Four Monetary Policy Strategies in Comparison: How to Deal with Financial Instability?

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The article provides a review of the monetary policy strategies of four major central banks – the Eurosystem, the Federal Reserve, the Bank of Japan and the Bank of England – and investigates whether these strategies are modified in times of financial instability. The study finds a number of – statutory and actual – differences regarding the central banks' objective(s), strategies and approaches to achieve the objective(s), and communication, including the publication of forecasts. While central bank laws are often not very explicit about financial stability, there is consensus that the latter is a major concern in practice. Many see the 2007/2008 financial crisis as yet another reminder that central banks in their monetary policy strategies need to take a longer-term and broader view than might have been suggested only a few years ago. All four central banks' monetary policy strategies in principle allow for adequate incorporation of financial stability concerns. The lender of last resort function poses challenges for the operational implementation of monetary policy and their credibility as competent and reliable policy institutions. While central banks have been praised for their flexibility in dealing with the recent crisis, this very flexibility may also create moral hazard for the future. Empirical estimates of Taylor-type reaction functions, augmented for a measure of financial instability, confirm some relevant differences in the reaction elasticities to inflation and the output gap, as well as significant effects of financial instability on the interest rate setting behavior of the Bank of England, which are in line with the theoretical view that less inertia in monetary policy should be allowed for in times of financial market risks.

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Ten years after the launch of European economic and monetary union (EMU) it is worth taking stock and comparing the Eurosystem's monetary policy strategy with that of three other major central banks: the Federal Reserve System, the Bank of Japan and the Bank of England. How do the differences in statutory objectives between the Eurosystem, the Bank of Japan and the Bank of England, on the one hand, and the Federal Reserve System, on the other hand, translate into actual monetary policy? How different are the Eurosystem's "two-pillar strategy," the Bank of England's inflation targeting, the Bank of Japan's "two perspectives" approach and the Federal Reserve's pragmatic ecleticism? How do the four central banks communicate with the public, and what information do they reveal to guide inflation and interest rate expectations?

Beyond such general comparison, the 2007/2008 financial turmoil and central banks' active responses to resolve tensions have highlighted another, more specific question relevant for central banks' monetary policy strategies, namely how to react to financial imbalances and how to include financial stability considerations among the central bank's objectives.

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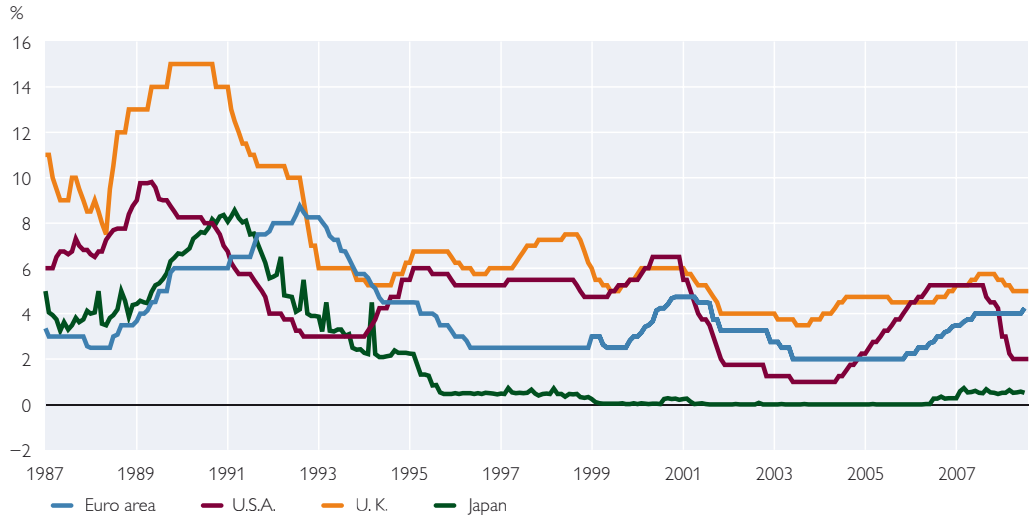
Chart 1

Policy Rates



Source: Thomson Financial.

