher (2002)	Uses a logit model to create an index of six indicators: real effective exchange rates, balance of payments, short-term debt to foreign exchange reserves, GDP growth rate, domestic credit, and financial interdependency.
Bank of Canada	Financial stress index	Illing and Liu (2006)	Weighted average, based on market size, of bond and CP spreads, beta of financial institution stock price returns, and other indicators.
Hong Kong Monetary Authority	Bank stress index	Yu et al. (2006)	An index based on stock prices, stock price volatility, debt, and the risk-free rate.
Hong Kong Monetary Authority	Early warnings systems	Wong et al. (2010)	An index of 15 indicators, including real economic variables (the true real estate price gap, per capita real GDP) and financial variables (real stock price gap, private sector credit-to-GDP ratio).
Banca d'Italia	Banking stability index (BSI)	Banca d'Italia (2010)	The joint probability of the number of banks that will become distressed if one bank out of a universe of 10 major banking groups becomes distressed.
Swiss National Bank	Banking stress index	Hanschel and Monnin (2005)	An index that comprises a bank stock price index, bank bond spreads, total interbank deposits, return on bank assets , bank capital, bank provision rate, the stock of banks under special scrutiny by regulators, and the number of bank branches.
De Nederlandsche Bank	Financial stress index	Slingenberg and Haan (2011)	A total of five normalized indicators: bank stock price volatility, bond spreads, TED spread, bank stock price beta, and volatility of the nominal effective exchange rate.
De Nederlandsche Bank	Financial stress index	De Nederlandsche Bank (2011)	A market-weighted average of indicators, including risk premium and volatility for bonds, stocks, exchange rates, other markets related to the banking sector.
IMF	Systemic liquidity risk index (SLRI)	International Monetary Fund (2011)	An index created using principal component analysis from 36 indicators, including bond/CDS, swap, and on-the-run/off-the-run spreads.
IMF	Financial stress index	International Monetary Fund (2008)	An index comprising such indicators as the beta of financial institution stock price returns, TED spreads, bond spreads, stock price returns, and the volatility of effective exchange rates.
IMF	Macroprudential Indicators (MPI)	Evans et al. (2000)	Microprudential indicators related to equity capital and capital quality, as well as macroeconomic indicators related to economic growth, current account balances, inflation rates, interest rates, credit, and asset prices.
IMF	Financial soundness indicators (FSI)	Sundararajan et al. (2002)	Core indicators related to capital, capital quality, profitability, liquidity, and sensitivity to market risk of deposit-taking institutions, as well as such supplementary indicators related to households, firms, and nonbank financial institutions.
BIS	Leading indicators of banking system distress	Borio and Drehmann (2009)	Calculated based on the deviation from trend for the credit-to-GDP ratio, real estate prices, and stock prices.

Sources: Reports for financial system etc. For details, see reference.

(Figure 3)

DI of financial institutions' lending attitudes

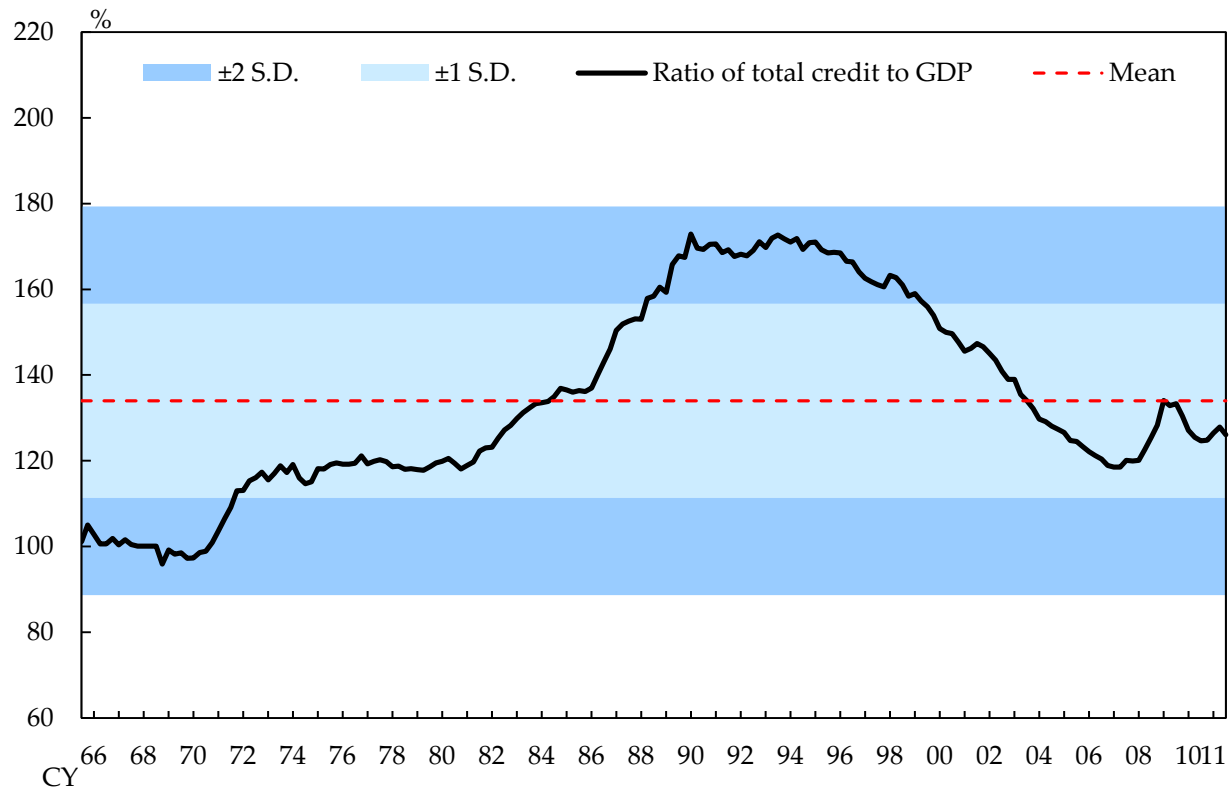


Notes: *1.* Q2 1974 through Q4 2011.
2. Diffusion index of "Accommodative" minus "Severe".

Source: Bank of Japan "*Tankan*".

(Figure 4)

Ratio of total credit to GDP



Notes: *1.* Q3 1965 through Q3 2011.

2. The indicator is given by Total credit / Nominal GDP × 100. Total credit is defined as the sum of the outstanding amout of loan by private financial institutions to non-financial sector (excluding general government) and the outstanding amount of securities investment by private financial institutions.

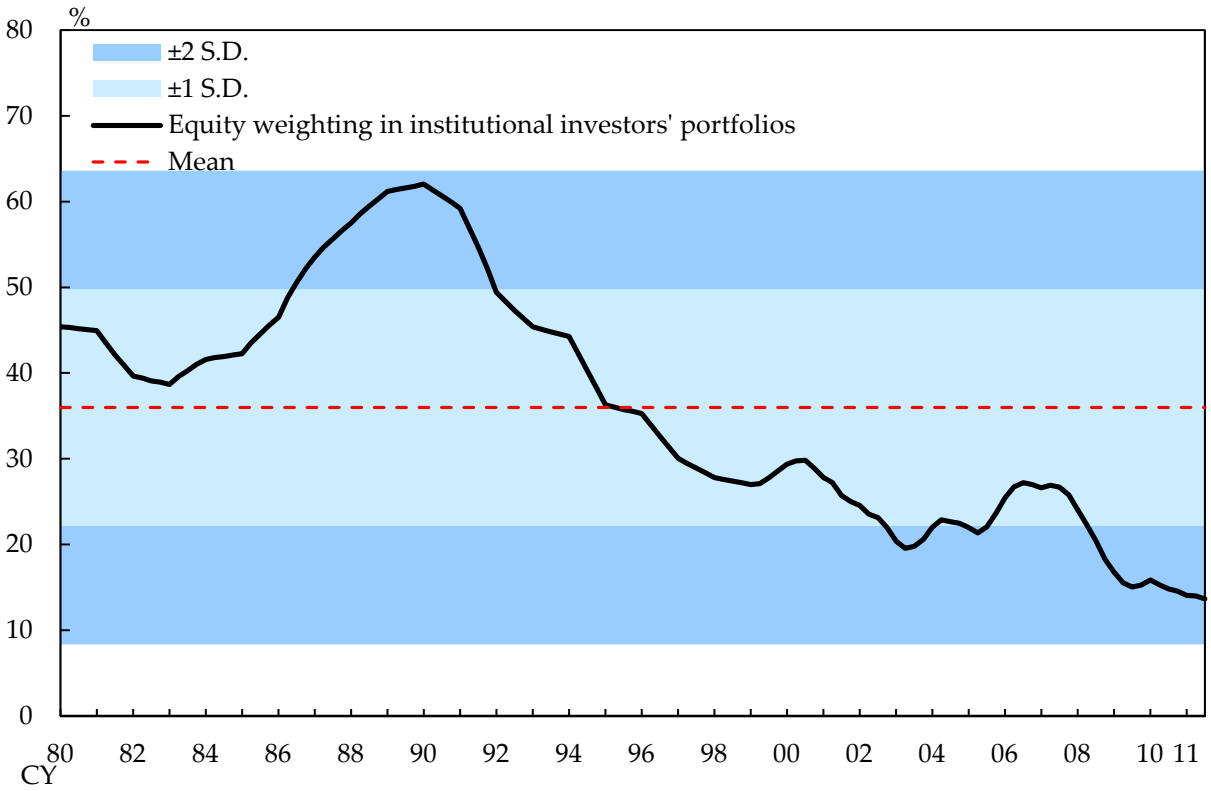
3. Total credits from Q1 1980 to Q4 1997 are calculated applying year-on-year rates of changes of the old basis data in those periods. Total credits before Q4 1979 are calculated applying year-on-year rates of changes of 1968 SNA basis data in those periods. Nominal GDP from Q1 1980 to Q4 1993 are calculated applying quarter-on-quarter rates of changes of CY2000 basis data in those periods. Nominal GDP before Q4 1979Q4 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.

