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**Working Paper**

# Pursuing Financial Stability Under an Inflation-Targeting Regime

Working Paper, No. 2006/8

**Provided in Cooperation with:**
Norges Bank, Oslo

*Suggested Citation:* Akram, Q. Farooq; Bårdsen, Gunnar; Lindquist, Kjersti-Gro (2006) : Pursuing Financial Stability Under an Inflation-Targeting Regime, Working Paper, No. 2006/8, ISBN 82-7553-361-9, Norges Bank, Oslo, https://hdl.handle.net/11250/2498367

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ANO 2006/8

Oslo

July 12, 2006

# Working Paper

Research Department

## Pursuing financial stability under an inflation-targeting regime

by

Q. Farooq Akram, Gunnar Bårdsen and Kjersti-Gro Lindquist

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ISSN 0801-2504 (printed) 1502-8143 (online)

ISBN 82-7553-360-0 (printed), 82-7553-361-9 (online)

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# Pursuing financial stability under an inflation-targeting regime

**Abstract** We evaluate two main views on pursuing financial stability within a flexible inflation-targeting regime. It appears that potential gains from an activist or precautionary approach to promoting financial stability are highly shock dependent. We find support for the conventional view that concern for financial stability generally warrants a longer target horizon for inflation. The preferred target horizon depends on the financial stability indicator and the shock. An extension of the target horizon favoring financial stability may contribute to relatively higher variation in inflation and output.

**Keywords** Monetary policy · financial stability

**JEL Classification Numbers** C51 · C52 · C53 · E47 · E52

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We are grateful to participants at the LSE-FMG Conference on Financial Stability: Theory and Applications, 2006, and seminar participants at Norges Bank and Sveriges Riksbank. We would like to thank especially Charles Calomiris, Roman Inderst, Gianni De Nicoló, Øistein Røisland and two anonymous referees for useful comments. The views expressed in this paper are those of the authors, and should not interpreted as reflecting those of Norges Bank (the central bank of Norway).

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# 1 Introduction

We investigate the macroeconomic implications of pursuing financial stability within a flexible inflation-targeting framework. Flexible inflation-targeting allows a central bank to pursue additional objectives such as output stabilization and financial stability when setting interest rates; see e.g. Svensson (1999).

There are two main views on how financial stability can be promoted under an inflation-targeting regime. The conventional view is that an inflation-targeting central bank should respond to variables linked to financial stability to the extent they affect (observed and expected) inflation and/or output; see e.g. Bernanke and Gertler (2001) and Bean (2004). It is argued that stabilization of inflation and output provides a substantial contribution to financial stability as well. An abrupt unwinding of asset price misalignment or financial imbalances may, however, lead to financial instability and, as a consequence, macroeconomic instability. In such a scenario, financial and macroeconomic stability could be taken into account by choosing a longer target horizon than out of concern for inflation and output stabilization alone; see e.g. Bean (2004).

The alternative view favors a more activist or precautionary approach, assuming that a monetary policy response to inflation and output may not be sufficient to achieve financial stability. Hence, a direct response to variables affecting or representing financial stability is advocated for precautionary reasons. It is argued that imbalances in financial markets and asset prices may well develop in situations with stability in inflation and output. Thus, monetary policy may not respond sufficiently to secure financial stability when financial imbalances or bubbles in asset prices are building up; see e.g. Borio and Lowe (2002) and White (2006).[1] A subsequent correction in asset prices, and hence a fall in collateral values, may reduce lending, which may give rise to unfavorable boom-bust cycles in investment and output; see e.g. Bordo and Jeanne (2002). Furthermore, a fall in bank shareholders' wealth and a possible credit crunch, if banks become more risk adverse, may have a strong negative impact on output; see e.g. Friedman and Schwartz (1963) and Bernanke and Gertler (1995). If the underlying development triggers a financial crisis, the costs in the form of both financial costs and output losses may be high; see e.g. Aziz et al. (2000), Bordo et al. (2001), Hoggarth et al. (2002) and Schwierz (2004).

To examine the merits of the two views, we characterize monetary policy in two different ways. In order to model monetary policy in line with the activist approach, we characterize monetary policy by a simple Taylor (type) rule that is augmented with two indicators representing excess financial vulnerability. In addition to contributing to financial stability, an extended Taylor (type) rule may perform better than a simple Taylor rule in terms of inflation and output stability for

[1] Borio and Lowe (2002) argue that a credible inflation-targeting regime may produce low inflation, credit growth and booming asset prices. Firstly, a stable economic environment may spur optimism about the future that leads to booming asset markets. Secondly, improvements in the supply side and labor market may put a downward pressure on consumer prices at the same time as asset prices grow steeply.

two main reasons.

First, the interest rate response may become better attuned to the shocks behind fluctuations in output and inflation. Ideally, the interest rate response should be shock-dependent, as suggested by the literature on optimal monetary policy rules. An interest rate rule that only admits response to inflation and output gaps may imply an interest rate response that is in disproportion to the effects of a shock behind movements in the inflation and/or output gap. An optimization of the weights in a simple Taylor type rule may alleviate but not eliminate this weakness. However, by augmenting it with additional variables, the interest rate response can become closer to that implied by an optimal rule suggesting shock-dependent response to all shocks.

And secondly, an augmented Taylor rule can give a head start on restraining the inflationary and/or expansionary effects of the shocks relative to a simple Taylor rule that is outcome based. In contrast with an augmented Taylor rule, the simple Taylor rule will not prescribe an interest rate response until effects of the shock become reflected in inflation and/or output. Essentially, under an augmented Taylor rule, the effects of an interest rate response can become more synchronized with effects of shocks and hence it can prove more stabilizing than the simple rule. However, if the transmission lags of effects from interest rates to key variables are shorter than those from shocks to the key variables, an augmented Taylor rule need not outperform the simple rule. In such cases, the simple rule can provide stabilizing impulses to the economy that are more synchronized with the destabilizing impulses from the shocks. Hence, the ranking of an augmented Taylor rule relative to the simple Taylor rule may be shock- and model-dependent.[2]

In order to model monetary policy in line with the conventional approach, we characterize monetary policy by interest rate rules that specify shock- and horizon-specific interest rate response to shocks. That is, they prescribe an interest rate response in proportion to the expected inflationary effects of a shock. And, output and/or financial stability are taken into account by choosing the horizon that balances these objectives with the objective of inflation stability. Thus, such rules allow one to choose a policy horizon that better synchronizes the effects of the interest rate response and those of a given shock to key variables affecting the policy maker's objective function. Accordingly, a relatively long horizon may be preferred if the effects of a shock on inflation, aggregate demand and/or indicators of financial stability build up gradually, while a relatively short horizon may be chosen if the effects appear without much delay. We are particularly interested in investigating the effect of taking into account financial stability on the optimal horizon. The details of the derivation of such rules can be found in Akram (2006).

