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Impact of Macroprudential Policy Measures on Economic Dynamics: Simulation Using a Financial Macro-econometric Model

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IMPACT OF MACROPRUDENTIAL POLICY MEASURES ON ECONOMIC DYNAMICS:[*]

SIMULATION USING A FINANCIAL MACRO-ECONOMETRIC MODEL

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ABSTRACT

This paper uses a financial macro-econometric model to compare and analyze the impact of macroprudential policy measures -- a credit growth restriction, loan-to-value and debt-to-income regulations, and a time-varying capital requirement -- on the economic dynamics through the financial cycle with the asset price bubble. Our analysis shows that although these macroprudential policy measures dampen economic volatility, it is possible that they reduce average economic growth, and the effects on the economic dynamics differ widely among macroprudential policy measures. In addition, the policy effects are changed dramatically by lags in recognizing the state of the economy. Our results also suggest that macroprudential policy measures can help contribute to more stable financial intermediation by raising the resilience of the financial system against risks.

I. Introduction

Since the last global financial crisis, international institutions, central banks, and regulatory agencies have all come to share an understanding that the existing microprudential approach to ensuring the soundness of individual financial institutions does not necessarily lead to stabilization of the financial system as a whole. Consequently, more attention is now being paid to macroprudence as a means of stabilizing the broader financial system.[1] The objective of macroprudence is to minimize systemic risks[2] (financial risks with serious negative consequences for the financial system and the broader economy), stabilize the financial system, and ensure stable growth in the real economy.[3] For its part, in October 2011 the Bank of Japan published a paper explaining its thinking on macroprudence, "The Bank of Japan's Initiatives on the Macroprudential Front" (Bank of Japan [2011]), and in addition it publishes an analysis and assessment of Japan's financial system stability through its Financial System Reports.

Moreover, because the financial cycle -- which creates bubbles and destabilizes the financial system -- is not the same as the business cycle, we believe that macroprudential policy in addition to monetary policy is important for simultaneously stabilizing both the financial system and the real economy. For example, both Borio (2011) and Drehmann *et al.* (2012) have shown that the financial cycle is longer than the business cycle, and thus they argue that both macroprudence and monetary policy are needed to keep the financial cycle from over-expanding, given the nature of the cycle.

The measures used to implement macroprudence are known as macroprudential

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[1] A specific example on the regulatory side is the effort to increase financial supervision, mainly through the establishment of macroprudential policy agencies in the United States, Europe, and the United Kingdom. In addition, in the United Kingdom the provisional Financial Policy Committee is engaged in the selection of specific macroprudential policy measures (BOE and FSA staff [2011] and FPC [2012]).

[2] IMF, FSB, and BIS (2011).

[3] For example, ESRB (2012a) states that "the ultimate objective of macroprudential policy is to contribute to the safeguard of the stability of the financial system as a while" and ensure "a sustainable contribution of the financial sector to economic growth."

policy measures or instruments. They include various measures to either directly or indirectly affect the financial system and the real economy, in an attempt to constrain both the financial cycle and systemic risk. Given that the particular shock that destabilizes a financial system is different each time, and given that each country inherently has different problems within its financial system, a variety of macroprudential policy measures are being deployed worldwide (Charts 1 and 2).[4] A multitude of policy measures are available, some concerned with the volume of credit, others with capital, and still others with liquidity. For example, because emerging and developing economies are exposed to risks from domestic credit fluctuations and foreign-currency liquidity as a result of rapid flows of foreign funds,[5] many of them have aggressively implemented multiple macroprudential policy instruments. Such instruments are not used as much in already-developed economies, however.

Rapid progress has been made since the last global financial crisis in efforts to analyze the impact from macroprudential policy measures, on both the theoretical and empirical sides. As theoretical studies, Bianchi (2010) and Farhi and Tirole (2012) provide a reason for introducing macroprudential policy measures to constrain excessive leverage of financial institutions and borrowing entities. Other theoretical studies using dynamic stochastic general equilibrium (DSGE) models to examine the impact of macroprudential policy measures include Cristensen *et al.* (2011), who look at countercyclical capital ratio requirements, Crowe *et al.* (2011), who look at a loan-to-value (LTV) regulation, and Funke and Paetz (2012), who look at a time-varying LTV regulation. On the empirical side, Aiyar *et al.* (2012) examine the impact that the time-varying minimum capital requirement introduced in the United Kingdom had on lending, and also look at the degree of regulatory arbitrage that resulted from

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[4] Moreover, a single macroprudential policy measure is not always ideal. For more on this, see Lim *et al.* (2011), who cite specific advantages to using multiple policy measures: (1) the ability to deal with the same risk from multiple perspectives; (2) the reduced leeway for evading regulation; and (3) the ability to maintain the efficacy of policy measures by responding to the multiple source of risks.

[5] The currency crises of Mexico (1994-95) and Asia (1997) are classic examples of the materialization of these risks.

introducing the regulations. Alberola *et al.* (2011) look at dynamic provisioning in Spain,[6] while Wong *et al.* (2011) look at the impact from the LTV regulation in Hong Kong and elsewhere. The papers noted focus above all on analyzing a single macroprudential policy measure, but not on a comparative analysis of multiple measures. Research that makes a comparative analysis of multiple macroprudential policy measures under a unified framework includes Angelini *et al.* (2011), who compare a countercyclical capital requirement with an LTV regulation, and Goodhart *et al.* (2012), who analyze an LTV regulation, a repo haircut, a capital ratio requirement, a liquidity coverage ratio requirement, and dynamic provisioning. These papers have their own set of issues, however, including modeling that is dependent on extreme simplification of the banking sector, and a reliance on models that are too abstract to analyze actual economic fluctuations.

In this paper, we use a financial macro-econometric model (FMM) to mimic Japan's macroeconomic dynamics and financial sector activities, expand the model to enable an analysis of individual banks, and compare the economic impact of multiple macroprudential policy measures. Specifically, assuming the type of shock to the financial cycle seen during Japan's economic bubble, we analyze what sort of impact the macroprudential policy measures (an LTV regulation, a debt-to-income [DTI] regulation, a credit growth restriction, and a time-varying capital ratio requirement) provide in deterring the bubble and during the subsequent recession. At the same time, we analyze the impact these measures have in raising the financial system's resilience against risks.

This paper is organized as follows. In Section 2, we give an overview of the FMM used in our analysis and explain how we expand it. In Section 3, we explain our simulation method. In Section 4, we show the specific effects of each macroprudential policy measure in Japan. In Section 5, we analyze the impact that these measures have on the resilience of the financial system against risks. In Section 6, we present our

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[6] Provisioning rules in which the loan-loss provisioning rate changes based on the economic trend. For example, the loan-loss provisioning rate would increase during an expansion in preparation for bankruptcies caused by a future contraction.

conclusions. In the Appendix, we lay out in detail the estimation results of the FMM extended to incorporate individual banks' activities.

II. The Financial Macro-Econometric Model (FMM)

To analyze the impact on the macroeconomy of using macroprudential policy to directly affect the financial system, it is necessary to use a model that incorporates the feedback loop between the financial sector and the real economy. The FMM from Ishikawa *et al.* (2012) that we use in this paper is a medium-scale structural model comprising two sectors, a financial sector and a macroeconomic sector (Chart 3). The financial sector of the FMM includes a credit cost function estimated using the self-assessment data of individual banks as a core part of the model, and calculates loan volume and capital ratios based on the function. These financial variables move in step with changes in the real economy. The FMM also models how the macroeconomic sector affects movements in financial variables. Thus, the FMM is a model that explicitly incorporates the feedback loop between the financial sector and the real economy. The FMM also incorporates expected growth rates and asset prices to recreate within the model fluctuations in the financial and real economic variables large enough to create a bubble. Using a model capable of recreating this feedback between the financial sector and the real economy as well as large movements in asset prices and other variables makes it possible to quantitatively analyze the characteristics of macroprudential policy instruments.

We also extend our analysis to model behaviors of individual banks. Until now, the FMM has formulated all functions other than the previously mentioned credit cost function on a macro basis, and conceptually assumed a single large bank. The results of any analysis of macroprudential policy measures, however, would be expected to differ depending on the perimeter of regulated institutions. Consequently, a model that is formulated at the individual bank level is needed to accurately measure and compare the impact from each macroprudential policy measure. With this in mind, we replace the macro functions of the loan volume, operating profits of core business, equity capital, and other financial sector variables in the FMM measured at the macro level by

micro functions on an individual bank basis by running a panel estimation on data from individual banks. We then define the macro-based variables as the sum total of the individual bank variables[7] (for more details on the functions and other estimation results, see the Appendix). As shown below, for the policy rate we use a policy response function based on the Taylor-type rule, wherein the policy rate changes in accordance with movement in the real economy.[8,9,10]

$$\text{Policy rate}_{t} = 0.957 \times \text{policy rate}_{t-1} + 0.042 \times \text{output gap}_{t}.$$

III. Setting Up the Simulation

We run a stochastic simulation using an FMM extended to incorporate activities on an individual bank basis to analyze and compare among different macroprudential policy measures. In this section, we explain our simulation assumptions and the macroprudential measures that we use in the paper.

A. Formation of the Financial Cycle

We assess the macroprudential policy measures based on how well they are able to dampen the overheating and subsequent unwinding of the financial and real economies that occurred during Japan's economic bubble. Such an analysis requires recreating this financial cycle within the model. As shown by Okina *et al.* (2001), bullish expectations during Japan's Heisei bubble drove asset prices substantially higher,

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[7] A weighted average is used for the macro-based lending rate, weighting each bank's lending rate by its share of total lending.

[8] Prices in the FMM are given exogenously. Given the importance of loans and other nominal variables to financial fluctuation and in light of the minimal price moves in Japan in the past, we make prices an exogenous variable. Consequently, the policy response function in the FMM responds only to the output gap. Endogenizing prices would not substantially change the conclusions outlined below.

[9] In simulations, we set nominal interest rate above about 5% at the starting point of the simulations to avoid the zero lower bound on these rates.

[10] We use the call rate as the policy rate.

caused economic activity to overheat and collateral prices to surge, and greatly expanded the volume of credit.[11] Hence we incorporate mechanisms in the model to ensure that large increases and decreases in the expected growth rate cause large fluctuations in the financial and real economies.[12] We assume that larger expansions are followed by more serious downturns. In addition, increasingly bullish expectations become self-reinforcing during the bubble, and our model recreates this mechanism as well. This makes it possible to examine the impact that macroprudential policy instruments have in curtailing these self-reinforcing moves in the economic and financial sector brought by bullish expectations.

Specifically, we incorporate into the FMM's expected growth function shocks that raise (lower) expected growth as the economy overheat (stagnate) as follows.

$$\text{Expected growth rate}_t = f(\text{potential real GDP}_t, \text{real GDP}_t) + \text{shock}_t$$

$$\text{Shock}_t = (X + Y \times \text{output gap}_t) \times I_t$$

$$I_t = \begin{cases} 1 \text{ if } t = \text{expansion phase} \\ -1 \text{ if } t = \text{contraction phase} \end{cases}$$

$$X \sim N(0, \sigma^2).$$

The shock in the first period of the simulation is given as X. The shock in the

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[11] Minsky (1992) emphasizes the importance of interaction between the financial sector and the real economy in which a credit boom and an investment boom accelerate each other. In such a process, although a lending standard is eased and an investment boom is further promoted, these booms collapse when the booms are recognized as overheated. Minsky states that "over periods of prolonged prosperity, the economy transits from financial relations that make for a stable system to financial relations that make for an unstable system."