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

(Figure 5)

Equity weighting in institutional investors' portfolios



Notes: *1.* Q1 1980 through Q3 2011.

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.

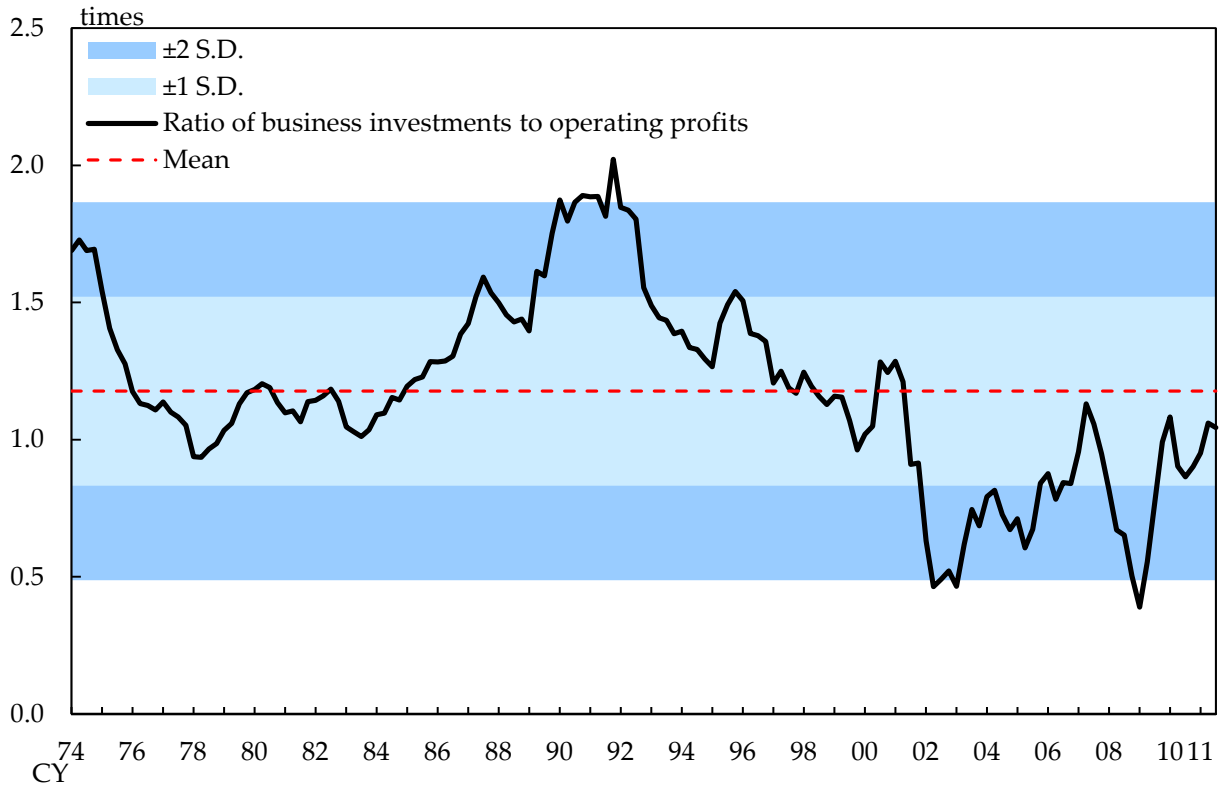
3. The outstanding amount of equity investment and that of total security investment from Q1 1980 to Q4 1997 are calculated applying year-on-year rates of changes of the old basis data in those periods.

4. The outstanding amount of equity investment and that of total security investment are measured as a four-quarter moving average.

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

(Figure 6)

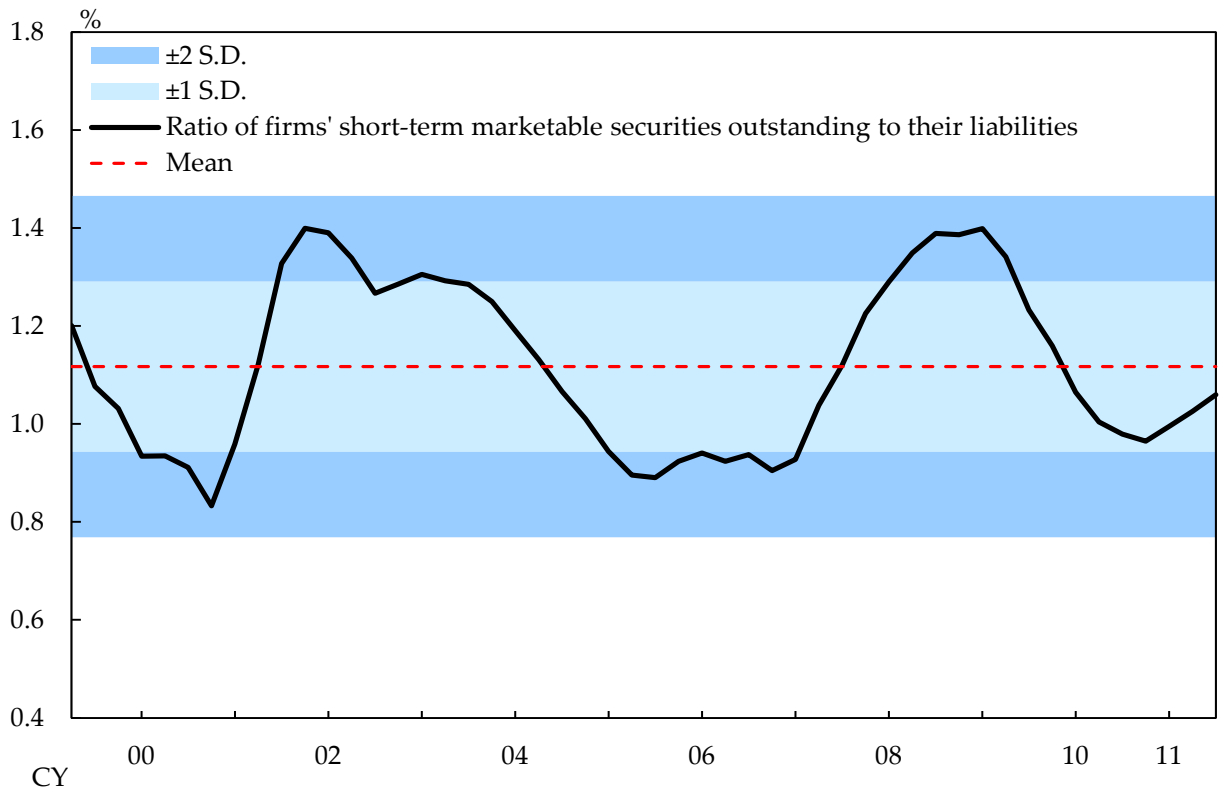
Ratio of business investments to operating profits



Notes: *1.* Q1 1974 through Q3 2011.
2. The indicator is given by business investments / operating profits. Business investments are defined as the sum of fixed investments, inventory investments and security investments.
3. Business investments and operating profits are measured as a four-quarter moving average.

Source: Ministry of Finance "Financial Statements Statistics of Corporations by Industry".

Ratio of firms' short-term marketable securities outstanding to their liabilities

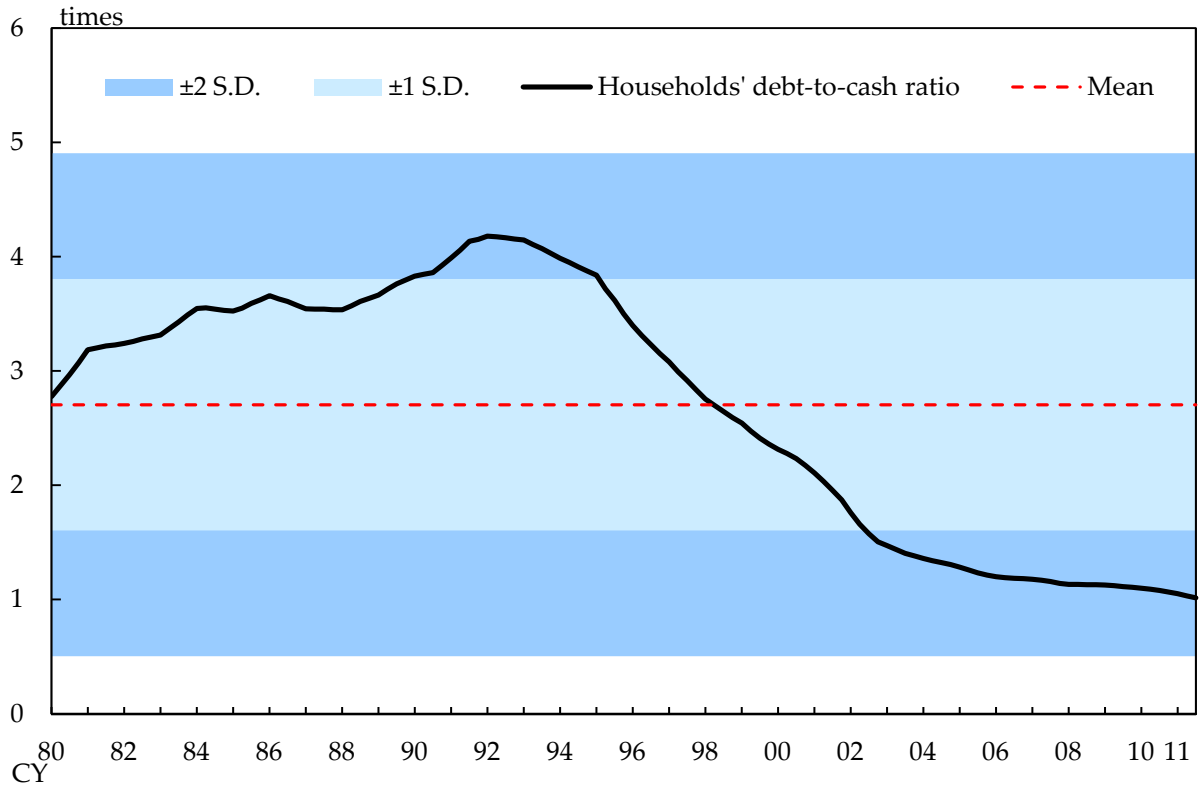


Notes: *1.* Q2 1999 through Q3 2011.
2. The indicator is given by the non-financial corporations' commercial papers outstanding / their financial liabilities (excluding shares and other equities) × 100.
3. The sample period begins in Q3 1998, because the CP issuance market was completely liberalized 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.