We implement both types of interest rate rules in a version of a well documented econometric model for Norway; see e.g. Bårdsen and Nymoen (2001) and Bårdsen, Jansen, and Nymoen (2003) and Bårdsen et al. (2005). The main properties of the model are set out in the Appendix. Briefly,

[2] The two arguments favoring an augmented Taylor rule relative to a simple outcome-based Taylor rule loose strength in the case of forecast based Taylor rules, though; see Levin, Wieland, and Williams (2003).

the model explicitly takes into account several channels of interplay between asset prices, credit, output and inflation. Besides equations for aggregate demand and inflation, the model includes equations for house prices, the nominal exchange rate, households' debt growth and the bankruptcy rate for domestic firms. These variables are often considered to be among key determinants of financial stability. The model includes two measures of financial stability that are functions of the bankruptcy rate of firms and the debt burden of households.

We evaluate the performance of the different interest rate rules in the face of shocks to house prices and credit growth. These shocks can be interpreted as demand shocks. In general, there is no conflict between inflation and output stability in the case of demand shocks. We may therefore focus on the outcomes in terms of financial stability versus those in terms of inflation and output stability. In the case of supply shocks, however, a trade-off may also emerge between inflation and output, which may complicate the analysis.

We proceed as follows. Section 2 defines a flexible inflation-targeting regime and presents an operational definition of financial stability. Section 3 characterizes the monetary policy in terms of the augmented Taylor rule and evaluates its performance relative to that of a simple Taylor rule. Section 4 presents a simple shock- and horizon-specific interest rate rule that can be used to characterize the conventional view and investigate its implications for financial stability in particular. Section 5 summarizes and concludes. Finally, the Appendix lays out a stylized version of the model used.

## 2 Flexible inflation-targeting and financial stability

We assume that the central bank has the following objective function:

$$L(\lambda, \phi) = V(Inf) + \lambda V(ygap) + \phi V(f), \tag{1}$$

where $V(Inf)$ denotes the variance of the (underlying) inflation rate, while $\lambda$ and $\phi$ express monetary authorities' aversion to variation in output gap $V(ygap)$ and in an indicator of financial stability $V(f)$. Often, $f$ is equated with changes in interest rates and motivated by concern for financial stability. However, our model allows us to employ a more appropriate measure of financial stability as explained below.

A flexible inflation-targeting regime can be defined by $\lambda > 0$ and/or $\phi > 0$, while a strict inflation-targeting regime can be defined by $\lambda = \phi = 0$; see Svensson (1999). The performance of different simple interest rate rules can be evaluated under different choices of these preference parameters. This is particularly useful when choosing among interest rate rules that have widely different effects on inflation, output and financial stability. In particular, it is of interest to investigate how concern for financial stability, i.e. $\phi > 0$, would affect the choice of an interest rate rule

characterizing monetary policy.

## 2.1 Financial stability indicators

There seems to be no consensus on an operational definition of 'financial stability' in the literature; see Bårdsen, Lindquist, and Tsomocos (2007) for a discussion of alternative definitions. Tsomocos (2003) and Goodhart, Sunirand, and Tsomocos (2006) argue that an operational definition should use information on the probability of default for banks, households and firms, together with bank profitability. The focus on banks is motivated by their importance for financial stability due to their dominant role as financial intermediaries and providers of payment services. An operational definition of financial stability along the recommended line, would allow one to study financial instability as a continuous economic state rather than merely as an extreme economic state or phenomenon. This makes such a definition more useful, since information on changes in the vulnerability of the financial system is normally of higher value to a policy maker, than information on whether the economy is in one of the two states: financial crisis – not financial crisis. In addition, such a definition can be applied at both disaggregated and aggregated levels.

We include an operational definition of financial stability in our model that is closely related to the definition suggested by Goodhart et al. (2006). Default of households and firms, as well as banks' losses and profits, are closely related to households' and firms' debt-servicing capacities. We represent the debt-servicing capacity of households by their debt ratio, i.e. debt relative to income. Households' debt ratio has been found important for banks' losses and the severity of a financial crisis by e.g. Barrell, Davis, and Pomerantz (2004). In particular, households' indebtedness may amplify and prolong a financial crisis. In order to represent the debt servicing capacity of firms, we use their bankruptcy rate rather than their debt ratio, which is not represented in our model. More importantly, the debt ratio may be less informative about firms' debt servicing capacity, since the debt ratio often depends on firms' strategic considerations regarding the equity-to-assets ratio and return on net capital. Both the households' debt ratio and firms' bankruptcy rate appear more appropriate indicators of financial stability than e.g. fluctuations in interest rates, which are often used as an indicator of financial stability in academic studies.

In the next section, we augment a simple Taylor (type) rule with these two indicators of financial stability: households' debt ratio and firms' bankruptcy rate. More precisely, households' debt ratio ($DR$) is calculated as households' debt divided by cumulative wage income over the last four quarters. Usually, households' debt ratio is calculated using disposable income, which is not defined in our model. Therefore, we adjust the debt ratio based on wage income to equal the debt ratio based on disposable income in 2004q4. The second indicator, firms' bankruptcy rate ($BR$) is defined as the quarterly number of bankruptcies as a percentage of the number of firms.

Alternatively, one can develop a single financial stability indicator as a function of these two

indicators. It is, however, not obvious how one should weigh these two indicators to derive the combined indicator, because an increase in households' debt ratio and firms' bankruptcy rate may have widely different implications for monetary policy.