[12] In addition, financial innovations can occur to promote credit expansions in the bubble period. For example, investment trusts and leveraged financial products that repackage such investment trusts appeared in the period leading up to the Great Depression in the United States, and they accelerated credit expansion (Galbraith [1952]). Moreover, prior to the Lehman shock credit expansion was accelerated by financial innovations in securitized products and a boom in such products in the United States. Furthermore, in the recent bubble credit expansion was observed in unconventional financial intermediations such as shadow banking due to regulatory arbitrage. It is difficult to incorporate all of these factors into a model, and factors that appear during a bubble can differ in each case.

second and subsequent periods is zero in the first term X but changes endogenously based the output gap in the second term. The shock in the first period is given by stochastic simulations of 5,000 times, and 15-year simulations for the top 10% of shocks in size that create positive large financial cycle are conducted. Parameters σ and Y are set so that the simulation recreates the economic fluctuations that occurred during Japan's Heisei bubble.[13] We exogenously set the length of the upward and downward phases of expected growth (the business cycle I_t) in simulations. We set the length of the expansion phase at four years, given that the boom period of the Heisei bubble defined by Okina *et al.* (2001) was the four-year period spanning 1987 to 1990, and given that the Cabinet Office defines the 11th economic expansion, which includes the Heisei bubble, as lasting 51 months, from November 1986 until February 1991(Chart 4). The expected growth rate reaches its highest point in the fourth year of the upward phase. Nominal GDP growth is also positive during this period, and reaches its highest level in its fourth and final year. We also set the length of the period of declining expectations at four years, keeping the entire cycle of expected growth symmetric and at eight years in length.

B. Formulating Macroprudential Policy Instruments

We analyze five macroprudential policy measures in this paper: a regulation on LTV ratios on loans to individuals; a regulation on LTV ratios on loans to corporations; a regulation on DTI ratios; a restriction on credit growth; and a time-varying capital ratio requirement. As shown in Chart 2, many countries have already used LTV, DTI, and credit growth regulations, and these could be viewed as the traditional policy measures for affecting credit.[14] In addition, although few countries have implemented

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[13] We use the standard deviation of the forecast error for the expected growth rate as the standard deviation σ of the normal distribution followed by X, and we set Y at 0.2. This allows us to replicate within the model the output gap seen during the bubble (as high as around 5%).

[14] Policy actions to loans to particular industry, such as a mortgage loan, can be assumed. Lim *et al.* (2011) show that a regulation focusing on a particular type of loan can be even more effective. The FMM, however, includes aggregate retail and corporate loans rather

time-varying capital ratio requirements, countercyclical capital buffers -- a similar policy measure -- are slated to go into effect under Basel III, which many countries are expected to adopt.[15]

The economic and financial conditions prevailing when polices are actually implemented must be taken into account. In this paper, when the thresholds or cap levels (regulatory hurdles) of the reference indicator for each policy measure are surpassed, specific policy measures are put into effect (Chart 5; we provide a detailed explanation of how the regulatory hurdles are set later in this section). Accordingly, macroprudential policy action is only taken when financial imbalances become large enough to exceed specific thresholds, thereby preventing the sort of extreme overheating of the financial and real economies that occurred during Japan's bubble. This marks a distinction from monetary policy, which does not set specific triggers but instead makes regular gradual adjustments to the policy rate based on economic conditions.

Now we take a closer look at each policy instrument. When the DTI or LTV caps for individual loans are exceeded, the regulatory variable -- year on year (YoY) growth in loan volume -- is restricted. For the LTV cap on corporate loans, it is the YoY growth in corporate lending that is restricted, and for the cap on credit growth, the YoY growth in all lending is restricted. With time-varying capital requirements, the regulatory capital ratio is raised, and this has the effect of constraining loan volume.[16,17]

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than loans to a specific industry. Thus, an important topic for the future is to evaluate the effects of regulations for a specific industry.

[15] A countercyclical capital buffer, which requires enough additional capital to completely absorb losses of common equity Tier I capital when the economy is strong and allows the buffer to be drawn down when the economy is weak, is scheduled to be phased in from January 1, 2016. The size of the buffer will be determined by the home-country authorities in accordance with the country's credit cycle, and will be between 0 and 2.5%.

[16] We base the indicator levels and regulatory details of our time-varying capital requirements on the countercyclical capital buffer outlined in Basel III. For more on this, see Drehmann *et al.* (2010).

[17] We do not consider an additional issuance of banks' stock as a transmission channel of time-varying capital requirements. We therefore assume that banks raise their capital ratios

The indicators we use in this paper are either the indices actually used by policymakers or those that we consider effective. Taking account of the specifics of this model, we set these indicators as follows. For the LTV ratio for loans to individuals, we divide loans to individuals by land prices. For the DTI ratio, we divide loans to individuals by employee compensation (total for the latest four quarters).[18] For the LTV ratio of corporate loans, we divide corporate loans by land prices. For restrictions on credit growth, we use the YoY growth in the total volume of loans to corporations and individuals combined as the indicator. For the time-varying capital requirement, we benchmark use the credit-to-GDP ratio, which is the loan volume divided by nominal GDP (total for the latest four quarters).

IV. Characteristics of the Results for Each Policy Measure

In this section, we analyze the basic characteristics of the outcome of introducing each policy measure and show the impact of operational settings and problems on these outcomes. In particular, we look at the impact on policy results brought by (1) the length and strength of action, (2) the presence of a recognition lag, (3) reference indicator settings, and (4) the perimeter of regulations.

A. Length and Strength of Actions

The length of time that macroprudential policy measures are in effect and the strength of these policies are both up to the policymakers' discretion, and multiple combinations of the two are possible. To look at the fundamental characteristics of each policy instrument, we run two simulations, one holding the strength of the policy response

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by reducing risk assets via a reduction in lending.

[18] The LTV ratio is usually defined as the ratio of the loan amount to the underlying collateral assets such as real estate, but taking account of the specifics of the model used in this paper, we define the LTV ratio as the amount of loans, retail or corporate, divided by the value of the land prices. Likewise with the DTI ratio, instead of using outstanding debt divided by household income, we define it as the ratio between the amount of retail loans and compensation of employees.

constant while varying the implementation period, and the other holding the implementation period constant while varying the strength of the policy response.[19]

Looking first at the impact of the length of the period of action, we simulate using four different fixed policy period lengths: one, two, three, and four years. For the four-year policy period, the policy would remain in force over the entire four-year period of rising growth expectations. The strength of the policy is held constant over this time. In other words, for the retail LTV regulation, the corporate LTV regulation, the DTI cap, and the restriction on credit growth, we lower the loan growth rate subject to restriction by only one-quarter of one standard deviation ($1/4\sigma$) of the fluctuation over the time series. For the time-varying capital requirement, we raise the required capital ratio by only one-quarter of one standard deviation of the fluctuation over the time series.

The strength of the policy action must be flexibly applied depending on economic conditions. We assume three different patterns of policy strength for the retail LTV regulation, the corporate LTV regulation, the DTI regulation, and the restriction on credit growth, restricting loan growth to $1/8\sigma$, $1/4\sigma$, and $1/2\sigma$. We also assume three patterns for the time-varying capital requirement: raising the regulatory capital ratio by $1/8\sigma$, $1/4\sigma$, and $1/2\sigma$. We assume the policy is implemented over the entire four-year period when the expected growth rate is rising.

Before showing the detailed results of our analysis, we start with an overview to facilitate an intuitive understanding. Chart 6 shows the change in nominal GDP when implementing each macroprudential policy measure at $1/4\sigma$ strength during the four-year period when expected growth is rising. The baseline in the chart is for the case when no policy action is taken. The results show that growth in nominal GDP during an expansion is suppressed as a result of implementing the various macroprudential

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[19] As mentioned, for the level and standard deviation of nominal GDP when no policy measure is used, we use the top 10% in size of positive fluctuation from the results of our stochastic simulation. This is because the systemic risk that is addressed by macroprudential policy measures has a large impact when it materializes but is a rarely occurring risk, and it is the effect on the tail event that must be measured.

policy measures. In addition, a consequence of constraining economic overheating with these policies is that the decline in nominal GDP during the subsequent contraction is reduced.

Next, we take a more detailed look at the specifics of the policy results across policy instruments. Chart 7 shows quantitatively the degree, relative to the baseline, to which economic fluctuations were suppressed (vertical axis) and also to which economic growth was lowered (horizontal axis) as a result of implementing each policy measure. Specifically, the vertical axis shows the difference in the standard deviation of nominal GDP between taking a policy action and not doing so.[20] The horizontal axis shows the difference in the average level of nominal GDP between the same options. Chart 8 likewise shows the policy results when altering the strength of the policy actions.

The following characteristics can be gleaned from the simulation results. First, in most of the policy measures, the longer the policy is in place, or the stronger the policy, the greater the reduction in both the standard deviation of nominal GDP and the average level of nominal GDP. In other words, implementing these policies has the benefit of reducing economic fluctuations, but also has the demerit of reducing average economic growth. Average economic growth is lowered because although the macroprudential policy instruments reduce economic overheating, they have only weak power to stimulate the economy during its contraction phase even if policy actions are eased. For example, implementing the LTV regulation in a period of economic overheating constrains both business fixed investment and housing investment through the mechanism of a reduction in lending. During an economic downturn, the volume of lending decreases substantially and the LTV falls below the regulatory level, even though the LTV regulation is eased. Thus, while the measures serve as a brake on an overheating economy, they have only weak power to boost a weakening economy, and thus can induce asymmetric effects depending on the phase

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[20] We calculate the average and standard deviation by pooling 15 years of samples for all stochastic simulation paths.

of the business cycle.[21]

Second, there are substantial differences among policy measures in terms of the effects on reducing economic fluctuations (decline in the standard deviation of nominal GDP). This trait becomes more pronounced both for longer periods of implementation and for stronger policies. Regarding the time-varying capital requirement, the decline in the nominal GDP standard deviation is the smallest. A reason is that time-varying capital requirements constrain the volume of loans less than other policy measures, since capital ratios rise in a boom due to banks' higher profit. On the other hand, other policy measures constrain the volume of loans regardless of the level of capital ratios when the speed of credit growth exceeds a certain level. Thus, these policy measures have a sufficient effect on suppressing an overheating of the economy.

Third, the declines in the average level of nominal GDP differ by policy measure. Both the LTV regulation on loans to individuals and the DTI regulation tend to result in a smaller reduction in the standard deviation of nominal GDP, but a greater reduction in the average level of nominal GDP. We attribute this to the structure of Japan's economy, where there is a fairly long time lag between changes in lending and changes in household spending. Consequently, the impact of macroprudential policy measures during periods of overheating is still lingering into the subsequent downturn. On the other hand, the corporate LTV regulation, which only constrains corporate loans, has less of a downward impact on average nominal GDP relative to its reduction in the standard deviation of nominal GDP than is the case for the LTV regulation on loans to individuals. Since corporate expenditures on fixed investments are more responsive to the changes in credit than household expenditures, the effects of the

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[21] Such a feature can be clear particularly in Japan's economy, which has a low potential growth rate. In other words, the relaxation of the macroprudential policy measures provides only a marginal positive impact on the economy since loan demand in a recession is very low due to the stagnant potential growth rate in Japan. On the other hand, in emerging economies with a high potential growth rate, loan demand would be strong even in a recession and so it is possible that relaxation of macroprudential policy measures would stimulate the economy. In this case, it is possible that no trade-off would be observed. Thus, the effects of macroprudential policy measures depend strongly on economic structures and empirical analysis is needed to evaluate such effects.

corporate LTV regulation persist less than those of the LTV regulations on loans to individuals. The credit growth restriction restrains both retail and corporate lending and so the absolute effect of such a policy is greater than that of the regulation focusing on corporate loans or retail loans. It should be noted that in the credit growth restrictions the decline in the average level of nominal GDP relative to the decline in the standard deviation of nominal GDP is smaller than that of the retail LTV regulation, but larger than that of the corporate LTV regulation. When the time-varying capital requirement is applied, the decline in the average level of nominal GDP is small. This is because the banks gradually restrain loans depending on their own capital ratios and so an excessive tightening of credit conditions is less likely to occur compared with other macroprudential policy measures that exogenously and sharply constrain loans.