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

(Figure 8)

Households' debt-to-cash ratio

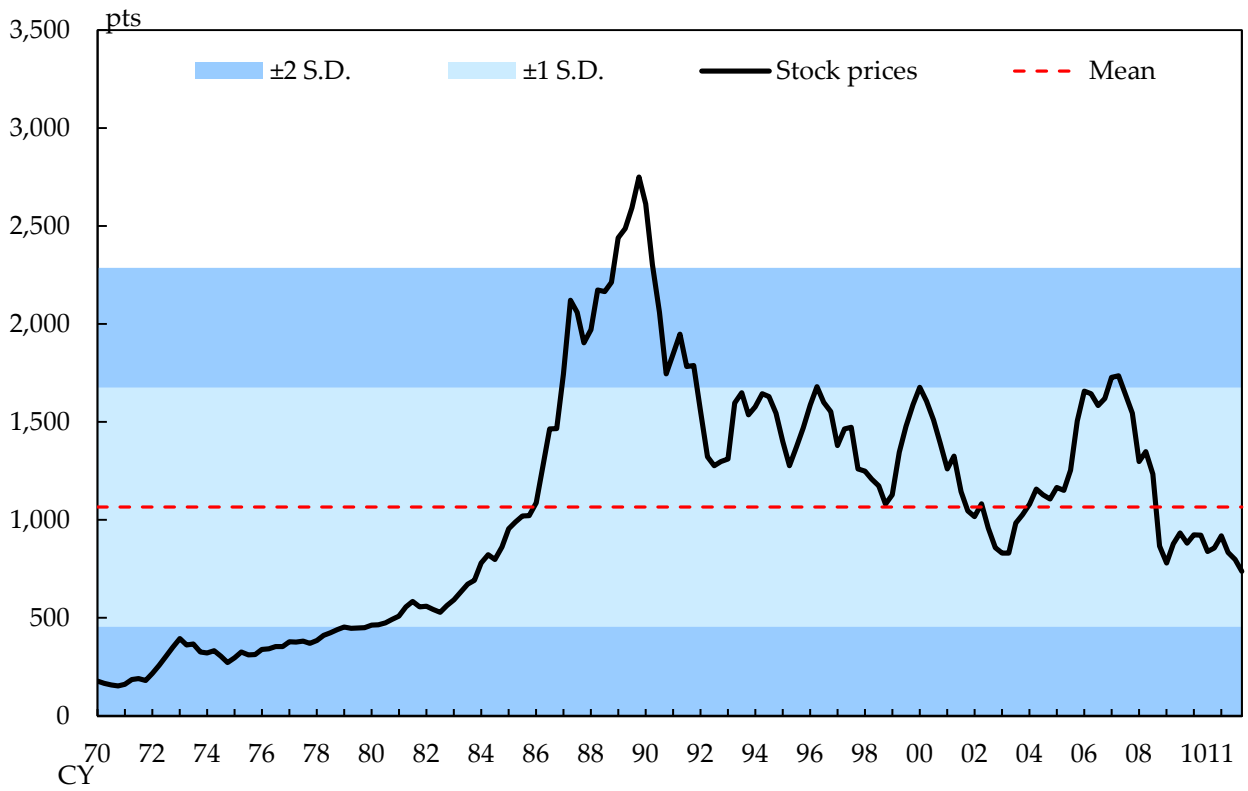


Notes: *1.* Q1 1980 through Q3 2011.
2. The indicator is given by the households' financial liabilities outstanding / on-hand liquidity. The on-hand liquidity is defined as the sum of cash and demand deposits.
3. The financial liabilities, the cash and the demand deposits from Q1 1980 to Q3 1997 are calculated applying year-on-year rates of changes of the old basis data in those periods.
4. "Flow of Funds Accounts" have included ordinary postal savings at the former Japan Post in the demand deposits since Q1 2003. The estimated households' ordinary postal savings are added to the demand deposits before Q4 2002.
5. The financial liabilities, the cash and the demand deposits are measured as a four-quarter moving averages.

Sources: Bank of Japan "Flow of Funds Accounts"; Ministry of Postal Services "Annual Statistical Report of Postal Services," "Annual Statistical Report of Postal Service Administrations"; Japan Post Holdings "The former Japan Post Statistical Data".

(Figure 9)

Stock prices

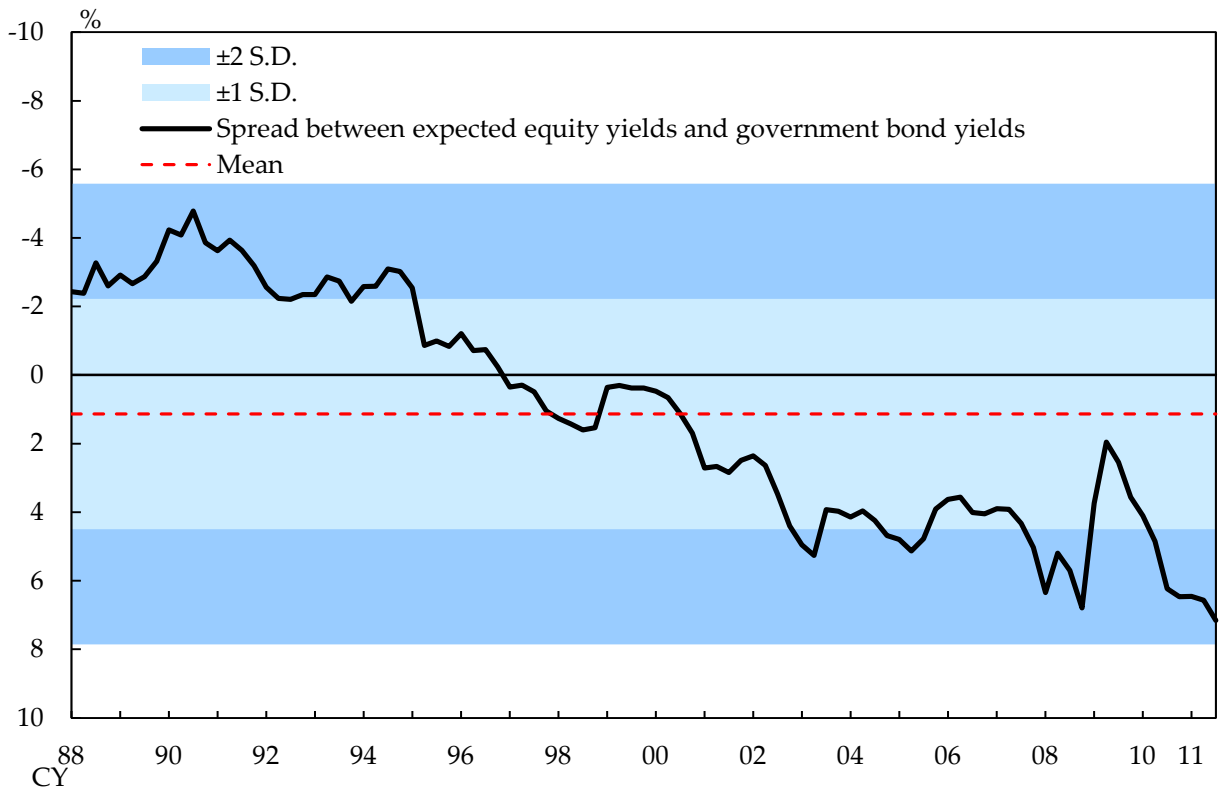


Notes: *1.* Q1 1970 through Q4 2011.
2. Stock price is defined as TOPIX.

Source: Bloomberg.

(Figure 10)

Spread between expected equity yields and government bond yields



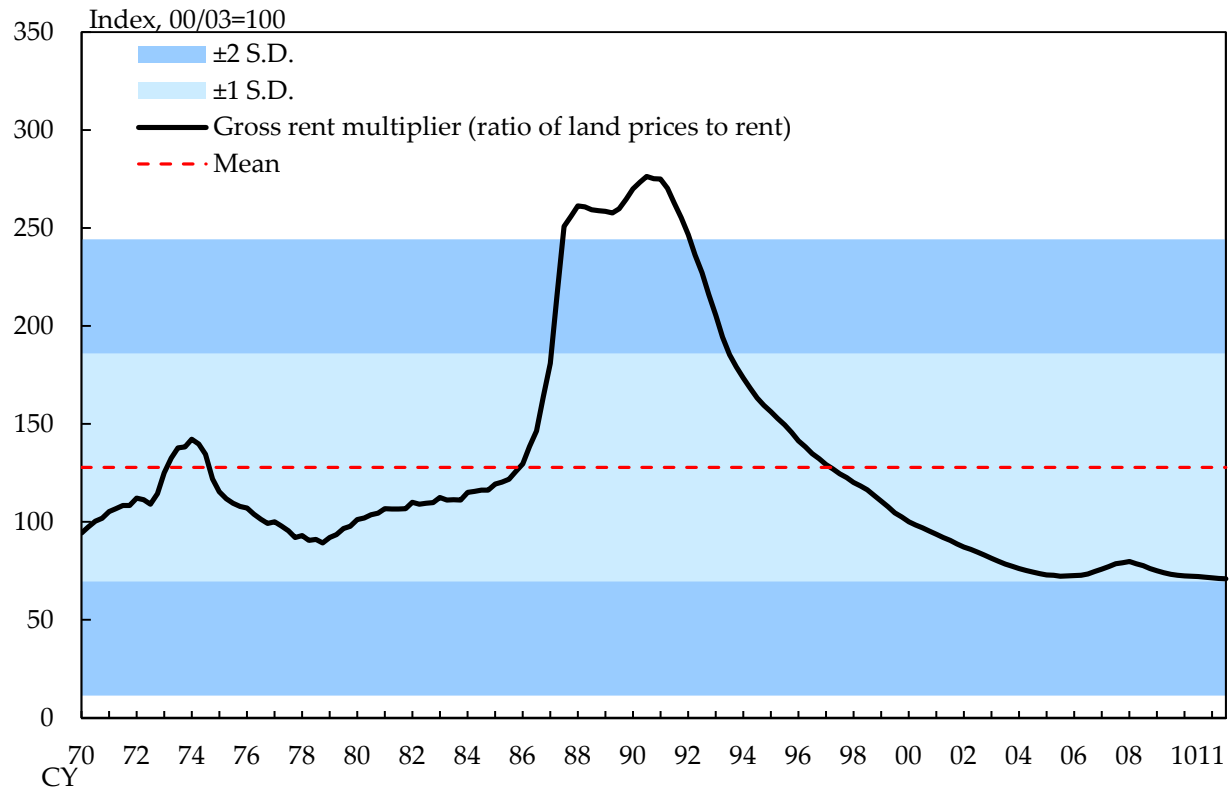
Notes: *1.* Q1 1988 through Q3 2011.