In our model, monetary policy should be contractionary if the debt ratio rises, while policy should be expansionary if the bankruptcy rate increases. In the latter case, the financial state of firms may improve by increasing domestic and foreign demand for their products through its expansionary effect at home and by strengthening their competitiveness through an exchange rate depreciation, respectively; see the Appendix. A contractionary monetary policy response to an increase in households' debt ratio helps reigning their debt ratio by reducing the demand for credit. Thus, such a monetary policy response reduces their debt burden and probability of default and thereby contributes to financial stability. However, since the interest rate would affect both the nominator (credit) and the denominator (income) of the debt ratio, the dampening effect of monetary policy on the debt ratio would be less than the dampening effect on credit growth.

It can also be argued that the two indicators should enter the interest rate rule in a non-linear way and affect interest rates only when they are particularly high. This is in line with the common argument that households' debt ratio and/or firms' bankruptcy rate should affect monetary policy only when they are high, while a normal increase or decline in these measures; e.g. during business cycles, do not call for a policy response. Nevertheless, in order to assess the contribution of the augmented Taylor rule relative to that of the Taylor rule, one would need to consider its performance when the terms added are active. Hence, for the purpose of comparing their performances, it does not add much to make the financial stability indicators enter in a non-linear fashion.

# 3 The precautionary approach

In this section, we present and evaluate the performance of a Taylor (type) interest rate rule that is augmented with the financial stability indicators. The augmented Taylor rule represents a monetary policy that responds directly to variables affecting financial stability, and hence represents features of a precautionary monetary policy regime. Both of the two rules are defined by constant response coefficients whose values are chosen for illustrational purposes. However, the results that follow remained qualitatively the same when we simulated the models with numerous alternative values of the response coefficients in both rules.

Equations (2) and (3) present the simple Taylor rule and the augmented Taylor rule, respectively; see e.g. Taylor (1993). Both rules allow for interest rate smoothing. The interest rate is represented by the 3-month nominal market interest rate ($r$). The inflation gap (*Infgap*) is defined as the (actual) deviation between the core inflation and the inflation target, which is 2.5 per cent

annualized. The growth in output gap ($\Delta ygap$) is defined as the deviation in annual growth in Mainland-GDP (GDP excluding oil, gas and shipping) from potential growth, which is assumed to be 2.5 per cent.[3] The weights on the inflation gap, the growth in output gap and lagged interest rate are set equal to: 1.5, 0.5 and 1, respectively. This is consistent with findings in Levin, Wieland and Williams (1999).

$$r_t = r_{t-1} + 0.5\Delta ygap_t + 1.5Infgap_t \tag{2}$$

$$\begin{aligned} r_t = {} & r_{t-1} + 0.5\Delta ygap_t + 1.5Infgap_t \\ & - 0.025 \times \frac{2}{3}BR_t + 0.025 \times \frac{1}{3}DR_t \end{aligned} \tag{3}$$

In Equation (3), the Taylor rule is augmented with the two financial stability indicators: firms' bankruptcy rate ($BR$) and households' debt ratio ($DR$). We have scaled down the two indicators to make a concession to the empirical fact that, historically, banks have suffered significantly higher losses on their lending to firms than on their lending to households. Thus, $BR$ is adjusted by 2/3, while $DR$ is adjusted by 1/3 to reflect the unequal distribution of losses. This distribution of losses reflects both the debt-servicing capacity of firms and households and the degree of loss given default. In line with the arguments in the previous section, their response coefficients are set at –0.025 and 0.025, respectively.

To examine the impact of responding directly to the two financial stability indicators, we provide (separately) a house price shock and a credit shock to the model, and simulate it with the two alternative interest rate rules over 40 quarters in each case. In both cases, the shock is transitory and designed to build up over a year. Compared with the baseline scenario, house prices and households' credit demand are assumed to increase by 2.5 per cent, 5 per cent, 7.5 per cent and 10 per cent in the first, second, third and fourth quarter, respectively. Figures 1 and 3 present the results of the simulations as percentage deviations from their reference values (under no shocks). For simplicity, in Figures 1 and 3, the two financial stability indicators, $BR$ and $DR$, are represented by a single "financial stability indicator", which is defined as: $-2/3BR + 1/3DR$. This combined indicator does not reflect the state of financial stability, but rather the net impulse to monetary policy. A positive (negative) value gives a positive (negative) impulse to the interest rate.

**Figure 1** Policy implications and results (over 40 quarters) when there is a transitory increase in house prices by 10% that builds up over four uarters. Solid lines: The outcomes under the Taylor rule (relative to the baseline scenario). Dotted lines: The outcomes under the augmented Taylor ule (relative to the baseline scenario). The financial stability indicator s defined as $-2/3BR+1/3DR$.

## 3.1 House price shock

In the case of a house price shock, the impulse to monetary policy comes indirectly from an effect on credit growth, output and inflation; see the Appendix. House prices affect credit growth through an effect on collateral values, and output through a wealth effect on demand. The effect on output then contributes to higher inflation and, due to increased employment, higher income. The latter reduces the debt ratio ($DR$), which is raised by the credit growth.

Figure 1 shows that both rules induce higher interest rates due to the rise in output growth and inflation. This brings inflation and output growth down (and consequently interest rates). Higher interest rates trigger an appreciation of the real exchange rate, however, which weakens the competitiveness of domestic firms. As a consequence, the bankruptcy rate ($BR$) increases and outweighs the favorable effect on the bankruptcy rate of the rise in domestic demand and output. The increase in the bankruptcy rate causes the combined financial stability indicator to fall in the medium run; see Figure 1. In the long run, the development in the financial stability indicator is driven by the increase in the debt ratio. Under the augmented Taylor rule, the higher bankruptcy rate contributes to lower interest rates.

[3] It is more common to formulate the Taylor rule with the output gap rather than growth in the output gap. However, in addition to the inherent possibility of measurement error in the output gap, as argued by Orphanides (2003), empirical evidence from Norwegian data suggests that an interest rate rule with growth in the output gap captures the actual behavior of short-term interest rates better than a rule with the output gap; see Bernhardsen and Bårdsen (2004).