B. The Problem of Recognition Lags

The lag between the actual change in economic conditions and the recognition of the need to implement policies (recognition lag) is a serious challenge for regulators in their actual use of policy measures.[22,23] In other words, when financial activity starts to overheat, regulators must ascertain whether this activity is temporary or the start of a long-term process of accumulating imbalances. This means that in order to avoid initiating the wrong policies, economic conditions need to be observed for a certain period before deciding on a policy action.

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[22] For example, Friedman (1948) finds three types of lag: (1) the lag between a need for action and the recognition of this need (a recognition lag); (2) the lag between recognition of the need for action and the taking of action (an action lag); and (3) the lag between the action and its effects (an impact lag).

[23] The inability to accurately ascertain the financial and economic conditions in real time is called the real-time problem (see Orphanides and Norden [2002]). One example of this is when the data are altered substantially between the quick estimation and final data releases. Although the real-time problem is often discussed in the context of monetary policy, the same problem occurs with macroprudence. This real-time problem is a key to assessing whether results are robust to changes in the recognition lag when evaluating macroprudential policy measures.

Chart 9 shows the results from policies initiated for a one-year period with five different starting points, from the first year of a period of rising expected growth all the way to the fifth year (actually the first year of the contraction). Because expected growth had already begun declining in the last (fifth) case, this means that the policy is being implemented at a time when nominal GDP growth is negative. The results suggest the following.

First, even when there is a recognition lag, a trade-off generally exists between suppressing nominal GDP standard deviation and lowering the average level of nominal GDP. Second, however, this recognition lag changes the policy impact. When the retail LTV regulation, the corporate LTV regulation, the DTI regulation, and restrictions on credit growth are implemented beginning with the first year of an economic expansion, the standard deviation of nominal GDP is suppressed more strongly. If initiated in the third year, one year before the fourth year, when expected growth is at its highest, for many policy actions the downward impact on average nominal GDP is minimized. If the policy is implemented in the fifth year, when the economy has already begun to turn downward, the contraction is made deeper, and thus all of the policy measures lower the average level of nominal GDP while raising its standard deviation. Third, the greater the policy impact of a particular policy, the more the policy's impact is changed by the recognition lag. The effects from capping the LTV on corporate loans and from restricting credit growth are altered more by the recognition lag than are the effects from capping the LTV on retail loans, DTI regulations, and time-varying capital requirements.

C. Problems with Reference Indicators

When regulators conduct macroprudential policy measures, rather than implement them for a predetermined time period, they are probably going to observe certain reference indicators and put the measures into effect when they exceed the regulatory thresholds. This presents the technical problem of deciding which reference indicators to use and where to set their maximums (threshold for action). As already noted, the reference indicators we use here are those outlined in Chart 5. We note that there is

currently no consensus on what the appropriate threshold level is. What we do here is calculate the gap from the indicator's trend and then set the regulatory trigger based on the indicator's historical distribution.[24] For our simulation, we used two different regulatory triggers, one at the 90th percentile and one at the 70th percentile of the gap's empirical distribution (Chart 10).[25]

Chart 11 shows the results from setting the regulatory trigger at the 70th and 90th percentiles. The results indicate that there is no major change in the relative characteristics of policy effects across policy measures when indicators are used. Furthermore, the lower the trigger is set (in the case of the 70th percentiles), the greater is the impact from each policy measure. This is because the policy measure is triggered at an earlier timing.

Chart 12 shows what happens when using a regulatory trigger at the 70th percentile and assuming a recognition lag for the indicator. Policy is implemented when a certain trailing moving average exceeds the threshold. For example, assuming

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[24] The trend is estimated by the HP-filter and the parameter for filtering tightness is a value borrowed from Drehmann *et al.* (2010) (λ= 400,000), which is a conventional one for detecting large financial cycles. It should be noted that qualitative outcomes of simulations do not change even for a standard parameter of filtering tightness (λ= 1,600) used in business cycle analysis. The economic fluctuations, however, can be smaller due to earlier responses of the policies in the case of λ= 1,600 for some prudential measures than in the case of λ= 400,000. The macroprudential policy measures are generally started and terminated at an earlier timing as the financial cycle is recognized to be shorter. In this case, the macroprudential policy measures can be terminated while financial activities are still overheating and eventually will not be able to suppress a large financial cycle if it is supposed incorrectly to be short. On the other hand, implementation of macroprudential policy measures can be delayed but prolonged for a long time, and so macroprudential policy measures can succeed in constraining a large financial cycle if it is supposed to be long. Practically speaking, therefore, policymakers should conduct a careful analysis of timing issues in implementing the macroprudential policy.

[25] Given that bubbles and financial crises do not occur frequently in each country, it is difficult to actually set regulatory triggers at reliable levels, even when quantifying these episodes and reference indicators' thresholds using statistical methods. It is also conceivable that the relationship between absolute levels of the indicator and the accumulation of risk will change as a result of technical innovations in finance and structural changes in the financial system.

a recognition lag of two quarters, policy would be implemented when the average of the index over the past two quarters exceeded the regulatory threshold. Observed in more detail, although it is difficult to ascertain a pattern, generally the shorter the recognition lag, the greater the degree to which the nominal GDP standard deviation tends to be suppressed.

D. Impact from the Regulatory Perimeter

To see the impact of the perimeter of regulation, Chart 13 shows the same simulation described in Chart 7 except that the capital requirements are applied only to internationally active banks.[26,27] These results confirm that narrowing the perimeter of regulation can reduce the policy measure's quantitative impact relative to when all banks are subject to the regulation.

V. Evaluating the Resilience of the Financial System against Risks

Another objective of macroprudential policy measures besides suppressing the financial cycle is raising the resilience of the financial system, that is, eliminating the risk from financial crises. Next we analyze the policy measures' characteristics from this perspective.

Chart 14 compares the average Tier I ratio, a measure of core capital, based on whether macroprudential policy measures are being used. In other words, for the retail loan LTV regulation, the corporate loan LTV regulation, the DTI regulation, and the restriction on credit growth, we assume that the growth rate of the regulated variable is lowered by only one-quarter of one standard deviation ($1/4\sigma$) of the fluctuation over the time series, and for the time-varying capital requirement we assume a policy of

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[26] The argument that systemically important financial institutions must be held to more rigorous regulations is gaining ground. For details, see Financial Stability Board (2010).

[27] As of end-September 2011, of the 117 major and regional banks, only 16 (six major banks and 10 regional banks) are deemed internationally active banks. This is just over 10% of the number of banks, but represents more than a 50% share of their aggregate total assets.

raising the regulatory capital requirement by only 1/4σ of the fluctuation over the time series -- in both cases over the entire four-year period of rising growth expectations. The results show that the average Tier I ratio is raised over the financial cycle regardless of which policy measure is implemented. Because this comes from the constraints put on excessive lending, restrictions on credit growth, which are most effective in this regard, raise the average Tier I ratio by the largest amount. This makes it possible to smoothly continue with financial intermediation during a recession. Chart 15 shows changes in loan volume based on whether macroprudential policy measures are used. The baseline is when no policy measures are used. During a contraction, lending volume increases above the baseline when policy measures are used. This suggests that implementing macroprudential policy measures strengthens the financial system's resilience against risks and makes more stable financial intermediation possible.

VI. Conclusion

We have used the FMM extended to incorporate individual banks' activities to analyze the impact on the economic dynamics of five macroprudential policy measures within a bubble financial cycle. We find that although these macroprudential policy measures dampened economic volatility, it is possible that they reduce average economic growth, and the effects on the economic dynamics differ widely among macroprudential policy measures. We also find that their effects are changed dramatically by lags in recognizing the state of the economy. Our results also suggest that macroprudential policy measures can help contribute to achieving more stable financial intermediation by raising the resilience of the financial system against risks.

We would like to end by proposing six areas where this paper could be developed further. First, there is room for further discussion on the appropriate criteria to be used in assessing the policy impact.[28] Our analysis uses the volatility and average level of

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[28] This is a formula that aims to maximize welfare by adjusting the short-term interest rate as a policy variable by minimizing fluctuations in the price and the real economy when

nominal GDP as a metric to assess the different macroprudential policy measures. This approach does not allow for any conclusions as to the appropriate levels of the strength of the policy measures and the most favorable combination of measures. It is necessary to make a deeper inquiry into the proper strength of macroprudential policy measures and how best to combine them, while taking into account the objectives and uses of each policy measure. Second, because of the major impact from the recognition lag, it is a challenge to use an analysis of capturing financial imbalances in real time when implementing macroprudential policy measures. Our approach has been to specify reference indicators and assume that policy measures are implemented automatically based on them, but a deeper analysis is needed to identify financial imbalances and the timing of policy actions, while making use of early warning indicators and other indicators of macro risk.[29] Third, we have looked at Japan's banking sector, without taking into account the impact from regulatory arbitrage between countries and between sectors.[30] As the experiences of Japan's past bubble economy and the latest financial crisis have shown, this regulatory arbitrage has more than a trivial impact on the efficacy of macroprudential policy measures, and thus the model needs to be extended to evaluate this aspect. Fourth, we do not analyze any macroprudential policy measures related to liquidity, such as the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR) schedule to be introduced under Basel III. As previous financial crises have shown, however, liquidity cannot be ignored when dealing with financial system stability, and there is room for the analysis to be extended into this domain. Fifth, over a somewhat longer time frame, monetary policy is also a factor that

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analyzing monetary policy (the optimal monetary policy analysis). A number of problems arise when considering whether such a formulation is appropriate in the context of macroprudential policy, as well as how best to formulate the mission of macroprudence, which is to avoid tail events that have a small probability of occurring but incur a major cost when they do occur.

[29] The Bank of Japan checks for the accumulation of financial imbalances based on a comprehensive assessment of multiple macro risk indicators, including the Financial Cycle Indices, an early warning indicator of financial crises, the ratio of total credit to GDP, and the Financial Activity Index. For details, see Bank of Japan (2012).

[30] Goodhart *et al.* (2012) show the results of an analysis that explicitly takes into account the presence of shadow banks and regulatory arbitrage.

has a major impact on financial system stability. This makes it important to analyze how monetary policy and macroprudential policy interrelate.[31] We use a policy response function based on the Taylor-type rule to incorporate adjustments of the policy rate in accordance with changes in the economy. When there is a danger of a bubble forming in the financial cycle, however, there may be a need to raise the policy rate above the rate normally indicated by the rule.[32] There is room for more in-depth analysis regarding this point. Sixth, given that shocks that destabilize the financial system can materialize via different channels depending on the situation, it is possible that no one-size-fits-all macroprudential policy measure exists, but rather that the desirable policy measure differs depending on the shock at the time. The characteristics of policy measures when used against a range of different types of shocks need to be clarified.

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[31] The Bank of Japan also places importance on a view of macroprudence in its monetary policy, and under the "second perspective" checks for financial system risks as one medium- and long-term risk factor.

[32] It would also be of interest to analyze the role of macroprudential policy when monetary policy faces the zero lower bound on the nominal interest rate.

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Appendix: Details of the Individual Bank-Based Model

This paper uses the FMM model extended to incorporate individual banks' activities. We provide details of both the individual bank-based functions added via an extension and the macro-based functions changed from Ishikawa *et al.* (2012). The values within the angular brackets appended to the estimation results show the P values.