2. The indicator is given by expected equity yields − ten-year JGB yields. Expected equity yield is defined as an inverse of the one year forward-looking PER of TOPIX.

Sources: Thomson Reuters; Bloomberg.

(Figure 11)

Gross rent multiplier (ratio of land prices to rent)

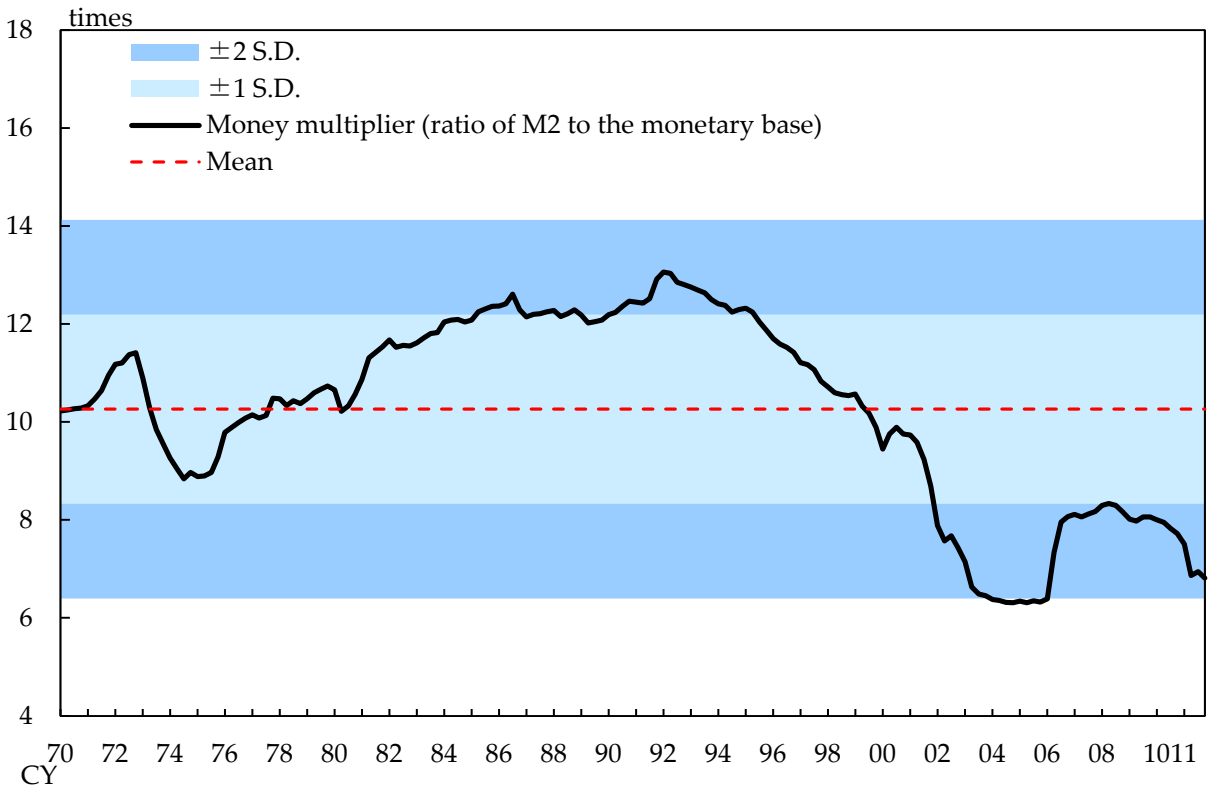


Notes: *1.* Q1 1970 through Q3 2011.
2. The indicator is given by urban land price index of Tokyo metropolitan area / consumer price index (rent) for Ku-area of Tokyo × 100.
3. The land prices before CY 1984 are calculated applying year-on-year rates of changes of the urban land price index of six large city areas in those periods.

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

(Figure 12)

Money multiplier (ratio of M2 to the monetary base)

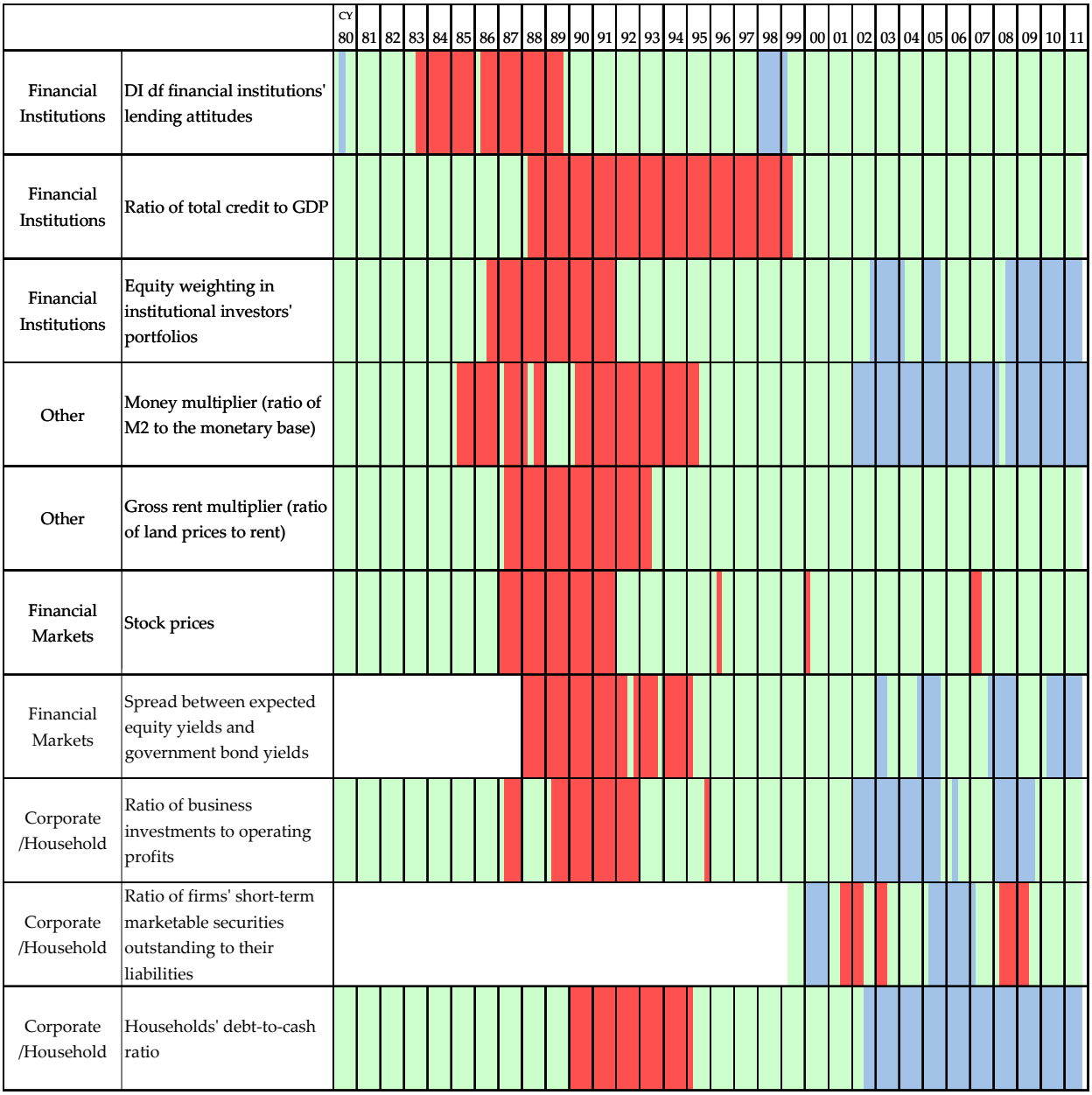


Notes: *1.* Q1 1970 through Q4 2011.
2. The indicator is given by the average outstanding amount of M2 / the average outstanding amount of monetary base.
3. The M2s before Q1 2003 are calculated applying quarter-on-quarter rates of changes of the M2+CD in those periods.

Sources: Bank of Japan "Money Stock", "Monetary Base".