The augmented Taylor rule seems to deliver a better performance in terms of inflation stability, and to some extent in terms of output stability, in the long run. The short- to medium-run effects of the two rules on inflation and output growth are comparable. Overall, however, there do not seem to be obvious gains in terms of financial stability by responding directly to the financial stability indicators.

**Table 1** Performance of the two Taylor type rules

| | I. House price shock | | | | |
|---|---|---|---|---|---|
| Std. deviations of: | $BR$ | $DR$ | $r$ | $ygap$ | $Infgap$ |
| Taylor rule | 0.0112 | 1.68 | 0.33 | 1.37 | 0.019 |
| Augmented Taylor rule | 0.0115 | 1.63 | 0.33 | 1.25 | 0.013 |
| | II. Credit shock | | | | |
| Std. deviations of: | $BR$ | $DR$ | $r$ | $ygap$ | $Infgap$ |
| Taylor rule | 0.0017 | 2.20 | 0.03 | 0.11 | 0.002 |
| Augmented Taylor rule | 0.0039 | 2.37 | 0.07 | 0.33 | 0.013 |

Table 1 summarizes the results in terms of the standard deviations of the two financial stability indicators, interest rates, output gap and inflation. Panel I records the performance of the two rules in the face of the house price shock. We note the relative superior performance of the augmented Taylor rule in terms of the output gap, inflation and the debt ratio. However, the bankruptcy rate fluctuates relatively more under the augmented rule, mainly because of larger fluctuations in the exchange rate due to a more activist monetary policy. The latter effect is especially important in the case of the credit shock, which is examined in the next subsection and in panel II of Table 1.

Figure 2 evaluates the performance of the augmented Taylor rule relative to the Taylor rule for different preference parameters $\lambda \in [0,\ 2]$ and $\phi \in [0,\ 2]$. It presents relative values of the loss-functions, $LR(.)$, which are the ratios of the loss-function values under the augmented Taylor rule to the corresponding values under the simple Taylor rule. Thus, for a specific pair of $\lambda$ and $\phi$, a value of the relative loss function ($LR(.)$) below 1 indicates that the performance of the augmented rule is considered superior to that of the Taylor rule, while a value above 1 indicates the opposite. The values of the loss-functions are obtained by weighting their performance recorded in Table 1 by numerous combinations of the preference parameters in the 0–2 space. For simplicity, both of the two indicators have been attached equal importance in the loss-functions, i.e. the same $\phi$ value.

It appears that the performance of the augmented Taylor rule would be considered superior to that of the Taylor rule for all combinations of the preference parameters considered; see Figure 2. This is especially the case when the concern for output stabilization is high. The augmented Taylor rule can be considered less successful if the policy maker is largely indifferent to output stabilization, but cares highly about financial stability, i.e. when $\lambda$ is small even though $\phi$ is large.

**Figure 2** Relative loss-function for $\lambda \in [0, 2]$ and $\phi \in [0,\ 2]$ under the house price shock. The relative loss function $LR(.)$ is the ratio of the loss-function under the augmented Taylor rule relative to that of the Taylor rule.

This reflects that the gains from the augmented rule are mainly in terms of output stability.

## 3.2 Credit shock

In the case of the credit shock, the two interest rate rules have widely different implications for interest rates and the economy; see Figure 3. Credit growth contributes to a higher level of activity and output growth in the economy, which leads to higher inflation. Credit growth also raises the debt ratio; the direct effect on the nominator (debt) clearly dominates that on the denominator (income). Higher output and inflation contribute to raising interest rates under both rules, and this has a stabilizing effect on particularly output and inflation.

Under the augmented rule, however, the increase in the debt ratio leads to relatively high interest rates over most of the simulation period and especially in the short run. This have relatively large contractionary effects on output and inflation. The contractionary effect on output dominates the expansionary effect of the initial credit shock, and, as a consequence, output growth falls in the short run. After about four years, however, output growth becomes positive and converges with its long-run rate. The effects on inflation are quite strong. In contrast to a low inflation under the simple rule, the augmented rule leads to a strong deflation over most of the simulation period.

However, the relatively strong contractionary policy and its effects lowers the (combined) financial stability indicator; see Figure 3. The relatively high interest rates reduce credit growth and

**Figure 3** Policy implications and results (over 40 quarters) when there is a ransitory increase in households' credit demand by 10% that builds up over our quarters. Solid lines: The outcomes under the Taylor rule (relative to he baseline scenario). Dotted lines: The outcomes under the augmented Taylor rule (relative to the baseline scenario). Here, the financial stability indicator is defined as $-2/3BR + 1/3DR$..

thereafter the debt ratio. The initial increase in interest rates also leads to a stronger nominal exchange rate, and hence a stronger real exchange rate, and recession. Thus, the bankruptcy rate of firms becomes higher. Therefore, the increase in the financial stability indicator is reversed relatively fast under the augmented Taylor rule compared with the simple Taylor rule. As a result, the interest rate under the augmented rule falls below the interest rate implied by the simple rule in the medium run; see Figure 3.

In sum, the augmented Taylor rule turns out to induce relatively higher volatility in all of the key variables examined; see panel II of Table 1. Both of the financial stability indicators, particularly the bankruptcy ratio, as well as inflation and output gap become more volatile than under the simple rule. Clearly, the performance of the augmented Taylor rule will be considered inferior to that of the simple Taylor rule for all values of the preference parameters $\lambda$ and $\phi$.

# 4 The conventional approach

In this section, we characterize the conventional approach of incorporating concern for objectives such as output stabilization and financial stability via the choice of the target horizon. We assume that the principal objective of monetary policy is to ensure an inflation rate close to its target rate (in the near future). Accordingly, output stability and financial stability can be considered

as secondary objectives.[4] This implies that the central bank minimizes the loss function (1) with respect to interest rate paths that bring inflation close to its target after specified periods.