I. Individual Bank-Based Functions

(1) Bank *i*'s Lending Volume

Bank *i*'s lending volume

= Bank *i*'s corporate lending volume

  + Bank *i*'s household lending volume

  + Bank *i*'s local governments lending volume

  + Bank *i*'s overseas yen lending volume

(2) Bank *i*'s Corporate Lending Volume

Year-on-year growth rate of Bank *i*'s corporate lending volume

= Bank *i*'s fixed-effect coefficient

  + 1.50 × expected growth rate <0.00>

  − 1.93 × year-on-year change in (Bank *i*'s lending interest rate − eight-quarter mean of year-on-year growth rate of consumer prices) <0.00>

  + 0.40 × Bank *i*'s capital adequacy ratio gap (excluding public funds) <0.00>

  + 0.32 × year-on-year growth rate of land prices <0.00>

  − 1.33 × off-balancing dummy <0.00>

  − 1.43 × Financial Revitalization Program dummy <0.00>

  + 1.11 × independent administrative institution dummy <0.00>

Note: Sample = 1989/Q3 through 2011/Q3; adjusted R^2 = 0.21

(3) Bank *i*'s Household Lending Volume

Year-on-year growth rate of Bank *i*'s household lending volume

= Bank *i*'s fixed-effect coefficient

  + 0.60 × expected growth rate <0.00>

  − 0.54 × year-on-year change in (Bank *i*'s lending interest rate − eight-quarter mean of

  year-on-year growth rate of consumer prices) <0.00>

  + 0.31 × Bank *i*'s capital adequacy ratio gap (excluding public funds) <0.00>

  + 0.47 × year-on-year growth rate of land prices <0.00>

  + 5.02 × consumption tax (on loans, 1997) dummy <0.00>

  + 3.51 × transition from housing loan company dummy <0.00>

  + 4.09 × Government Housing Loan Corporation's reduced business dummy <0.00>

Note: Sample = 1989/Q3 through 2011/Q3; adjusted R^2 = 0.12

(4) Bank *i*'s Lending Interest Rate

Bank *i*'s lending interest rate

= Bank *i*'s fixed-effect coefficient

  + 0.95 × Bank *i*'s funding interest rate <0.00>

  + 0.006 × lending volume gap <0.00>

Note: Sample = 1988/Q1 through 2011/Q3; adjusted R^2 = 0.97

(5) Bank *i*'s Funding Interest Rate

Bank *i*'s funding interest rate

= Bank *i*'s fixed-effect coefficient

  + 0.67 × call rate <0.00>

  − 0.08 × Bank *i*'s capital adequacy ratio gap <0.00>

Note: Sample = 1989/Q3 through 2011/Q3; adjusted R^2 = 0.94

(6) Bank *i*'s Net Interest Income

Bank *i*'s net interest income

= Bank *i*'s fixed-effect coefficient

  + 0.54 × (Bank *i*'s lending interest rate − Bank *i*'s funding interest rate) / 100 / 4 × Bank *i*'s lending volume <0.00>

  + 0.002 × (Bank *i*'s Japanese Government Bond holdings + Bank *i*'s municipal bond holdings + Bank *i*'s corporate bond holdings + Bank *i*'s other security holdings) <0.00>

Note: Sample = 1983/Q2 through 2011/Q3; adjusted R^2 = 0.96

(7) Bank *i*'s Operating Profits of Core Business

Bank *i*'s operating profits of core business

= Bank *i*'s net interest income + Bank *i*'s net non-interest income

  − Bank *i*'s general administrative expenses

(8) Bank *i*'s Net Income

Bank *i*'s net income

= (Bank *i*'s operating profits of core business − Bank *i*'s credit cost + Bank *i*'s realized gains / losses on bondholdings + Bank *i*'s realized gains / losses on stockholdings)

  − max ([Bank *i*'s operating profits of core business − Bank *i*'s credit cost + Bank *i*'s realized gains/losses on bondholdings + Bank *i*'s realized gains/losses on stockholdings], 0) × 0.4

(9) Bank *i*'s Capital

Bank *i*'s capital

= Bank *i*'s Tier I capital + Bank *i*'s Tier II capital + (Bank *i*'s Tier III capital − Bank *i*'s regulatory adjustment)

(10) Bank *i*'s Tier I Capital

Bank *i*'s Tier I capital

= Bank *i*'s shareholders' equity + Bank *i*'s other Tier I capital

  + min (Bank *i*'s revaluation difference on available-for-sale securities, 0)

(11) Bank *i*'s Risk Asset

Bank i's risk asset

= Bank *i*'s credit risk asset + Bank *i*'s market risk asset + Bank *i*'s operational risk asset +

Bank *i*'s other risk asset

(12) Bank *i*'s Credit Risk Asset

Year-on-year growth in Bank *i*'s credit risk asset

= Bank *i*'s fixed-effect coefficient

  + 1.00 × year-on-year growth in (Bank *i*'s corporate lending volume + Bank *i*'s household lending volume + Bank *i*'s corporate bond holdings + Bank *i*'s other security holdings) <0.00>

  + 2.83 × year-on-year growth in Bank *i*'s stockholdings <0.00>

  − 260.51 × introduction of Basel II dummy <0.00>

  − 3146.57 × (introduction of Advanced Internal Ratings-Based Approach dummy × internationally active bank dummy × major bank dummy) <0.00>

Note: Sample = 2000/Q1 through 2011/Q3; adjusted R^2 = 0.76

(13) Bank *i*'s Market Risk Asset

Bank *i*'s market risk asset

= Bank *i*'s fixed-effect coefficient

  + 0.68 × (interest rate volatility × market risk bank dummy) <0.00>

Note: Sample = 1998/Q1 through 2011/Q3; adjusted R^2 = 0.87

(14) Bank *i*'s Operational Risk Asset

Bank *i*'s operational risk asset

= Bank *i*'s fixed-effect coefficient

  + 2.32 × (three-year mean of Bank *i*'s total gross income × introduction of operational

  risk dummy) <0.00>

Note: Sample = 2007/Q1 through 2011/Q3; adjusted R^2 = 0.98

(15) Bank *i*'s Shareholders' Equity

Year-on-year growth in Bank *i*'s shareholders' equity

= four-quarter total of Bank *i*'s net income − max (four-quarter total of Bank *i*'s net

income, 0) × 0.2

II. Macro-Based Functions

(1) Lending Volume

Lending volume

= Σ_i Bank *i*'s lending volume

(2) Corporate Lending Volume

Corporate lending volume

= Σ_i Bank *i*'s corporate lending volume

(3) Household Lending Volume

Household lending volume

= Σ_i Bank *i*'s household lending volume

(4) Lending Interest Rate

> Lending interest rate
>
> = Σ_i Bank i's lending interest rate × (Bank i's lending volume / lending volume)

(5) Net Interest Income

> Net interest income
>
> = Σ_i Bank i's net interest income

(6) Operating Profits of Core Business

> Operating profits of core business = Σ_i Bank i's operating profits of core business

(7) Capital

> Capital = Σ_i Bank i's capital

(8) Tier I Capital

> Tier I capital = Σ_i Bank i's Tier I capital

(9) Risk Asset

> Risk asset = Σ_i Bank i's risk asset

(10) Credit Risk Asset

> Credit risk asset = Σ_i Bank i's credit risk asset

(11) Market Risk Asset

> Market risk asset = Σ_i Bank i's market risk asset

(12) Operational Risk Asset

Operational risk asset = Σ_i Bank i's operational risk asset

(13) Shareholders' Equity

Shareholders' equity = Σ_i Bank i's shareholders' equity

(14) Policy Rate (Call Rate)

Policy rate = 0.96 × policy rate (- 1) <0.00>

  + 0.04 × output gap <0.00>

Note: Sample = 1985/Q4 through 2011/Q3; adjusted R^2 = 0.98

(Chart 1)

Types of Macroprudential Policy Measures

Type of instrument	Examples
Limits calibrated to borrower risk characteristics	LTV caps, DTI limits, foreign currency lending limits
Absolute limits	Aggregate or sectoral credit growth ceilings, limits on exposures by instrument
Limits on leverage	Size-dependent leverage limits or asset risk weights, capital surcharges for systemically important institutions
Financial system concentration limits	Limits on interbank exopsures
Capital	Time-varying capital requirements, restrictions on profit distribution
Provisioning	Countercyclical/dynamic provisioning
Liquidity risk	Loan-to-deposit limits, core funding ratios, reserve requirements
Currency risk	Limits on open currency positions or on derivatives transactions

Source: CGFS (2010).
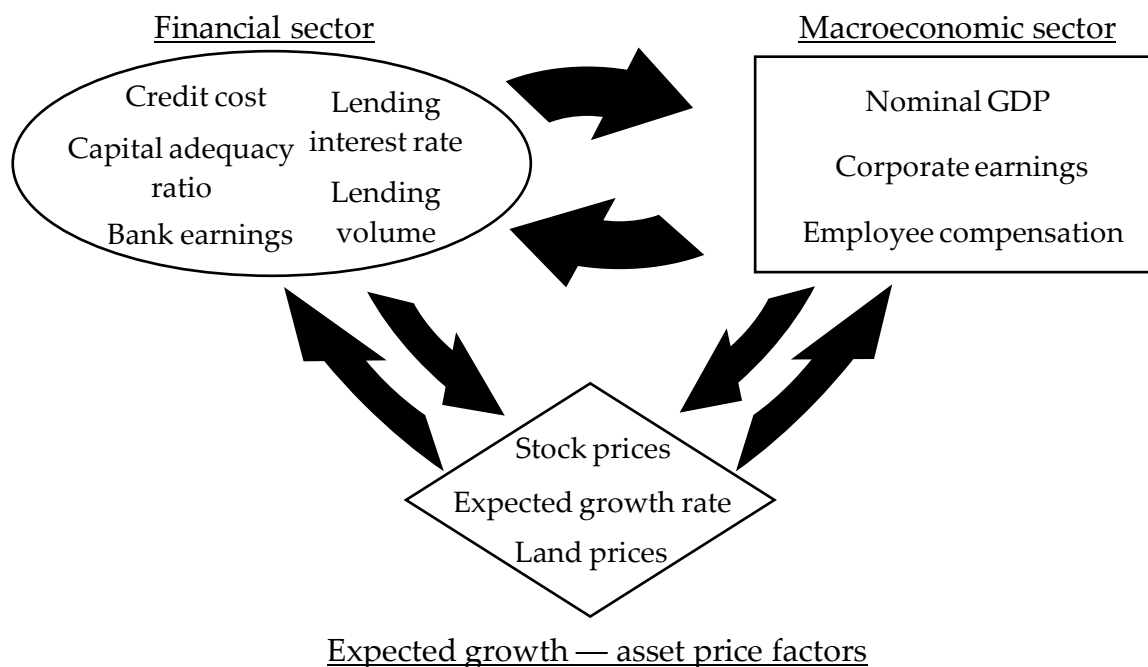
(Chart 2)

Macroprudential Policy Measure Use by Country

	LTV cap	DTI cap	Credit growth cap	Of which foreign currency	Time-varying capital requirements	Profit distribution limits	Risk weight restrictions	Dynamic provisioning	Liquidity ratio regulation	Of which foreign currency	Reserve requirements
Japan											
China	○		○		○			△			○
South Korea	○	○	○	○					○		○
Hong Kong	○	○	○								
Mongolia								○	○	○	○
Indonesia											○
Singapore	○		○						○		
Thailand	○	○					○		○	○	
Philippines											
Malaysia	○		○				○				○
India	○				○			○			○
Canada	○										
United States											
Mexico	○		○					○	○	○	
Italy	○										
Germany											
France									○		
United Kingdom					△						
Ireland							○				
Austria											
Netherlands											
Croatia	○	○	○		○		○	○	○		○
Greece		○	○					△			
Switzerland					△						
Sweden	○										
Spain							○	○			
Slovakia						○			○		
Serbia		○	○	○		○			○	○	○
Czech Republic											
Turkey	○		○	○		○			○	○	
Norway	○	○					○				
Hungary	○	○	○	○							
Finland											
Bulgaria					○		○	○			○
Belgium											
Poland		○	○	○			○	○			○
Portugal							○	△			
Romania	○	○	○	○				△			○
Russia								○	○	○	○
Jordan											
Lebanon	○								○	○	○
Australia											
New Zealand									○		
Argentina						○					
Uruguay							○	○	○	○	
Colombia	○	○	○			○		○	○	○	○
Chile	○				△						○
Paraguay											
Brazil	○						○	○	○	○	○
Peru								○	○	○	○
Nigeria			○						○	○	○
South Africa					○						

Notes:
1) Shaded countries are considered developed countries in BIS data.
2) Examples of time-varying capital requirements marked with a triangle indicate additional capital requirements for SIFIs.
3) Examples of dynamic provisioning marked with a triangle indicate a simple raising of the provisioning rate.