(Figure 13)

Assessments from a long-term perspective: Heat map

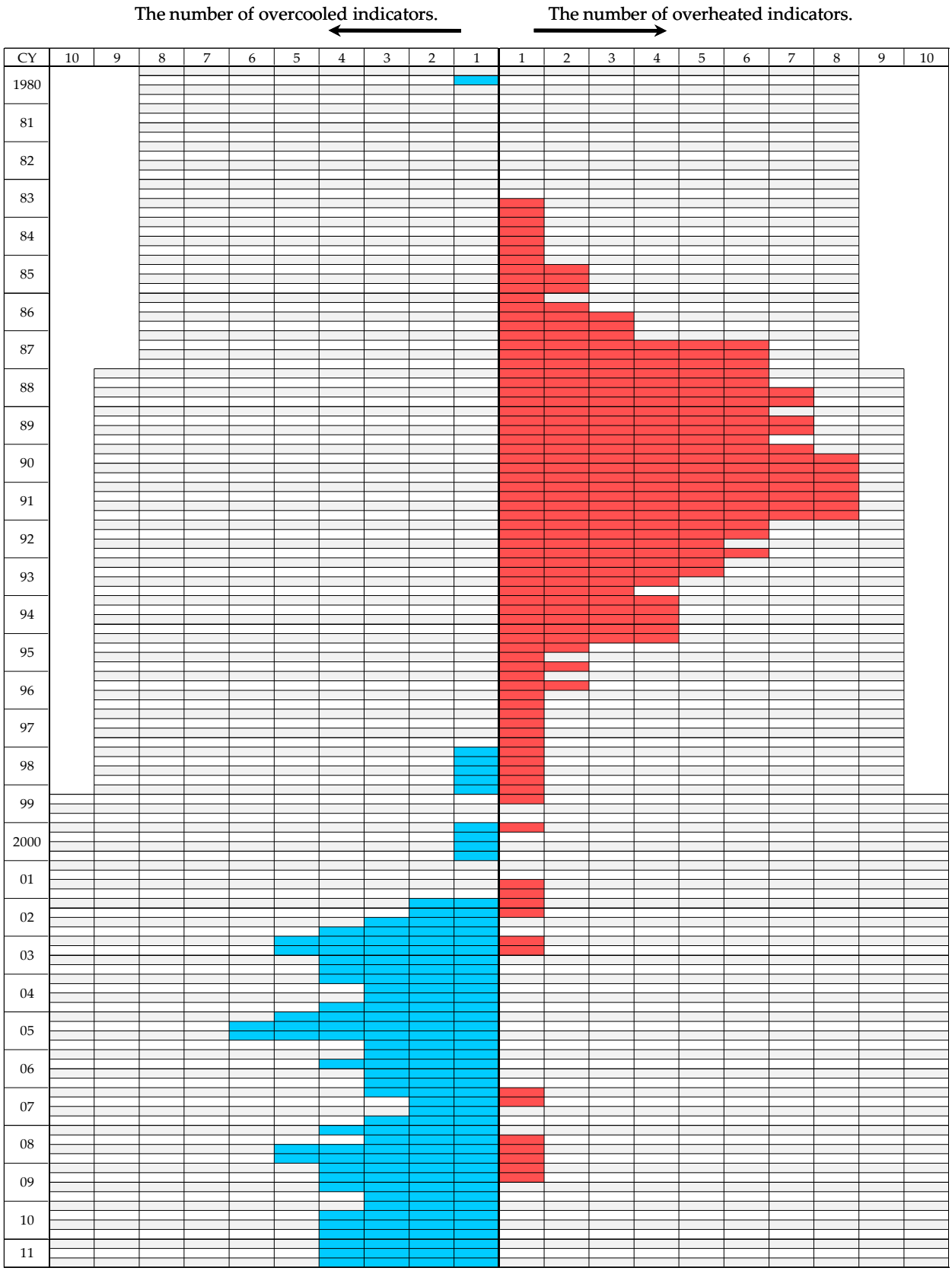


Notes: *1.* Q1 1980 through Q3 2011.

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

(Figure 14)

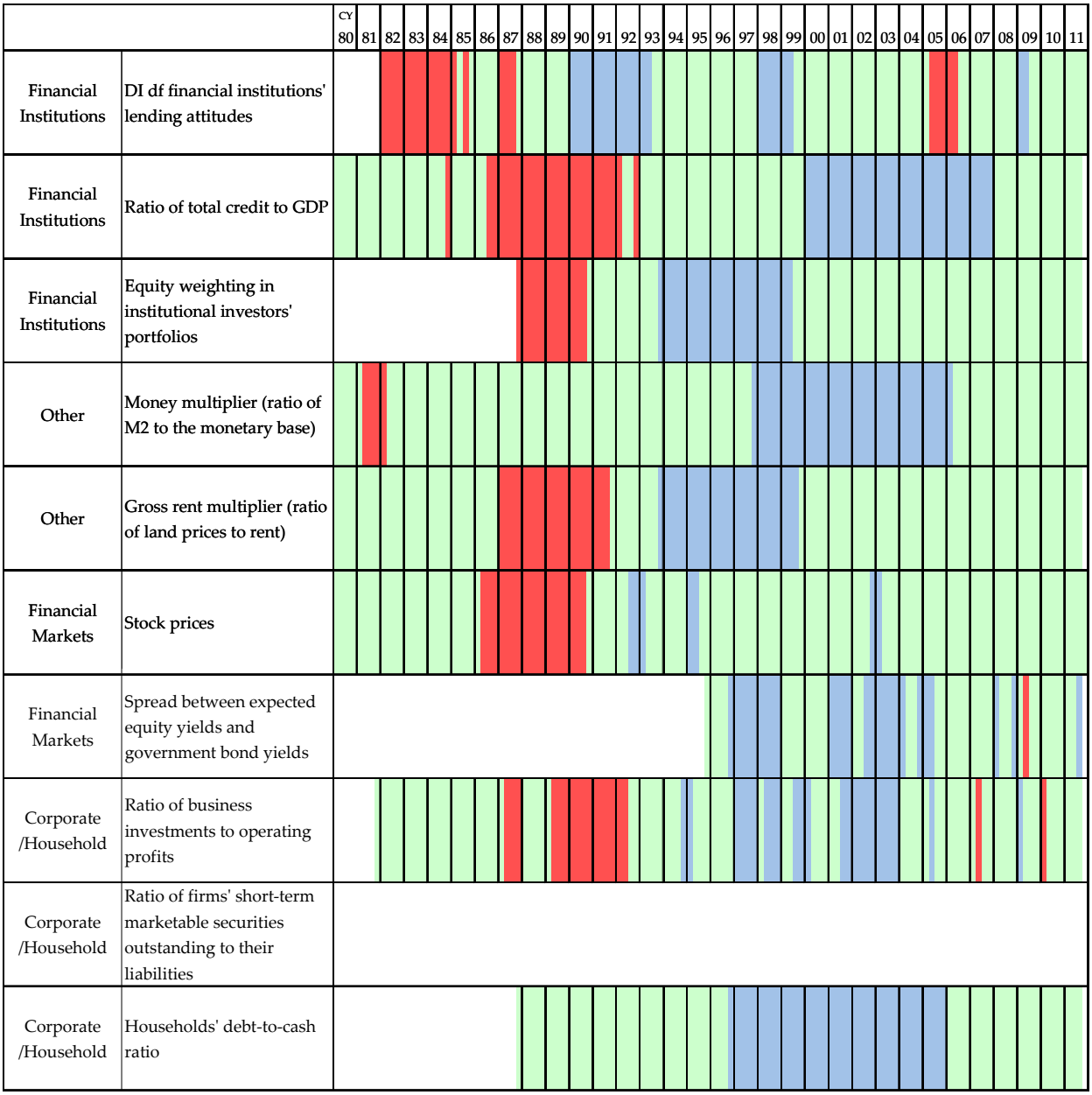
Assessments from a long-term perspective: Stretch chart



Note: *1.* The number of indicators is eight from Q1 1980 to Q4 1987, nine from Q1 1988 to Q1 1999, ten from Q2 1999 to Q3 2011.

(Figure 15)