If the model is linear and interest rate smoothing is possible, an interest rate rule that would bring inflation close to its target in about $H$ periods can be specified as follows:[5]

$$i_t = i_0 + (1 - \varrho_H)\beta_\varepsilon \varepsilon_\tau + \varrho_H(i_{t-1} - i_0) \quad ; t = \tau, \tau + 1, \tau + 2, .... \tag{4}$$

Here, $i_0$ represents the neutral rate of the nominal interest rate. The response coefficient $(1 - \varrho_H)\beta_\varepsilon \equiv \beta_{\varepsilon,H}$ determines how much the interest rate must change initially to counteract the inflationary effects of a shock $\varepsilon_\tau$. This initial deviation is thereafter eliminated gradually depending on the value of an interest rate smoothing parameter $\varrho_H$. $H$ represents the policy horizon, i.e. the number of periods during which interest rates will deviate from their reference value and stimulate or restrain the economy. The target horizon, i.e. the number of periods it would take to bring inflation close to its target, will generally be linked and be close to the policy horizon.[6] The subscript "$H$" indicates that both the response coefficient and the degree of smoothing depend on the policy horizon.

The value of $\beta_\varepsilon$ depends on the shock and the model. It is a derived parameter whose value increases with the pass-through of the inflationary effects of the shock, but declines with the effectiveness of interest rates in controlling inflation. It can be considered a constant (shock- and model-specific) parameter, if the transmission mechanism is super exogenous with respect to policy changes considered; see Engle, Hendry, and Richard (1983).

The smoothing parameter $\varrho_H$ is defined as $\delta^{1/(H+1)}$ and takes on a value in the range of (0, 1) depending on the policy horizon $H$. The parameter $\delta$ is a sufficiently small fixed parameter of choice that indicates when the interest rate may be considered converged with its reference value; $|i_{\tau+H+1} - i_0| \leq \delta > 0$.

The degree of smoothing increases with the policy horizon ($H$) in a concave fashion. In particular, $H = 0$ leads to (almost) no interest rate smoothing ($\varrho_H = \delta$) while large values of $H$ imply a high degree of interest rate smoothing, since $\varrho_H = \delta^{1/(H+1)} \longrightarrow 1$ when $H \longrightarrow \infty$. The case $H = 0$ refers to the case when the policy maker only allows interest rates to deviate from their reference value in (effectively) a single period at time $\tau$, i.e. in the period the shock occurs.

However, the required initial response becomes stronger with a short policy horizon than with a relatively longer policy horizon. The value of the response coefficient $\beta_{\varepsilon,\ H}$ $(\equiv (1-\varrho_H)\beta_\varepsilon)$ declines (in a geometric fashion) with the policy horizon or degree of interest rate smoothing. In particular,

[4] This perspective on monetary policy is consistent with what Faust and Henderson (2004) regard as best-practice monetary policy. Accordingly, "...best-practice policy can be summarized in terms of two goals: First get mean inflation right; second, get the variance of inflation right.", but "...getting the mean right may be the goal of greatest importance"; see Faust and Henderson (2004, pp. 117–118).

[5] See Akram (2006) for details.

[6] In a simple model, policy horizon and target horizon typically coincide. In a complex dynamic model, however, they may usually differ by some months or quarters, depending on the dynamic properties of the model used.

$\beta_{\varepsilon,\ H} \approx \beta_{\varepsilon}$ when $H = 0$, while $\beta_{\varepsilon,\ H} \longrightarrow 0$ when $H \longrightarrow \infty$; since $\varrho_H \longrightarrow 1$. This suggests that if a very long policy horizon is allowed, the interest rate needs to deviate only marginally from its reference value, but this deviation has to persist for a long time. A long horizon would help subdue the required initial response to a shock. In contrast, a short horizon may imply a particularly large deviation from the neutral interest rate level.

Clearly, the parameters characterizing the interest rate rule depend on the policy horizon, in a given model and a given $i_0$. Thus, by varying $H$, one can vary the interest rate rule and thus the complete interest rate path. It follows that once the rule (4) is implemented in the model, the optimal policy response to a shock can be found by minimizing the loss function (1) with respect to the policy horizon $H$. The optimal value of $H$ will define the optimal value of $\beta_{\varepsilon,H}$ as well as the optimal degree of smoothing $\varrho_H$. The optimal value of $H$ and consequently those of $\beta_{\varepsilon,H}$ and $\varrho_H$ will depend on the preferences for output stabilization and financial stability: $\lambda$ and $\phi$, respectively.

## 4.1 Implementation

**Figure 4** Left frame: Initial required interest rate response in percentage points to house price ($ph$) and credit ($cr$) shocks, respectively, ssociated with different policy horizons, $H$ (horizontal axis), in uarters. Right frame: The degree of interest rate squarters. Right frame: The degree of interest rate smoothing associated with the different policy horizons.

Figure 4 presents the estimated required initial responses, $\beta_{\varepsilon,H}$, associated with different policy horizons in the range of 0–20 quarters for both shocks. They have been obtained by simulating our

model under the two shocks separately. Estimates of the response coefficients $\beta_{\varepsilon,H}$ are obtained from its formula: $(1-\varrho_H)\beta_\varepsilon$. Estimates of $\beta_\varepsilon$ are obtained by taking the ratio of the inflationary effects of a given shock to the deflationary effects of an interest rate shock (over the simulation period of 40 quarters); see Akram (2006) for details. Values of $\varrho_H$ for different policy horizons are obtained from $\varrho_H = \delta^{1/(H+1)}$, where $\delta$ is set to 0.1. This implies that we would consider an interest rate approximately equal to its reference value if it deviates not more than 1/10 of a percentage point from the reference value. Alternative values of $\delta$ do not bring about substantially different results.

The parameter estimates in the figure allow one to define 21 horizon-specific interest rate rules to characterize policy response to each of the shocks. It appears that the house price shock requires a stronger monetary policy response than the credit shock. This reflects that the inflationary effects of a house price shock are stronger than those of the credit shock. The figure also shows that the required initial response to a shock declines with the policy horizon $H$.

For example, if $H = 0$, the interest rate must be initially raised by 0.23 percentage points (pp) if the house prices ($ph$) increase by 1 pp and thereafter are brought back rapidly, i.e. in the subsequent quarter. The deviation of the interest rate from its neutral value in the subsequent quarter will be 1/10 of the initial increase (and lower thereafter); the implied degree of smoothing is 0.1 as shown in Figure 4. However, if e.g. $H = 8$, then interest rates must initially be raised by about 0.06 pp if house prices increase by 1 pp. In this case, the implied degree of interest rate smoothing will be 0.78. (The response to the 10% increase in house prices can be obtained by multiplying the required initial interest rate by 10.)