Sources: Nier *et al.* (2011), Lim *et al.* (2011).

(Chart 3)

Structure of FMM

Financial sector

Credit cost

Lending interest rate

Capital adequacy ratio

Lending volume

Bank earnings

Macroeconomic sector

Nominal GDP

Corporate earnings

Employee compensation

Stock prices

Expected growth rate

Land prices

Expected growth — asset price factors

(Chart 4)

Japan's Business Cycle

	Trough	Peak	Trough	Period		
				Expansion	Contraction	Full cycle
Cycle 1	—	June 1951	October 1951	—	4 months	—
Cycle 2	October 1951	January 1954	November 1954	27 months	10 months	37 months
Cycle 3	November 1954	June 1957	June 1958	31 months	12 months	43 months
Cycle 4	June 1958	December 1961	October 1962	42 months	10 months	52 months
Cycle 5	October 1962	October 1964	October 1965	24 months	12 months	36 months
Cycle 6	October 1965	July 1970	December 1971	57 months	17 months	74 months
Cycle 7	December 1971	November 1973	March 1975	23 months	16 months	39 months
Cycle 8	March 1975	January 1977	October 1977	22 months	9 months	31 months
Cycle 9	October 1977	February 1980	February 1983	28 months	36 months	64 months
Cycle 10	February 1983	June 1985	November 1986	28 months	17 months	45 months
Cycle 11	November 1986	February 1991	October 1993	51 months	32 months	83 months
Cycle 12	October 1993	May 1997	January 1999	43 months	20 months	63 months
Cycle 13	January 1999	November 2000	January 2002	22 months	14 months	36 months
Cycle 14	January 2002	February 2008	March 2009	73 months	13 months	86 months
Average	—	—	—	36 months	17 months	53 months

Source: Economic and Social Research Institute.

(Chart 5)

Macroprudential Policy Measures Analyzed

Policy measure	Content	Reference indicators and regulatory hurdles
Retail LTV regulation	Restrictions on YoY growth in household lending	Retail LTV ratio gap is greater than the regulatory threshold
Corporate LTV regulation	Restrictions on YoY growth in corporate lending	Corporate LTV ratio gap is greater than the regulatory threshold
DTI regulation	Restrictions on YoY growth in household lending	DTI ratio gap is greater than the regulatory threshold
Credit growth restriction	Restrictions on YoY growth in both household and corporate lending	Lending volume growth gap is greater than the regulatory threshold
Time-varying capital requirement	Regulatory capital adequacy ratio is raised	Credit-to-GDP ratio gap is greater than the regulatory threshold

Notes:
1) The corporate LTV ratio, retail LTV ratio, DTI ratio, lending volume growth rate, and credit-to-GDP ratio are calculated as follows.

Retail LTV ratio = household lending volume / land price
Corporate LTV ratio = corporate lending volume / land price
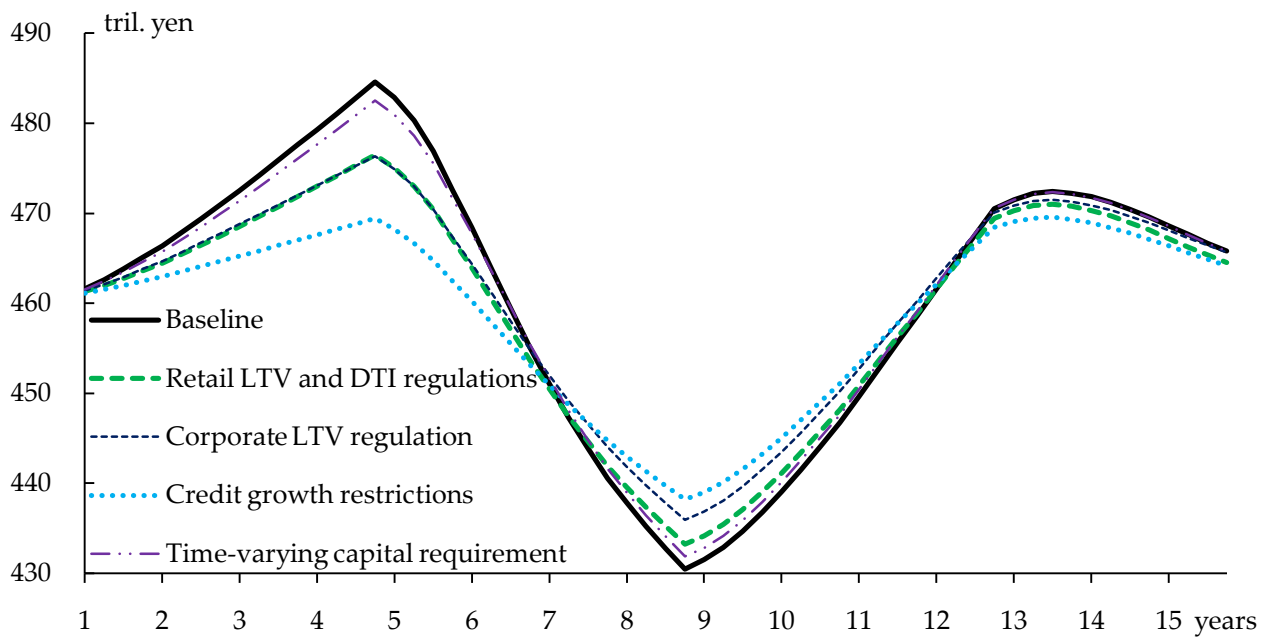DTI ratio = household lending volume / (trailing four-quarter total of employee compensation)
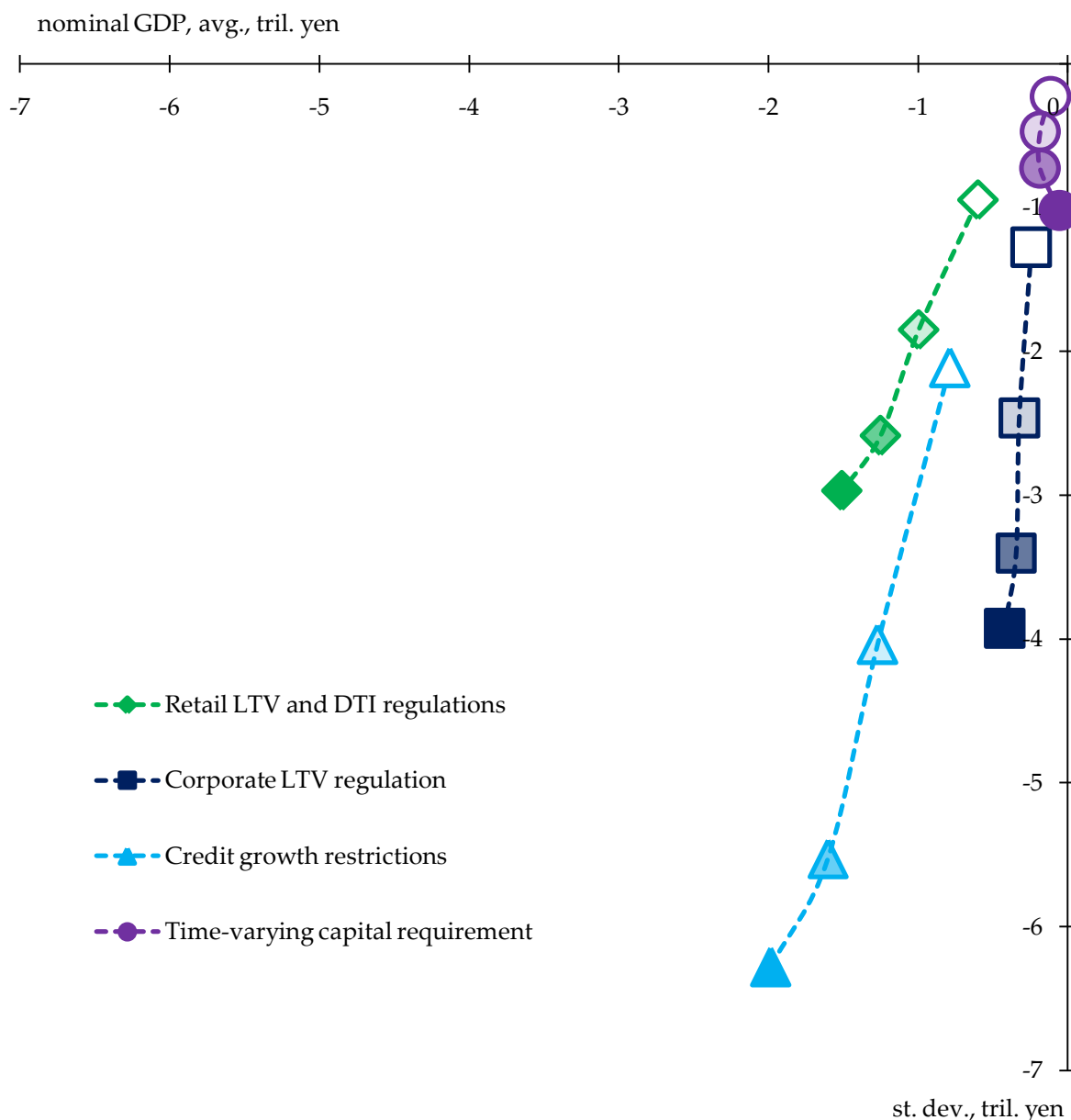Lending volume growth rate = lending volume / lending volume (-4) $\times 100 - 100$
Credit-to-GDP ratio = lending volume / (trailing four-quarter total of nominal GDP)

2) The gap is defined as the deviation from the HP filter trend ($\lambda = 400,000$).

(Chart 6)

Nominal GDP

(Chart 7)

Impact from Each Policy Measure

nominal GDP, avg., tril. yen

- ◆ Retail LTV and DTI regulations
- ■ Corporate LTV regulation
- ▲ Credit growth restrictions
- ● Time-varying capital requirement

st. dev., tril. yen

Notes:
1) Both the average and the standard deviation are expressed as differences relative to no policy action.
2) Shading indicates the length of time the policy is enacted. The non-shaded symbols indicate one year, the lightly shaded symbols two years, the second-lightest shaded three years, and the darkest shaded symbols four years.

(Chart 8)

Differences in the Size of the Policy Response

nominal GDP, avg., tril. yen

Notes:
   1) Both the average and the standard deviation are expressed as differences relative
      to no policy action.
   2) The darker the shading of the symbol, the more restrictive the regulation.