Assessments from a medium-term perspective: Heat map

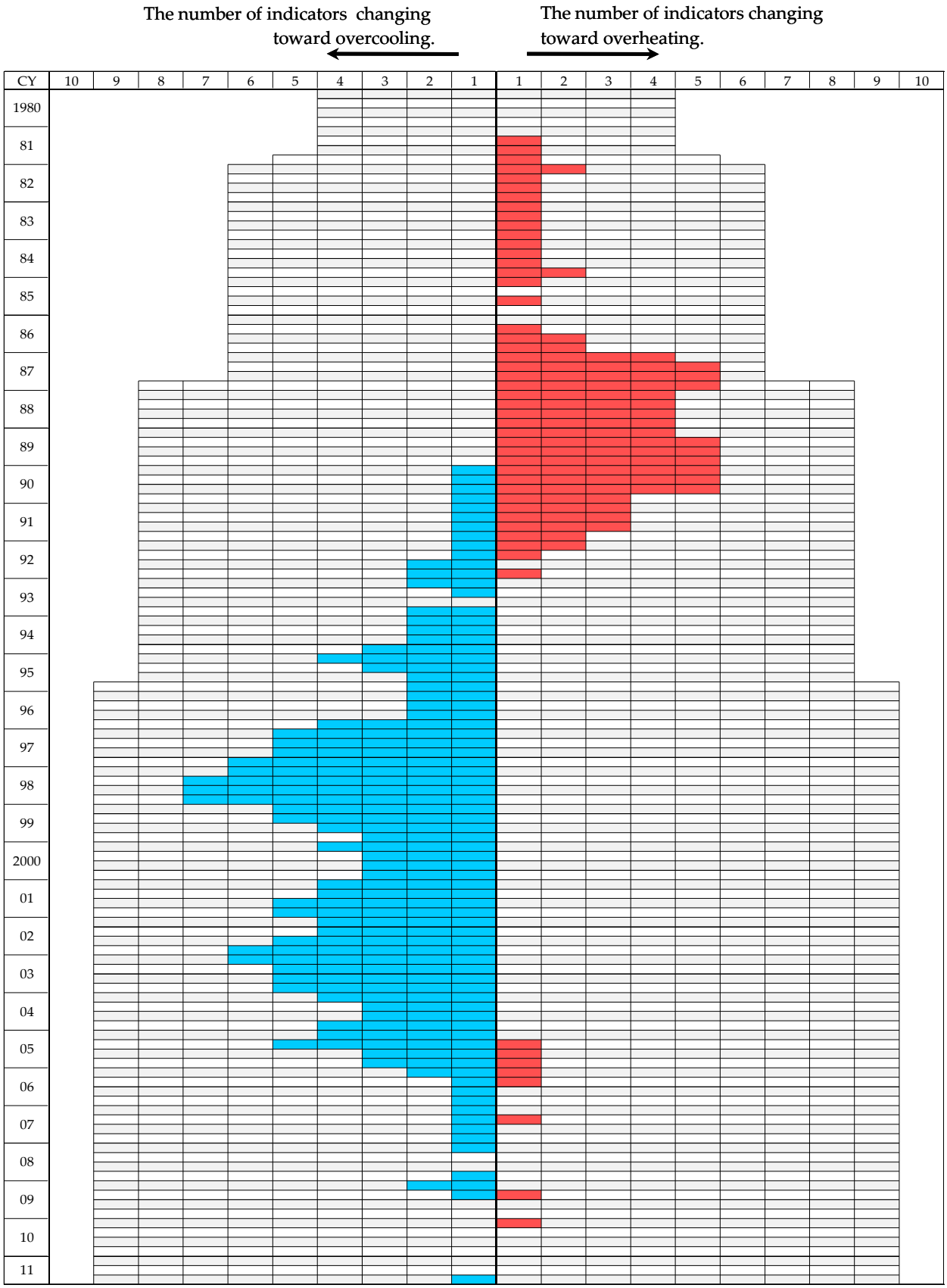


Notes: *1.* Q1 1980 through Q3 2011.

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

(Figure 16)

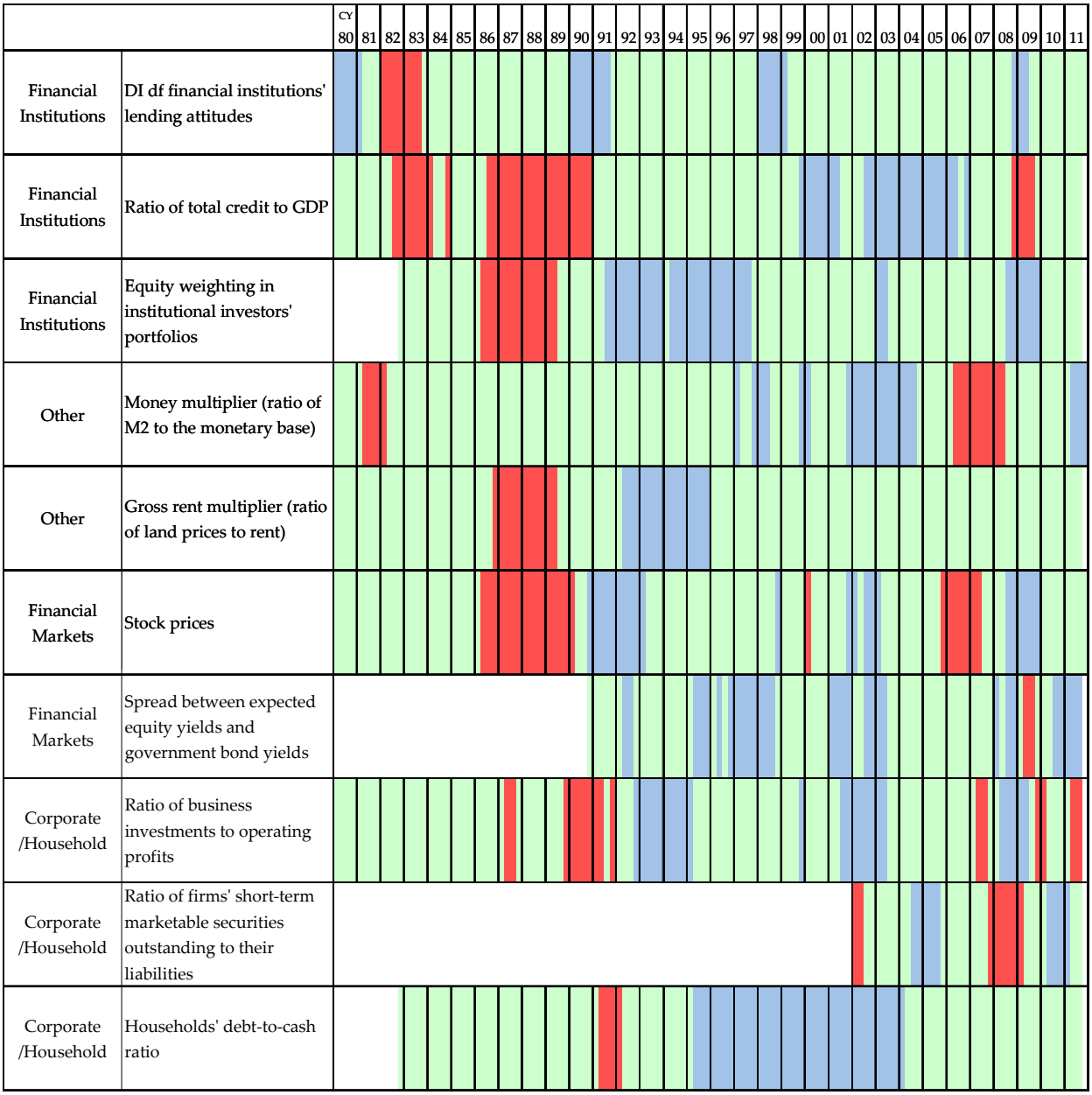
Assessments from a medium-term perspective: Stretch chart



Note: *1.* The number of indicators is four from Q1 1980 to Q3 1981, five at Q4 1981, six from Q1 1982 to Q3 1987, eight from Q4 1987 to Q3 1995, nine from Q4 1995 to Q3 2011.

(Figure 17)

Assessments from a short-term perspective: Heat map

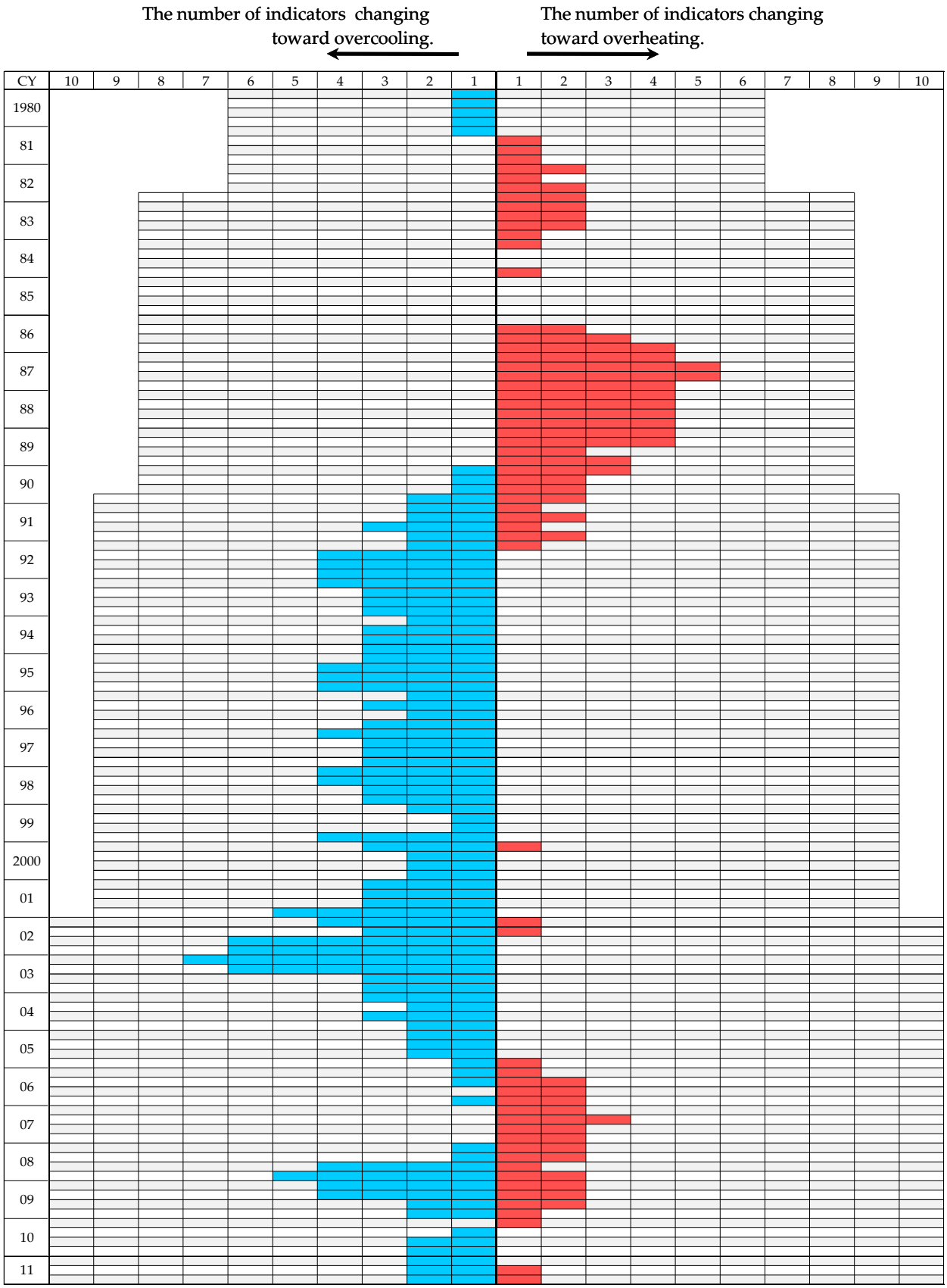


Notes: *1.* Q1 1980 through Q3 2011.

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

(Figure 18)

Assessments from a short-term perspective: Stretch chart



Note: *1.* The number of indicators is six from Q1 1980 to Q3 1982, eight from Q4 1982 to Q3 1990, nine from Q4 1990 to Q4 2001, ten from Q1 2002 to Q3 2011.