#### 4.1.1 House price shock

Figure 5 presents the outcomes of monetary policy responses to the 10 per cent transitory increase in house prices. They have been obtained by implementing 21 different horizon-specific interest rate rules, defined by the derived parameter values for the house price shock. The outcomes are measured in terms of standard deviations of key variables (circled lines). We also present the standard deviations of the key variables when monetary policy is assumed to not respond to the shock (straight crossed lines). In this case, equilibrating forces in the model bring the economy back to its equilibrium state after the shock. This case serves as a reference case for evaluating possible gains from responding to the shock.

The performance of an activist monetary policy depends on the policy horizon. The preferred horizon in terms of the different variables depends on how fast they become affected by the house price shock. Stabilization gains increase with the degree of synchronization between the (destabilizing) effects of the shock and the (stabilizing) effects of an interest rate rule defined by a given policy horizon $H$.

**Figure 5** Outcomes of monetary policy response to the transitory house price hock of 10% that builds up over four quarters. The outcomes are measured in standard deviations of key variables over the simulation period of 40 quarters. $Std(j)$ denotes the standard deviation of variable $j = Inf$ (inflation rate), $ygap$ (output gap), $BR$ (bankruptcy ratio) and $DR$ (debt ratio). Each circle marks the outcome of an interest rate rule defined by a specific policy horizon ($H$) in the range of 0–20 quarters (horizontal axis). The straight crossed lines represent the outcomes when monetary policy is assumed to not respond to the shock.

It appears that concern for inflation alone would favor a horizon of two quarters, while concern for output would favor a horizon of a single quarter. The two financial stability indicators, however, favor widely different policy horizons. The debt ratio favors an aggressive response, while the bankruptcy rate warrants a relatively long horizon, which implies a small initial interest rate increase that is brought gradually to its neutral level over a long period.

In general, the gains from responding decline with the length of the policy horizon, because the initial monetary policy stimulus declines, but persistence in interest rates increases (i.e. $\varrho_H$ rises). Thus, the bulk of effects from monetary policy on inflation and output takes place later than those of the shock. However, a too short horizon, implying an aggressive response to the house price shock, is inefficient in terms of price and output stability. This is because an overly aggressive interest rate response would not adequately take into account the time lags from the house price shock to its effect on inflation and output in the model.

The debt ratio favors a relatively shorter horizon because house prices affect both the nominator and the denominator of the debt ratio relatively fast. House prices interact with credit growth directly and indirectly, and affect income indirectly, through their wealth effect on aggregate demand. Therefore, the main effects of house prices on the debt ratio emerge relatively fast, favoring

**Figure 6** The vertical axis shows values of the relative loss-function, $LR(.)$, implied by the different horizon-specific interest rate rules and a few values of the preference parameters. The horizontal axis shows the policy horizons identifying the associated interest rate rules.

an aggressive monetary policy stance.

With respect to the bankruptcy rate, the gains from responding to the initial shock increase with the policy horizon. Horizons up to 7 quarters lead to more variability than in the case of no response to the house price shock. The reason is that an increase in the interest rate to offset the house price shock has the additional consequence that the exchange rate appreciates rather abruptly. This reduces the competitiveness of domestic firms that compete with foreign firms, and the result is an increase in the bankruptcy rate due to the monetary policy response itself. The longer the policy horizon, the smoother the interest rate path, and the less important is this effect. Furthermore, the effects from monetary policy become better synchronized with those from the shock itself. Thus, a longer policy horizon is favored rather than a short one.

There is generally a conflict regarding the appropriate policy horizon, or the policy response, between financial stability and stability in inflation and output. This is especially the case when financial stability is defined in terms of both the bankruptcy rate and the debt ratio. The optimal policy horizon can be chosen by minimizing the linear combinations of variances for the variables entering the loss function (1).

Figure 6 suggests that concern for output stabilization will tend to call for a shorter policy horizon than under strict inflation targeting ($\lambda = \phi = 0$), while concern for financial stability will call for a relatively longer policy horizon; cf. Bean (2004). The figure presents values of the loss-

function relative to its values under no-policy response under the 21 different horizon-specific rules. Each of these rules are identified by the corresponding policy horizon ($H$), which is marked on the horizontal axis. On the vertical axis, values below 1 suggest gains from responding relative to remaining passive, while values above 1 suggest the opposite.

Specifically, Figure 6 shows that the optimal policy horizon is 2 quarters under strict inflation targeting, while it is 1 quarter if $\lambda$ is 0.5. However, if there is additional concern for financial stability and $\phi$ is 0.5, the optimal horizon will be 3 quarters. We note that the values of the corresponding (relative) loss-functions obtain their minimum values at 2, 1 and 3 quarters, respectively.

Figure 6 also shows that there are gains from an active response to the house price shock relative to the hypothetical case of leaving the economy to adjust on its own when exposed to the house price shock. The gains decline with an increase in the policy horizon, but less so when one cares about financial stability.

#### 4.1.2 Credit shock

Figure 7 presents the outcomes of monetary policy responses to the 10 per cent transitory increase in credit to households. They have been obtained by implementing 21 different horizon-specific interest rate rules defined by the derived parameter values for the credit shock presented in Figure 4.

In general, a longer policy horizon is preferred relative to the case of the house price shock. This is mainly because there are longer lags from credit growth to output and (via that) to inflation. These lags are longer than those from a change in the interest rate to output and inflation. A short policy horizon would therefore prove counterproductive and have a destabilizing effect on the economy.

The explanation for favoring a long policy horizon in the case of the two financial stability indicators differs. Specifically, the bankruptcy rate is not that much affected by the higher growth of credit to households. In comparison, an increase in the interest rate has a relatively stronger effect on the bankruptcy rate, through e.g. exchange rate appreciation. The end result is that the bankruptcy rate becomes more unstable with a policy response relative to the case of no response for the policy horizons considered. A particularly long policy horizon contributes to making the interest rate quite stable and mimics closely the case with no interest rate response. Thus at the limit, financial stability as measured by the bankruptcy rate becomes close to that in the case of no policy response (straight crossed lines).