(Chart 9)

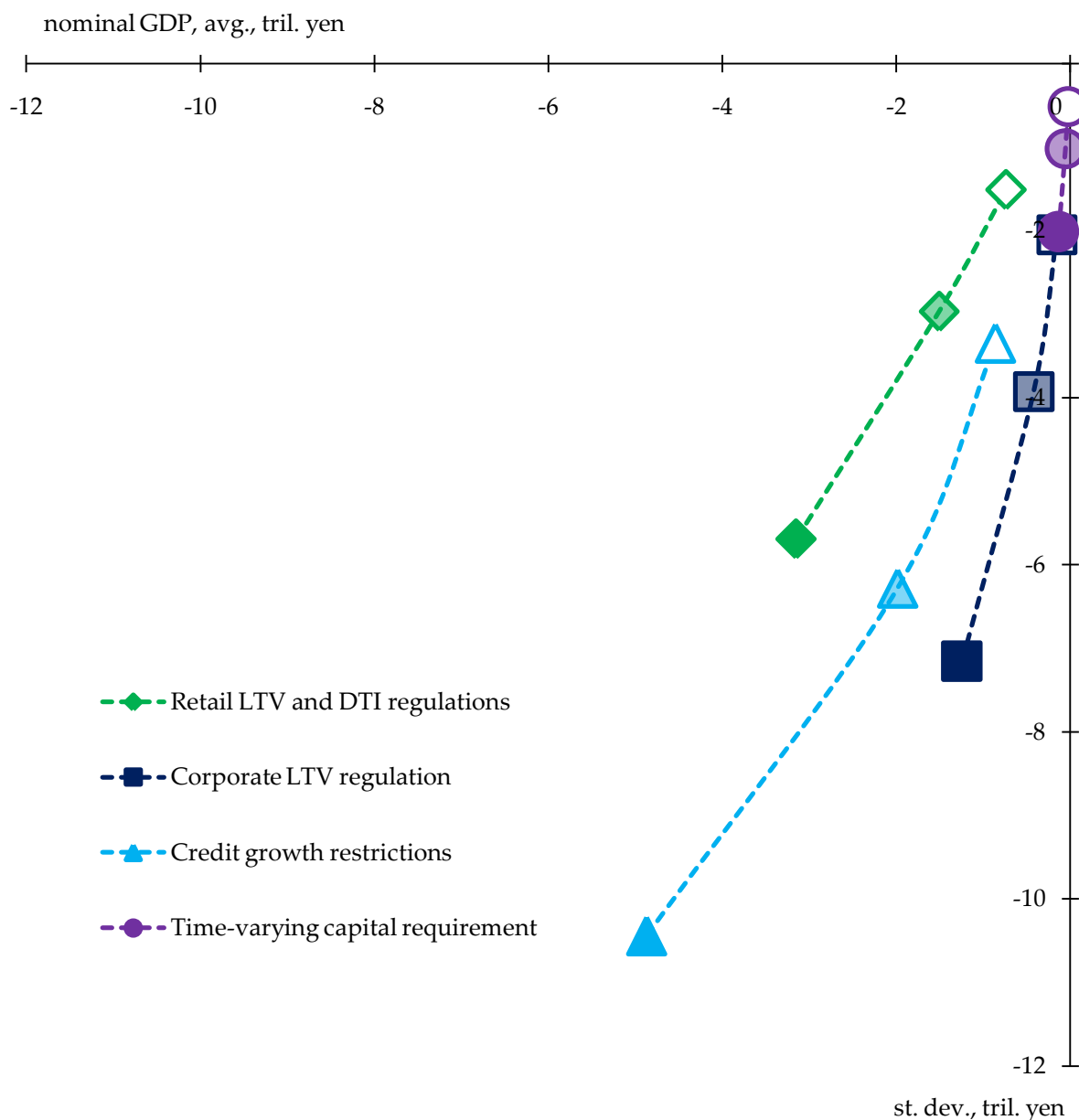# The Recognition Lag Problem
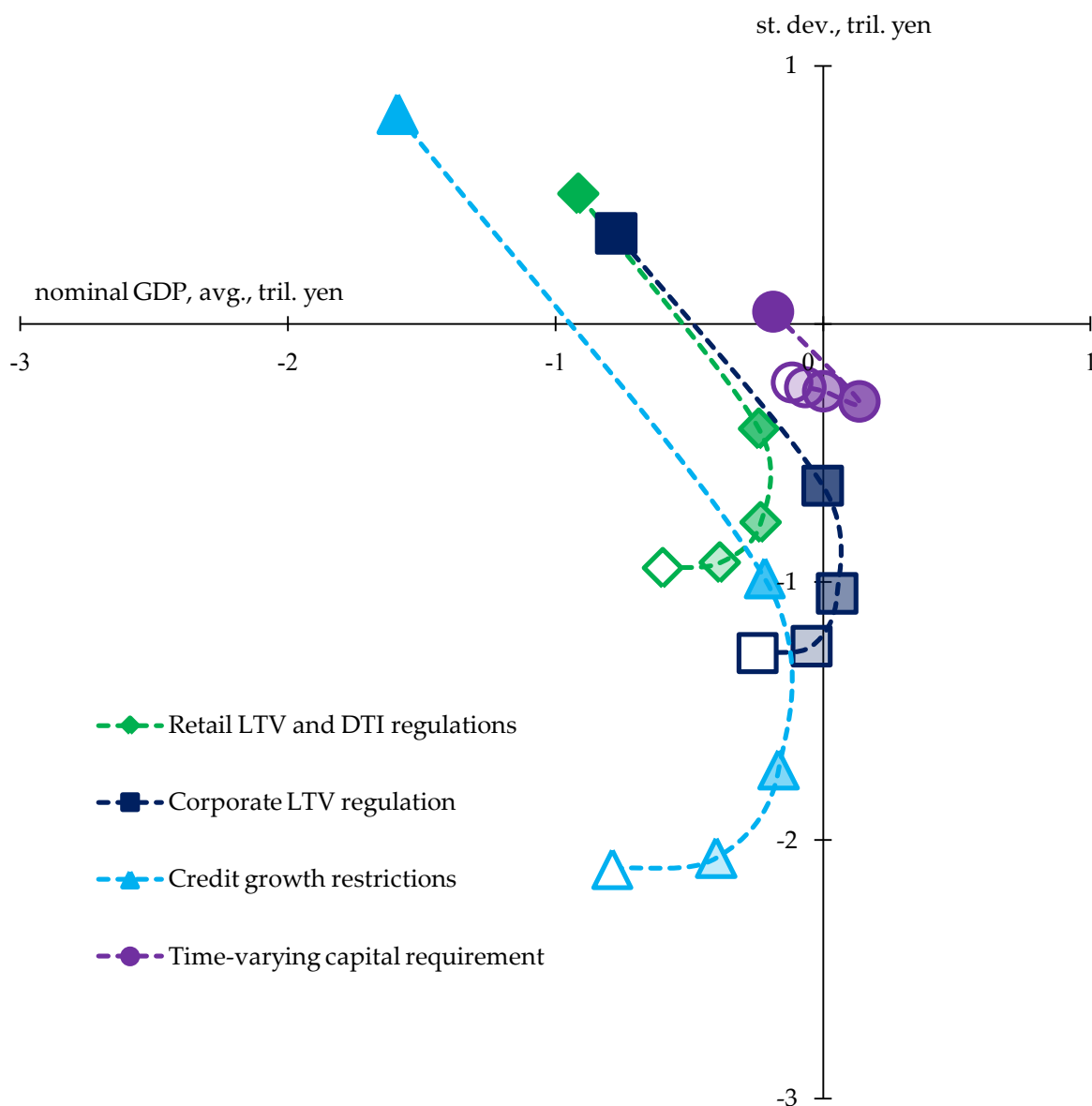
Notes:
   1) Both the average and the standard deviation are expressed as differences relative
      to no policy action.
   2) Shading indicates the number of years into the expansion phase that the policy is enacted.
      The non-shaded symbols indicate the first year, the lightly shaded symbols the second year,
      the second-lightest shaded symbols the third year, the third-lightest shaded symbols the
      fourth year, and the darkest shaded symbols the first year of the contraction phase.

(Chart 10)

Reference Indicators and Regulatory Triggers

(1) Retail LTV ratio

% pts

Gap — 90th percentile --- 70th percentile

FY78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 11

(2) Corporate LTV ratio

% pts

Gap — 90th percentile --- 70th percentile

FY78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 11

(3) DTI ratio

% pts

Gap — 90th percentile --- 70th percentile

FY78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 11

(4) Lending volume growth

% pts

Gap — 90th percentile --- 70th percentile

FY78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 11

(5) Credit-to-GDP ratio

% pts

Gap — 90th percentile --- 70th percentile

FY78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 11

Notes:

1) The gap is defined as the deviation from the HP filter trend ($\lambda = 400{,}000$).
2) The corporate and retail LTV ratios, the DTI ratio, and the credit-to-GDP ratio show the results of a time series indexed at 100 for the fiscal 2000 average.

(Chart 11)

Impact from Each Policy Measure (Based on a Benchmark Trigger)