(Supplementary Figure 1-1)

The indicators by the first condition (1)

	Indicator	Sector	Main source
1	(Cash + Required reserves) / Total assets	Financial Institutions	Demirgüç-Kunt, A., and Detragiache, E., 1997, "The Determinants of Banking Crises: Evidence from Developing and Developed Countries," IMF Working Paper, No. WP/97/106.
2	ROA	Financial Institutions	Hanschel, E., and Monnin, P., 2005, "Measuring and forecasting stress in the banking sector: evidence from Switzerland," *BIS Papers* , Vol. 22, pp. 431-449.
3	ROE	Financial Institutions	Evans, O., Leone, A. M., Gill, M., and Hilbers, P., 2000, "Macroprudential Indicators of Financial System Soundness," IMF Occasional Paper, No. 192.
4	Tier I capital ratio	Financial Institutions	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
5	Loan outstanding	Financial Institutions	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
6	Bank stock price	Financial Institutions	Hanschel, E., and Monnin, P., 2005, "Measuring and forecasting stress in the banking sector: evidence from Switzerland," *BIS Papers* , Vol. 22, pp. 431-449.
7	Volatility of excess bank stock return	Financial Institutions	Holló, D., Kremer, M., Duca, M. L., 2011, "CISS – A Composite Indicator of Systemic Stress in the Financial System," mimeo.
8	Yield spread of bank issued bonds	Financial Institutions	Hanschel, E., and Monnin, P., 2005, "Measuring and forecasting stress in the banking sector: evidence from Switzerland," *BIS Papers* , Vol. 22, pp. 431-449.
9	Capital ratio	Financial Institutions	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".
10	Wholesale funding / Total liabilities	Financial Institutions	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
11	Real domestic credit growth rate	Financial Institutions	Demirgüç-Kunt, A., and Detragiache, E., 1997, "The Determinants of Banking Crises: Evidence from Developing and Developed Countries," IMF Working Paper, No. WP/97/106.
12	Real deposit interest rate	Financial Institutions	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
13	Real deposit outstanding	Financial Institutions	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
14	Net assets / Total liabilities	Financial Institutions	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
15	Credit cost ratio	Financial Institutions	Hanschel, E., and Monnin, P., 2005, "Measuring and forecasting stress in the banking sector: evidence from Switzerland," *BIS Papers* , Vol. 22, pp. 431-449.
16	External liabilities	Financial Institutions	Evans, O., Leone, A. M., Gill, M., and Hilbers, P., 2000, "Macroprudential Indicators of Financial System Soundness," IMF Occasional Paper, No. 192.
17	Short-term liabilities / Total liabilities	Financial Institutions	Burkart, O., and Coudert, V., 2002, "Leading Indicators of Currency Crises for Emerging Economies," *Emerging Markets Review* , Vol. 3, pp. 107-133.
18	VaR on trading accounts	Financial Institutions	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
19	Non performing loans outstanding	Financial Institutions	Davis, E. P., and Karim, D., 2008, "Comparing early warning systems for banking crises," *Journal of Financial Stability* , Vol. 4, pp. 89-120.
20	Demand deposit / Total liabilities	Financial Institutions	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.

Sources: Several papers.

(Supplementary Figure 1-2)

The indicators by the first condition (2)

	Indicator	Sector	Main source
21	Deposit / M2	Financial Institutions	Evans, O., Leone, A. M., Gill, M., and Hilbers, P., 2000, "Macroprudential Indicators of Financial System Soundness," IMF Occasional Paper, No. 192.
22	Existence of deposit insurance	Financial Institutions	Demirgüç-Kunt, A., and Detragiache, E., 1997, "The Determinants of Banking Crises: Evidence from Developing and Developed Countries," IMF Working Paper, No. WP/97/106.
23	Lending to deposit rate spread	Financial Institutions	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
24	Loan to deposit ratio	Financial Institutions	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".
25	Liquid asset ratio	Financial Institutions	Demirgüç-Kunt, A., and Detragiache, E., 1997, "The Determinants of Banking Crises: Evidence from Developing and Developed Countries," IMF Working Paper, No. WP/97/106.
26	Leverage ratio	Financial Institutions	Evans, O., Leone, A. M., Gill, M., and Hilbers, P., 2000, "Macroprudential Indicators of Financial System Soundness," IMF Occasional Paper, No. 192.
27	ROA	Corporates	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".
28	ROE	Corporates	Agresti, A. M., Baudino P., and Poloni, P., 2008, "The ECB and IMF Indicators for the Macro-prudential Analysis of the Banking Sector: A Comparison of the Two Approaches," ECB Occational Paper Series, No. 99.
29	Interest coverage ratio	Corporates	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".
30	Leverage ratio	Corporates	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".
31	The diffusion index of financial institutions' lending attitudes (large firms)	Corporates	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
32	The diffusion index of financial institutions' lending attitudes (small firms)	Corporates	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
33	Fixed investment / Internal cash flow	Corporates	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
34	Total liabilities / Operating surpluses	Corporates	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
35	Total liabilities / Internal cash flow	Corporates	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
36	Total liabilities / Demand deposit	Corporates	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
37	Total liabilities / (Demand deposit + Cash)	Households	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
38	Total liabilities / Disposable income	Households	Minsky, H. P., 1982, *Can "It" Happen again? - Essays on Instability and Finance* , M.E.Sharp, Inc.
39	Total liabilities / Financial assets	Households	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
40	Total liabilities / Nominal GDP	Households	International Monetary Fund and Financial Stability Board, 2010, "The IMF-FSB Early Warning Exercise: Design and Methodological Toolkit".

Sources: Several papers.

(Supplementary Figure 1-3)

The indicators by the first condition (3)

	Indicator	Sector	Main source
41	Saving rate	Households	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
42	Interest payment / Income	Households	Agresti, A. M., Baudino P., and Poloni, P., 2008, "The ECB and IMF Indicators for the Macro-prudential Analysis of the Banking Sector: A Comparison of the Two Approaches," ECB Occational Paper Series, No. 99.
43	10 year government bond yield	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
44	The amount of ABS issuance	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
45	CP rate spread	Financial Markets	Illing, M., and Liu, Y., 2006, "Measuring financial stress in a developed country: An application to Canada," *Journal of Financial Stability* , Vol. 2, pp. 243-265.
46	The amount of CP issuance	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
47	CP outstanding	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
48	LIBOR-OIS spread	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
49	TED spread	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
50	VIX (VXJ)	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
51	High-yield bond yield spread (7 year)	Financial Markets	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
52	Implied volatility of exchange rate	Financial Markets	Carlson, M. A., Lewis, K. F., and Nelson W. R., 2012, "Using Policy Intervention to Identify Financial Stress," Finance and Economics Discussion Series, 2012-02, Federal Reserve Board.
53	Exchange rate volatility	Financial Markets	Holló, D., Kremer, M., Duca, M. L., 2011, "CISS – A Composite Indicator of Systemic Stress in the Financial System," mimeo.
54	Stock price growth rate	Financial Markets	Hutchison, M., and McDill, K., 1999, "Are All Banking Crises Alike? The Japanese Experience in International Comparison," *Journal of the Japanese and International Economies* , Vol. 13, pp. 155-180.
55	Cumulative excess stock return	Financial Markets	Haldane, A., 2010, "What is the contribution of the Financial Sector: Miracle or Mirage?," *The Future of Finance: And the Theory that underpins it* , LSE.
56	Correlation between stock return and government bond yield	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
57	Bank CDS spread	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
58	Implied volatility of government bond yield	Financial Markets	Carlson, M. A., Lewis, K. F., and Nelson W. R., 2012, "Using Policy Intervention to Identify Financial Stress," Finance and Economics Discussion Series, 2012-02, Federal Reserve Board.
59	Government bond yield volatility	Financial Markets	Holló, D., Kremer, M., Duca, M. L., 2011, "CISS – A Composite Indicator of Systemic Stress in the Financial System," mimeo.
60	Growth rate of real exchange rate	Financial Markets	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.

Sources: Several papers.

The indicators by the first condition (4)

	Indicator	Sector	Main source
61	Real stock return	Financial Markets	Reinhart, C., and Rogoff, K., 2008, "Is the 2007 U.S. Sub-Prime Financial Crisis So Different? An International Historical Comparison," NBER Working Paper 13761.
62	Corporate bond spread (Baa, 10 year)	Financial Markets	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
63	Short-term interest rate	Financial Markets	Alessi, L., and Detken, C., 2011, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity," *European Journal of Political Economy* , Vol. 27, pp. 520-533.
64	Long-term interest rate	Financial Markets	Alessi, L., and Detken, C., 2011, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity," *European Journal of Political Economy* , Vol. 27, pp. 520-533.
65	Long-term / Short-term rate spread (10 year - 3 month)	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
66	Long-term / Short-term rate spread (2 year - 3 month)	Financial Markets	Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson. M. W., 2010, "Financial Conditions indexes: A fresh look after the financial crisis," NBER Working Paper 16150.
67	Real interest rate differential	Financial Markets	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
68	Corporate stock return volatility	Financial Markets	Holló, D., Kremer, M., Duca, M. L., 2011, "CISS – A Composite Indicator of Systemic Stress in the Financial System," mimeo.
69	Forward-looking PER	Financial Markets	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
70	Forward-looking equity risk premium	Financial Markets	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
71	M2 / Reserve	Other	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
72	M2 / Nominal GDP	Other	Burkart, O., and Coudert, V., 2002, "Leading Indicators of Currency Crises for Emerging Economies," *Emerging Markets Review* , Vol. 3, pp. 107-133.
73	M2 growth rate	Other	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
74	Reserves outstanding	Other	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
75	Reserves growth rate	Other	Berg, A., and Pattillo, C., 1999, "Predicting Currency Crises: The Indicators approach and an alternative," *Journal of International Money and Finance* , Vol. 18, pp. 561-586.
76	Current accounts / GDP	Other	Reinhart, C., and Rogoff, K., 2008, "Is the 2007 U.S. Sub-Prime Financial Crisis So Different? An International Historical Comparison," NBER Working Paper 13761.
77	Terms of trade	Other	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
78	Real M1	Other	Alessi, L., and Detken, C., 2011, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity," *European Journal of Political Economy* , Vol. 27, pp. 520-533.
79	Real M3	Other	Alessi, L., and Detken, C., 2011, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity," *European Journal of Political Economy* , Vol. 27, pp. 520-533.
80	Real M3 growth rate	Other	Alessi, L., and Detken, C., 2011, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity," *European Journal of Political Economy* , Vol. 27, pp. 520-533.