In the case of the debt ratio, the nominator depends on the credit level, while the denominator depends on the income level. An increase in the interest rate lowers both credit growth and income growth, but with different lags and strength; income is affected after about 6 lags as shown in the upper right-hand chart. In sum, the debt ratio becomes more unstable with a policy response

**Figure 7** Outcomes of monetary policy response to the transitory credit shock f 10% that builds up over four quarters. The outcomes are measured in tandard deviations of key variables over the simulation period of 40 quarters. $Std(j)$ denotes the standard deviation of variable $j = Inf$ (inflation), $ygap$ (output gap), $BR$ (bankruptcy ratio) and $DR$ (debt atio). Each circle marks the outcome of an interest rate rule defined by a specific policy horizon ($H$) in the range of 0–20 quarters (horizontal axis). The straight crossed lines represent the outcomes when monetary policy is assumed to not respond to the shock.

relative to the case of no response. Hence, stabilization of the debt ratio essentially favors no response rather than a response to the credit shock, irrespective of the policy horizon. Thus, in contrast to the case of the house price shock, stabilization of the debt ratio favors a longer horizon than stabilization of the bankruptcy rate.

Figure 8 illustrates the effect on the optimal policy horizon of preferences regarding output and financial stability. In contrast to the house price shock, concerns for output stabilization and financial stability favors a relatively long horizon as in the case of strict inflation targeting.

However, a sufficient concern for financial stability implies a no-response to the credit shock. Figure 8 shows that when $\phi = 0.5$ (and $\lambda = 0.5$), values of the relative loss-function remain above 1 even when an interest rate rule with policy horizon 20 quarter is chosen. Accordingly, the outcome of the no-response policy would lead to lower losses than all of the different horizon-specific interest rate rules. This is, however, not the case when $\phi = 0$, as interest rate rules associated with relatively long horizons outperform the no-response policy.

**Figure 8** The vertical axis shows values of the relative loss-function, $LR(.)$, implied by the different horizon-specific interest rate rules and a few values of the preference parameters. The horizontal axis shows the policy horizons identifying the associated interest rate rules.

# 5 Summary and conclusions

We have implemented two main approaches to taking financial stability into account when conducting monetary policy within a flexible inflation-targeting framework. We have then investigated the implications of the two approaches for the behavior of interest rates over time, developments in financial stability, real economic stability and inflation stability.

The activist or precautionary approach towards promoting financial stability has been characterized by a Taylor-type interest rate rule augmented with two financial stability indicators: the bankruptcy rate of non-financial firms and the debt ratio for households. The conventional approach has been implemented by shock- and horizon-specific interest rate rules. To study the merits of the two approaches, we have simulated a well-documented macroeconometric model of the Norwegian economy under a house price shock and a credit shock, separately. We may draw the following conclusions from these simulations.

Under the precautionary approach, gains or losses from responding directly to financial stability indicators are highly shock-dependent. This is especially the case for inflation and output. In particular, there are gains in terms of inflation and output stability in the case of a house price shock, while there are costs in terms of relatively large variation in inflation and output in the case of a credit shock. The effects on the two financial stability indicators, the debt ratio and the

bankruptcy rate, are highly shock dependent. The variance of the bankruptcy rate increases while that of the debt ratio becomes slightly lower in the case of the house price shock. In the case of the credit shock, however, the variances of both indicators increase substantially. Furthermore, if we use variation in interest rates as an indicator of financial stability or fragility, there are small gains in the case of the house price shock, but considerable costs in the case of the credit shock. Thus, the precautionary approach prove to be counterproductive in the case of the credit shock.

Under the conventional approach, there are generally gains in terms of financial stability by extending the policy horizon. However, the two different indicators tend to prefer different horizons under the two shocks. Concern for the debt ratio of households would favor a relatively short horizon in the case of the house price shock, but a relatively long horizon in the case of the credit shock. In contrast, concern for the bankruptcy rate of firms would favor a long horizon in the case of both shocks.

However, if we focus on inflation and output stability, there is largely no conflict between the two regarding the horizon, since both the house price shock and the credit shock are demand shocks in the model. The preferred horizon is highly shock-dependent. Specifically, a relatively short horizon would be preferred in the case of the house price shock, as longer horizons would prove to be destabilizing. In the case of the credit shock, relatively long horizons are more stabilizing than relatively short horizons.

Thus, our findings largely support the conventional approach that concern for financial stability can be incorporated in interest rate decisions by choosing a longer horizon than out of concern for inflation and output stability alone. However, our analysis also suggests that this is not always the case, as e.g. concern for the debt ratio favors a relatively shorter horizon than that favored by inflation and output stability alone.

In sum, our results suggest that incorporating concern for financial stability when setting interest rates under a flexible inflation-targeting regime is a demanding task in terms of the information required, irrespective of whether one follows the precautionary approach or the conventional approach. In particular, it appears crucial to choose appropriate indicator(s) of financial stability, especially because different indicators may move in opposite directions with widely different policy and economic implications.

Our analysis has brought forward some of the trade-offs that may exist between the objective of financial stability and inflation and output stability under the two different approaches. These trade-offs appear even in the face of shocks that can be considered demand shocks. In the case of supply shocks, a more complex set of trade-offs is likely to emerge, as all of the three objectives of inflation, output and financial stability may conflict with each other. These trade-offs and the possible consequences of imperfect information on the identity of shocks raise the question of whether the objective of financial stability should be pursued through interest rates, or whether

alternative policy instruments would be more appropriate. An exploration of this issue as well as an examination of our findings using alternative models is left for future research.

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# Appendix: The macroeconometric model

The model is an extension of the specifications reported in Bårdsen and Nymoen (2001), Bårdsen et al. (2003) and (2005). It is a macroeconometric model estimated on quarterly aggregate data. It explicitly takes into account several channels of interplay between output, inflation, and financial stability. The equations are in equilibrium-correction form, with backward-looking expectations formation. The model is econometrically well-specified, with invariant parameters with respect to changes in monetary policy over the sample; see the citations above for further documentation.