Eight-Year Business Cycle

st. dev., tril. yen

nominal GDP, avg., tril. yen

- Retail LTV regulation
- Corporate LTV regulation
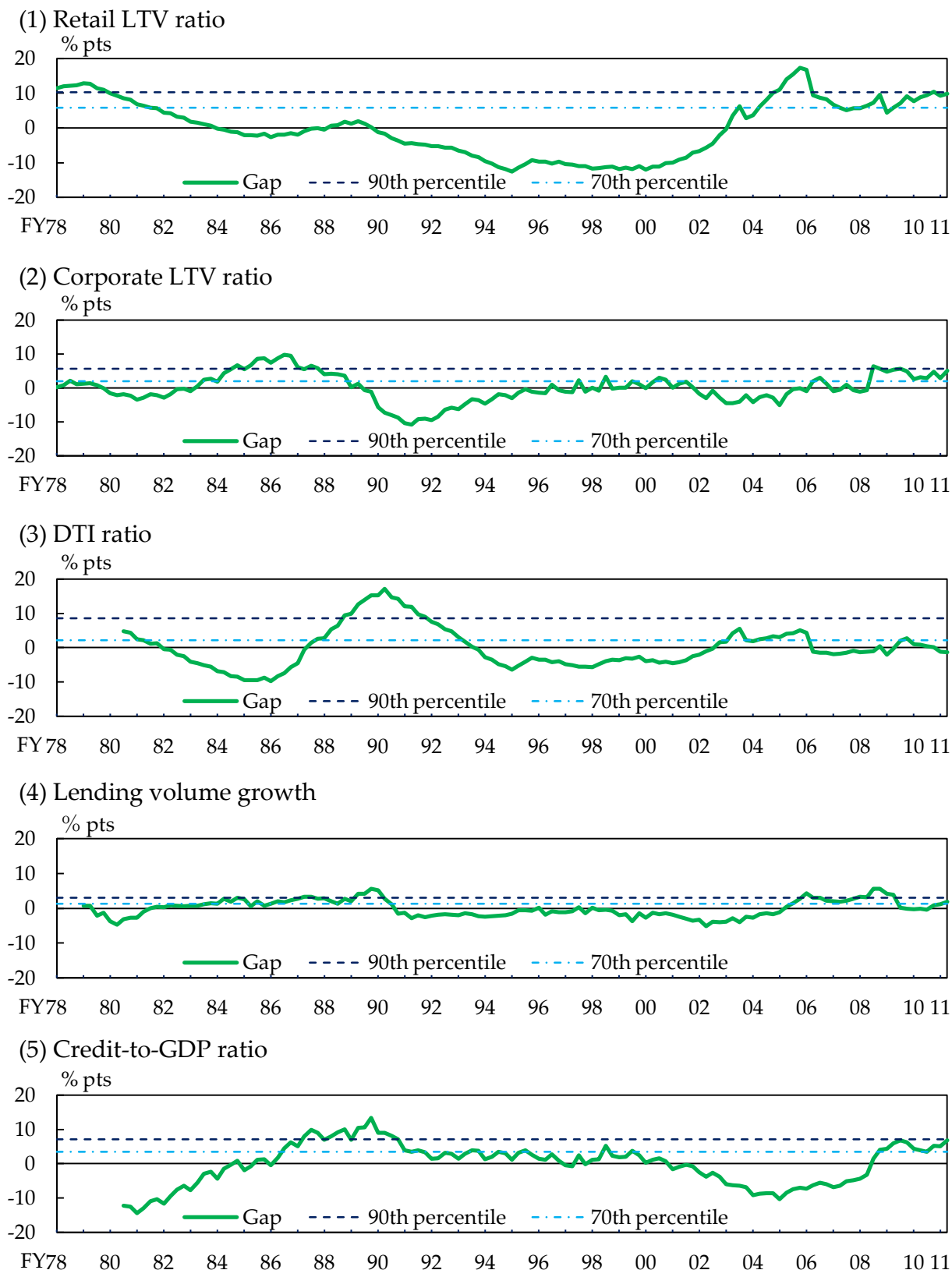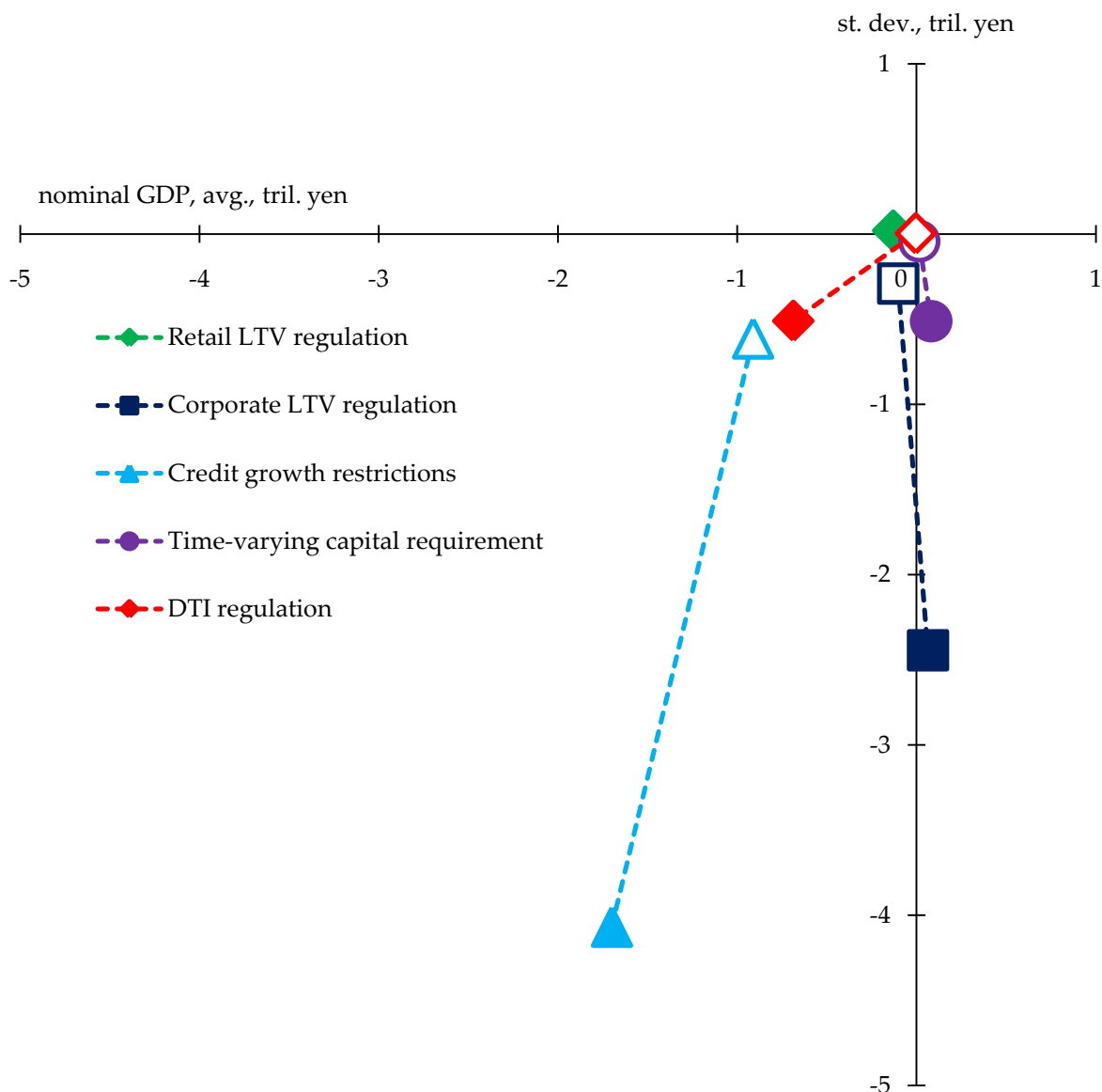- Credit growth restrictions
- Time-varying capital requirement
- DTI regulation

Notes:

1) Both the average and the standard deviation are expressed as differences relative to no policy action.

2) The non-shaded symbols indicate when regulatory trigger is set at the 90th percentile, and the shaded symbols indicate when it is set at the 70th percentile.
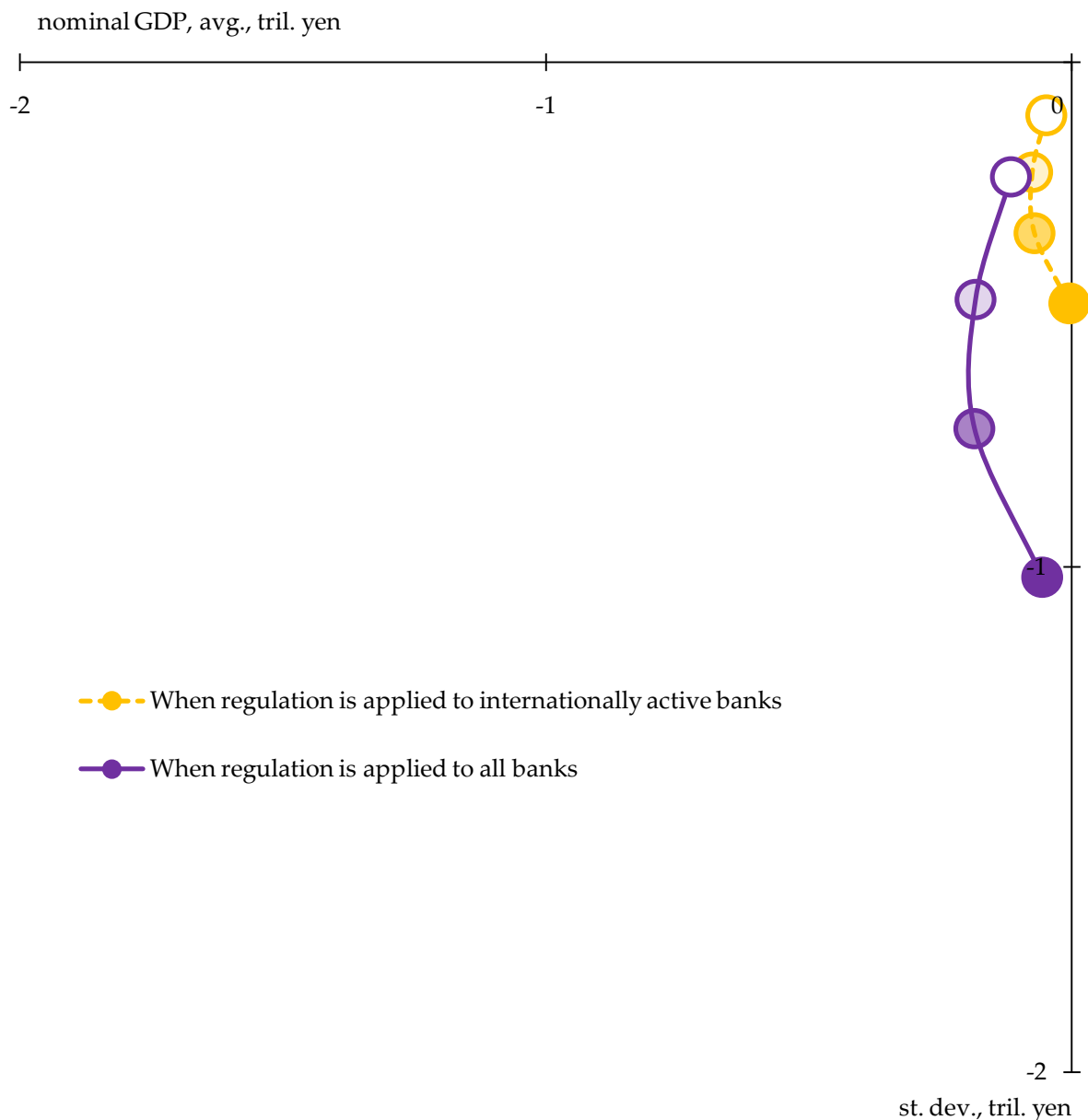
(Chart 12)

Impact Based on the Length of the Recognition Lag

Regulatory Trigger Set at the 70th Percentile
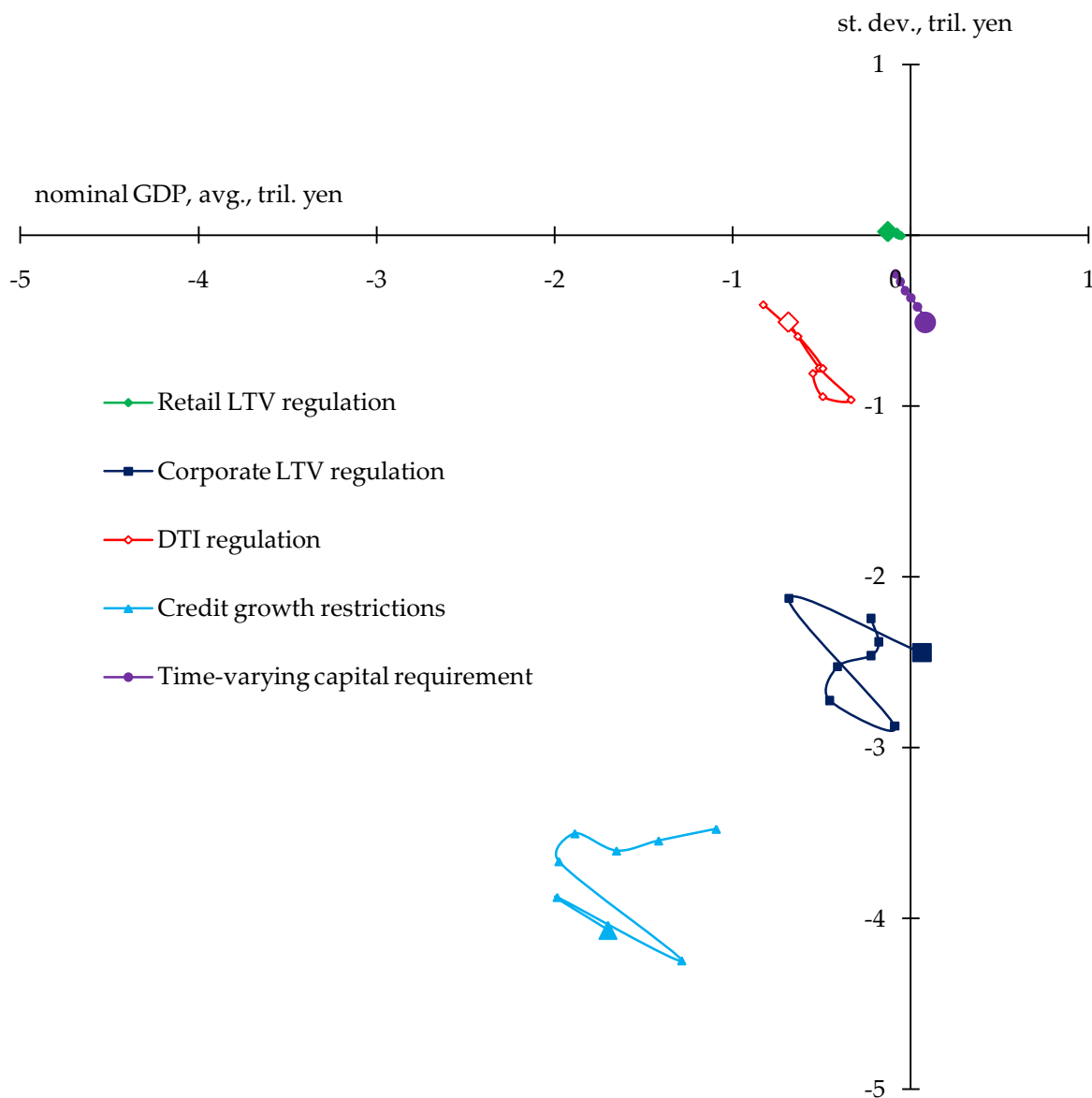
st. dev., tril. yen