Sources: Several papers.

(Supplementary Figure 1-5)

The indicators by the first condition (5)

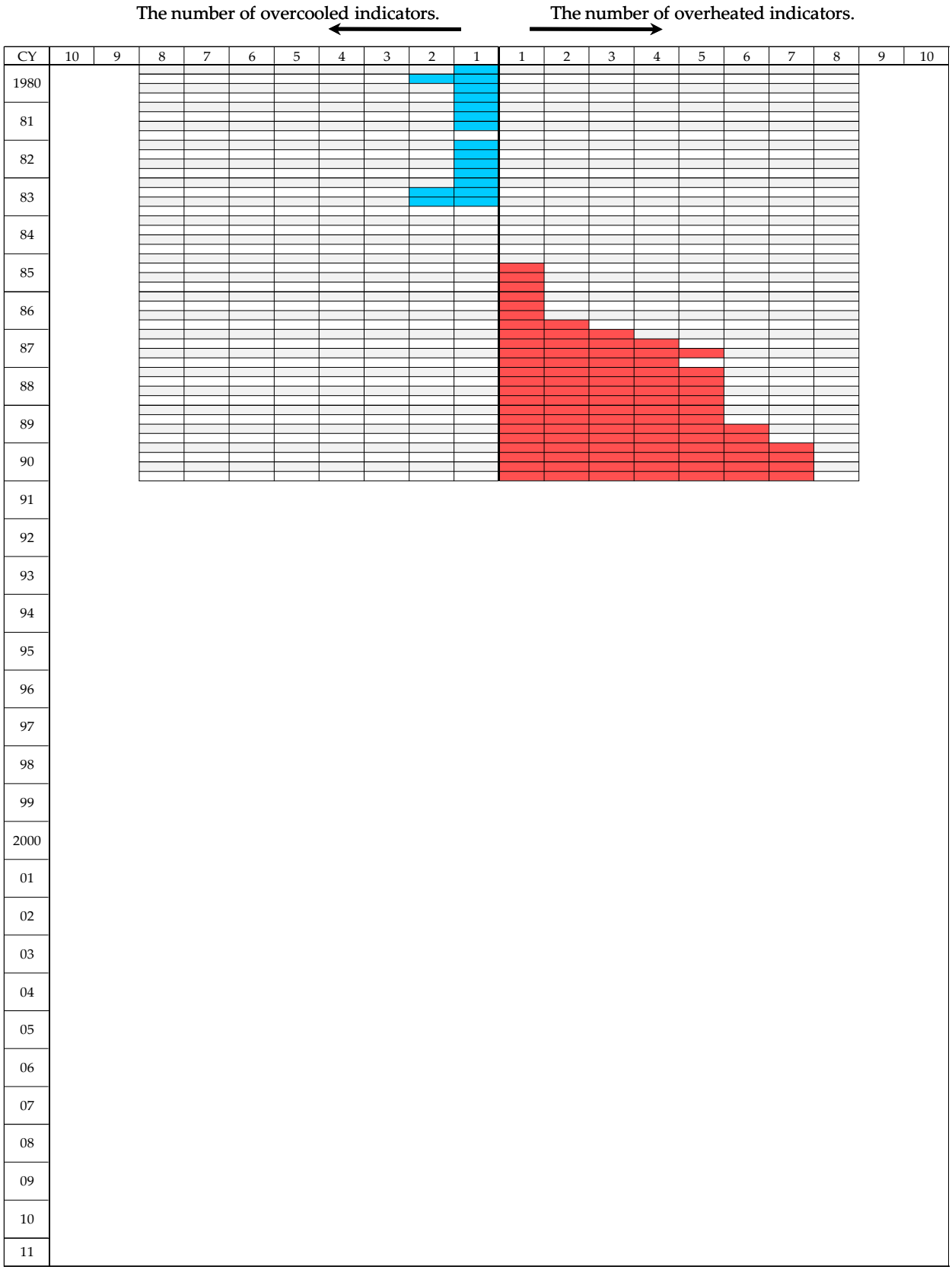
	Indicator	Sector	Main source
81	Real interest rate	Other	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.
82	Real effective exchange rate	Other	Burkart, O., and Coudert, V., 2002, "Leading Indicators of Currency Crises for Emerging Economies," *Emerging Markets Review* , Vol. 3, pp. 107-133.
83	Real house price	Other	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
84	Real house price / Rent	Other	Meyer, L. H., and Bomfim, A. N., 2011, "Bubble Watch," Macroeconomic Advisers.
85	Real commercial property price	Other	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
86	Real long-term interest rate growth	Other	Mörttinen, L., Poloni, P., Sandars, P., and Vesala, J., 2005, "Analysing Banking Sector Conditions: How to Use Macro-Prudential Indicators," European Central Bank Occasional Paper Series, No. 26.
87	Excess M1	Other	Kaminsky, G. L., and Reinhart, C. M., 1999, "The Twin Crises: The Causes of Banking and Balance-of-Payments Problem," *The American Economic Review* , Vol. 89, pp. 473-500.

Sources: Several papers.

(Supplementary Figure 2)

Robustness to real-time estimation problems (1)

- The end of 1990 -

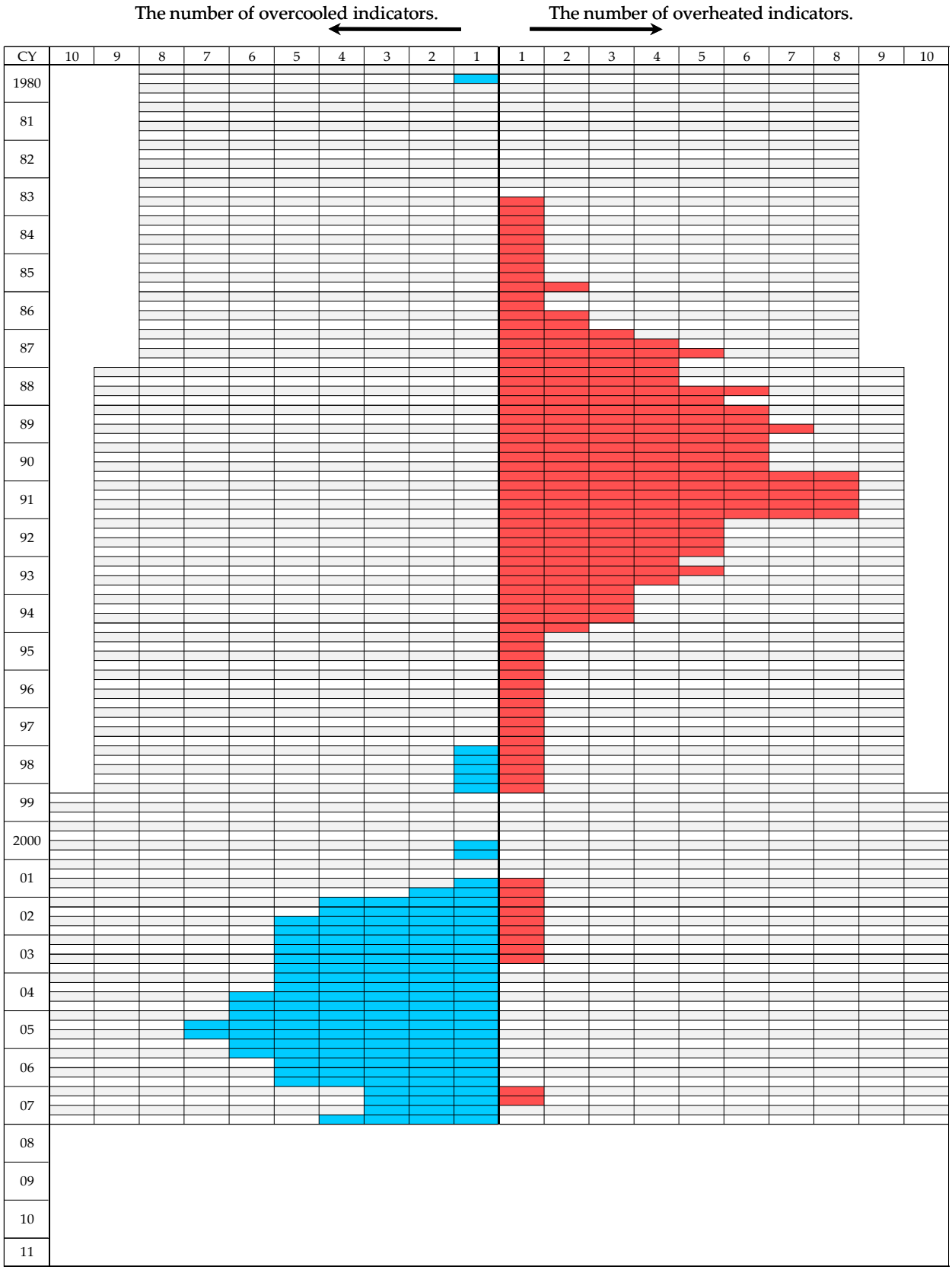


Note: *1.* The number of indicators is eight from Q1 1980 to Q4 1990. Indicators whose sample periods are less than 5 years are excluded.

(Supplementary Figure 3)

Robustness to real-time estimation problems (2)

- The end of 2007 -



Note: *1.* The number of indicators is eight from Q1 1980 to Q4 1987, nine from Q1 1988 to Q1 1999, ten from Q2 1999 to Q4 2007.