Aggregate demand:

$$\Delta y_t = 0.5\Delta g_t + 0.05\Delta\left(e + p^* - p\right)_t + 0.1\Delta(ph - p)_t$$
$$- 0.2\left[(y + 1.4\left(r - \Delta_4 p\right) - 0.5g - 0.1(ph - p)\right]_{t-1} \tag{5}$$

Household debt:

$$\Delta cr_t = \Delta hs_t \ + 0.03\Delta(inc \ + ph)_t - 0.3\Delta r_t + 0.01\Delta turn_t - 0.02\Delta u_t$$
$$- 0.05\left[l - hs - 1.7r - 0.2turn_t \ - 0.6s_share\right]_{t-1}, \tag{6}$$

House prices:

$$\Delta ph_t = 0.2\Delta inc_t + 0.05h_t^e - 4.5\Delta r_t$$
$$- 0.1\left[ph + 5r + 0.4u - 1.5\left(inc - hs\right) - 0.15cr\right]_{t-1}, \tag{7}$$

Exchange rate:

$$\Delta e_t = -0.1\left(e + p^* - p\right)_{t-1} \ - 0.3[(r - \Delta_4 p) - (r - \Delta_4 p^*)]_{t-1}, \tag{8}$$

Unemployment:

$$\Delta u_t = -0.1u_{t-1} - 2.8\Delta y_t, \tag{9}$$

Wages:

$$\Delta w_t = 0.7\Delta p_t - 0.1\left(w - p - pr + 0.1u\right)_{t-1}, \tag{10}$$

Consumer prices:

$$\Delta p_t = 0.4\Delta w_t + 0.05\Delta y_t - 0.06\left[p - 0.7\left(w - pr\right) - 0.3\left(e + p^*\right)\right]_{t-1}, \tag{11}$$

Bankruptcies:

$$\Delta b_t = 2.4\Delta\left(w - p - pr\right)_t - 0.8\Delta\left(e + p^* - p\right)_t$$
$$- 0.6\left[(b - f) - 9.8\left(r - \Delta_4 p\right) + 3.5\left(w - p - pr\right) - 0.9\left(q - p\right) + 3.4\left(e + p^* - p\right)\right]_{t-1} \tag{12}$$

We present a stylized version of the model in Equations (5)–(12). All variables except nominal interest rates ($r$) are in natural logarithms, $\Delta$ denotes the first difference operator, $\Delta_4$ denotes the four period difference operator, and foreign variables are denoted with starred superscripts. The

nominal exchange rate (in logs denoted $e$) expresses the number of domestic currency units per unit of foreign currency.

Growth in aggregate demand $\Delta y$ is modeled in Equation (5). Real house prices $(ph - p)$ have wealth effects on aggregate demand. In addition, aggregate demand is affected by the real interest rate $(r - \Delta_4 p)$, government expenditures $g$ and the real exchange rate $(e + p^* - p)$. Thus, a change in the nominal exchange rate would also directly affect aggregate demand. The relationship explaining movements in household debt in Equation (6) follows Jacobsen and Naug (2004). Growth in household debt $\Delta cr_t$ reacts positively to the real value of the housing stock $hs$, growth in income $inc$ and house prices $ph$, as well as to changes in the interest rate $r$, the turnover rate of houses $turn$, the share of young people proxied by students in the population $s_share$ and movements in the unemployment rate $u$; see Jacobsen and Naug (2004) for further details.

The model of house prices $ph$ in Equation (7) is based on Jacobsen and Naug (2005). The growth rate of nominal house prices $\Delta ph$ is explained by growth in nominal income $inc$ and household expectations $h^e$ regarding own income prospects from survey data as well as interest rate changes and deviations from steady state. In steady state, real house prices $(ph - p)$are mainly determined by income $inc$ and housing stock $hs$ in addition to the interest rate $r$, the unemployment rate $u$, and credit $cr$.

The equation of growth of the nominal effective exchange rate $\Delta e$ (Equation 8) reacts to deviations from PPP $(e + p^* - p)$ and hence contributes to stabilizing the real exchange rate. In the long run, the nominal exchange rate reflects the difference between domestic and foreign prices and the difference between domestic and foreign interest rates $(r - \Delta_4 p) - (r - \Delta_4 p^*)$. Accordingly, domestic inflation becomes fully reflected in the nominal exchange rate in the long run.

The unemployment rate $u_t$ follows output growth $\Delta y$ in the short run, as in an Okun's law relationship; see Equation (9). In addition, it exhibits slow reversion towards its equilibrium rate; an intercept term has been omitted from this equation for ease of exposition.

There is a partial pass-through of consumer price inflation $\Delta p$ to nominal wage growth $\Delta w$ in the short run; see Equation (10). In each period, nominal wages adjust towards their long-run relationship where there is a full pass-through of consumer prices and productivity $pr$. However, the mark-up of wages on prices and productivity is inversely related to the unemployment rate.[7] In the short run, consumer price inflation varies with changes in aggregate demand $\Delta y$ and to some extent nominal wage growth $\Delta w$; see Equation (11). In addition, it adjusts to deviations from the long-run relationship for consumer prices.

In the long run, consumer prices $p$ reflect a weighted average of domestic and imported costs, represented by unit labor costs $(w - pr)$ and import prices $(e + p^*)$. It follows that the initial effect of a nominal exchange rate on aggregate demand would become modified over time due to

[7] The constant mark-up term is suppressed. In the full econometric model, productivity $pr$ is also an endogenous variable that depends on real wages $w - p$, unemployment $u$ and a deterministic trend.

the exchange rate pass-through to inflation, which would have an effect opposite to that of the nominal exchange rate on the real exchange rate. The model also includes an equation for the underlying inflation rate ($Inf$), which is linked to consumer price inflation.

Finally, the model contains a relationship, (12), explaining the number of bankruptcies, adapted from Jacobsen and Birkeland Kloster (2005). The number of bankruptcies $b$ are modeled as a long-run relationship with the number of enterprises $f$, the real interest rate $(r - 4\Delta p)$, real unit labor costs $(w - p - pr)$, real material input costs $(q - p)$, and the real exchange rate $(e + p^* - p)$. In the short-run the growth rate $\Delta b$ reacts to growth rates in unit labor costs and the real exchange rate.

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