nominal GDP, avg., tril. yen

-5   -4   -3   -2   -1   0   1

1

-1

-2

-3

-4

-5

Retail LTV regulation

Corporate LTV regulation

DTI regulation

Credit growth restrictions

Time-varying capital requirement

Notes:
1) Both the average and the standard deviation are expressed as differences relative to no policy action.
2) The largest symbols indicate a recognition lag of one quarter, and the smaller symbols indicate recognition lags of two to eight quarters.

(Chart 13)

Narrowing the Regulatory Perimeter

nominal GDP, avg., tril. yen

-2   -1   0

When regulation is applied to internationally active banks

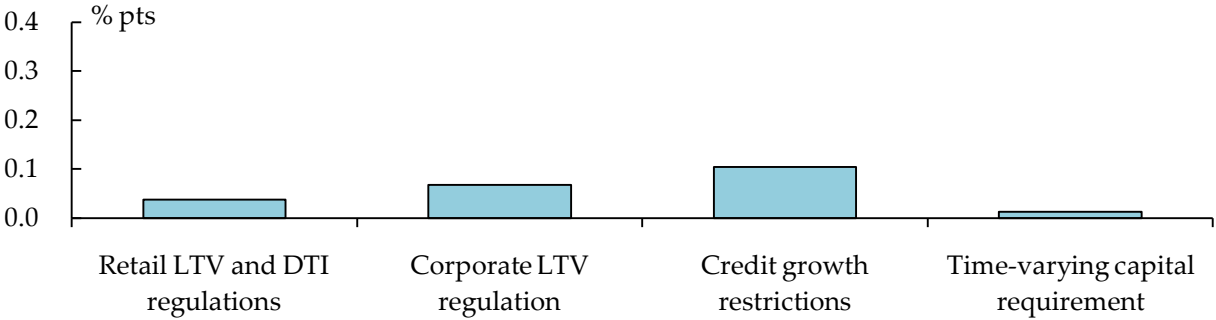When regulation is applied to all banks

-2
st. dev., tril. yen

Notes:
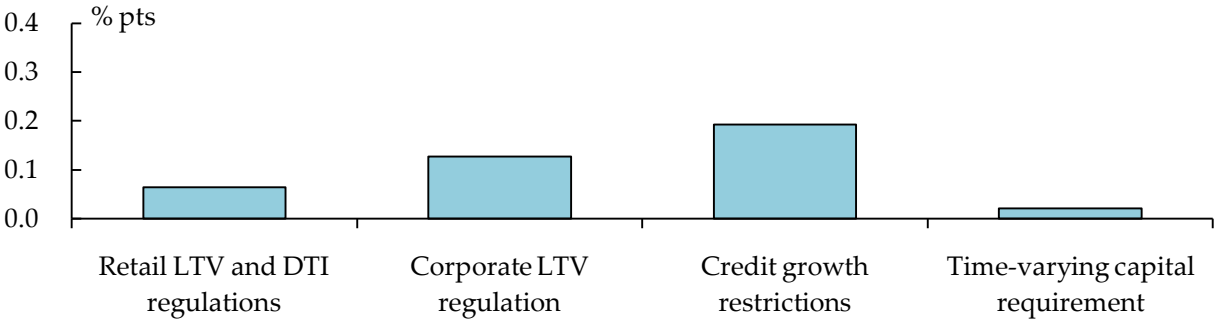   1) Both the average and the standard deviation are expressed as differences relative
      to no policy action.
   2) Shading indicates the length of time the policy is enacted. The non-shaded symbols indicate
      one year, the lightly shaded symbols two years, the second-lightest shaded symbols three
      years, and the darkest shaded symbols four years.
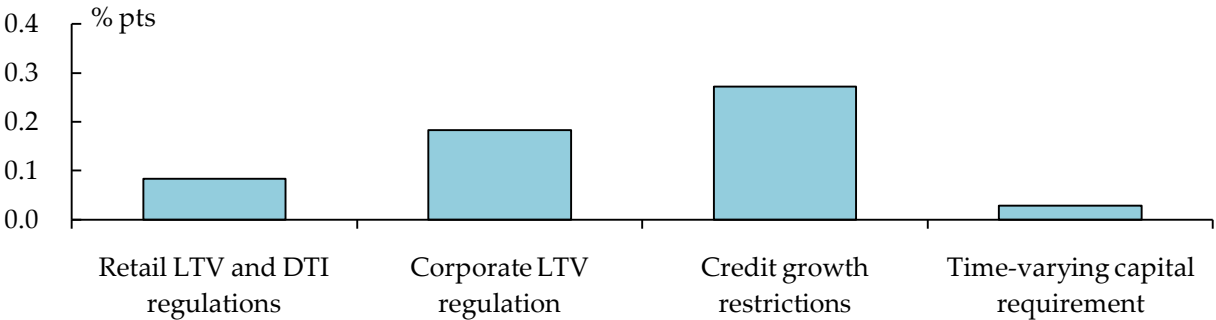
(Chart 14)

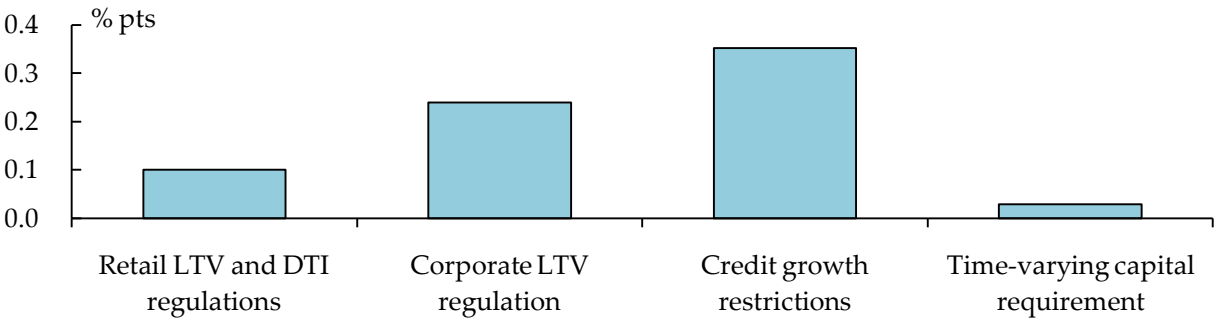# Tier I Capital Ratios

(1) One year of policy action

% pts

Retail LTV and DTI regulations   Corporate LTV regulation   Credit growth restrictions   Time-varying capital requirement

(2) Two years of policy action

% pts

Retail LTV and DTI regulations   Corporate LTV regulation   Credit growth restrictions   Time-varying capital requirement

(3) Three years of policy action

% pts

Retail LTV and DTI regulations   Corporate LTV regulation   Credit growth restrictions   Time-varying capital requirement

(4) Four years of policy action

% pts

Retail LTV and DTI regulations   Corporate LTV regulation   Credit growth restrictions   Time-varying capital requirement

Note: The difference is shown relative to no policy action.

(Chart 15)

Lending Volume

(1) Lending volume

tril. yen

Baseline
Retail LTV and DTI regulations
Corporate LTV regulation
Credit growth restriction
Time-varying capital requirement
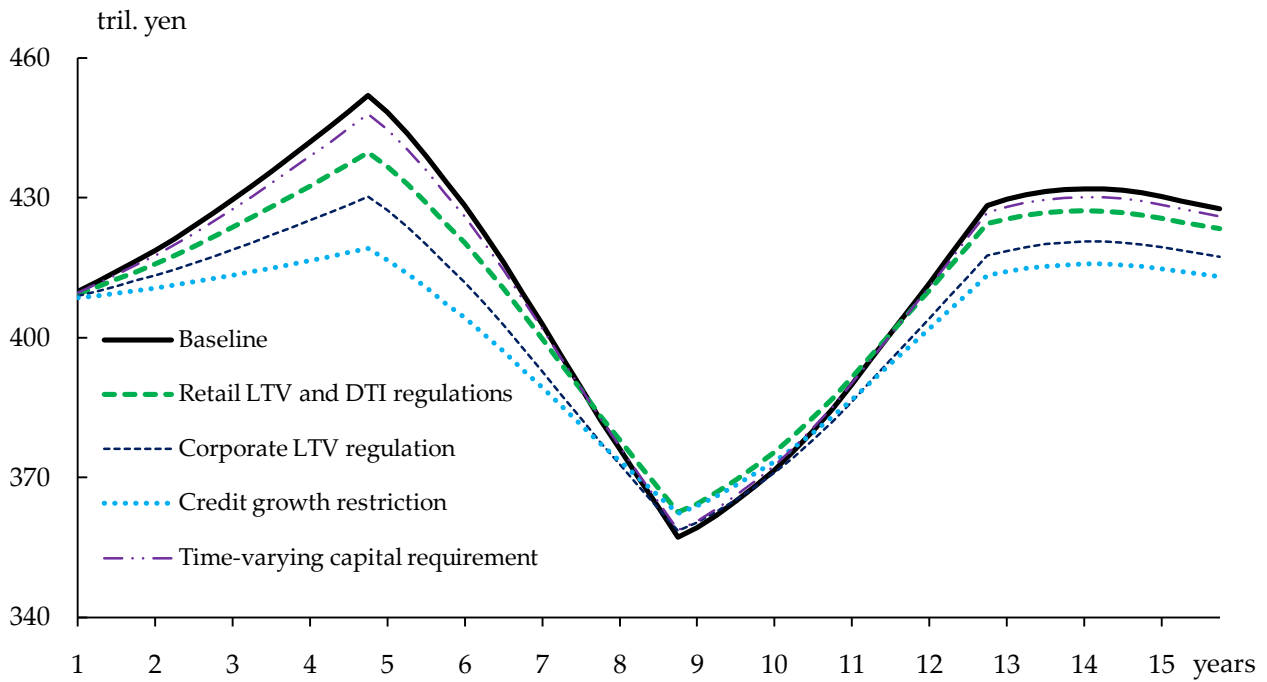
(2) Deviation from the baseline

tril. yen

Retail LTV and DTI regulations
Corporate LTV regulation
Credit growth restriction
Time-varying capital requirement