Note: Values for the euro area prior to 1999 are German rates.
Standard deviations – whole period: euro area 1.8%, U.S.A. 2.1%, U.K. 3.2%, Japan 2.5%; 1999 to 2008: euro area 0.9%, U.S.A. 1.8%, U.K. 0.7%, Japan 0.2%.

This article addresses both of these issues. Section 1 sets the frame for the ensuing analysis by summarizing the major themes in the economic literature, which inform our current understanding, but may also motivate possible differences of views, on central banks' objective(s) and monetary policy strategy. Against this background, section 2 describes and analyzes the main characteristics, and the differences, of the four central banks' monetary policy strategies. Section 3 addresses the nexus between monetary policy and financial stability from various angles: first, a conceptual one (channels of mutual influence, arguments for and against central banks' close involvement in financial stability responsibilities), second, an institutional one (what do the four central bank laws say); and third, a practical one (how do financial stability concerns fit into the monetary policy strategies of the four central banks). Building on the – scarce – empirical literature on the influence of financial stability concerns on central banks' interest-rate setting behavior, section 4 estimates Taylor rules for the four central banks, with proxies for financial instability explaining central banks' inertia in changing policy interest rates. Section 5 summarizes and draws conclusions.

1 Monetary Policy Strategies: Underlying Economic Thinking

An analysis and assessment of central banks' monetary policy strategies needs to take into account a number of threads along which economic thinking has evolved over the past decades.[3] Underlying these threads are two fundamental questions:

1. What should the central bank's objective(s) be?
2. How can it best achieve this or these objective(s), and thus maximize society's welfare?

[3] *For a comprehensive, nontechnical treatment of the subject, see also Mishkin (2007a).*

Most economists now clearly agree that a central bank's primary objective should be price stability. This view reflects a substantial body of theoretical and empirical economic research.

The basic argument is that while monetary policy can, due to sluggish adjustment in prices and/or wages, temporarily affect output and employment in the short run, it is neutral with respect to real growth and employment over the longer run. Excessive monetary expansion will over the medium run result only in a rise in the general price level, without positive effects on the level of real activity. In other words, over the medium run, the quantity theory of money holds: There is no medium- or long-run tradeoff between price stability and real economic growth or employment. Thus, the conclusion emerges that monetary policy can – and should – in the first place focus on safeguarding price stability.[4]

A related strain of the literature studies the costs and – at low rates of inflation – the benefits of inflation. On the one hand, inflation entails a number of costs ("sand") for the economy.[5] High inflation rates might, according to this literature, even dampen growth, implying that achieving price stability in the medium to long run also supports economic growth and employment. On the other hand, deflation and also positive inflation rates very close to zero have been argued to entail costs[6] – at low values, inflation can act as "grease" for the economy. Estimates for the "optimal rate of inflation" come up with values between 1% and 3%.[7] Importantly, the optimal rate of inflation can vary over time. In particular, extended periods of low inflation can soften downward price and wage rigidities, thus reducing the costs of inflation and thus lowering the optimal rate of inflation (see below for the experience in Japan).

[4] *Note, however, that despite broad agreement on these notions among the economic profession, the idea that a central bank should also – or even as importantly – support growth and, along with this, other real economic goal variables, is widespread: It is reflected in the widely-used Taylor rules, which describe central banks' interest rate setting as a function of the development of inflation and output relative to a target or equilibrium value; it is a commonly held view among politicians and the media; and it is in the mandate of the Federal Reserve.*

[5] *Often quoted costs of inflation are blurred relative price signals, additional transactions costs from avoidance of cash transaction balances due to losses in real asset value, increasing tax rates due to nominal progressive tax brackets ("bracket creep"), an erosion of companies' value due to depreciation rates not covering inflated replacement costs for a given stock of machinery and equipment, arbitrary redistribution between creditors and debtors resulting from varying inflation rates, and costs for the socially disadvantaged in the absence of less than complete indexation of social benefits and pensions, to name just a few.*

[6] *The zero lower-bound for nominal interest rates implies that at inflation rates close to zero, the central bank has less leeway to kickstart the economy by means of negative real interest rates. Nominal wage and price downward rigidities imply, for instance, that in an environment of very low inflation, a downward adjustment of real wages in sectors or entire economies which are hit by negative shocks is hampered, implying a rise in unemployment. The situation is further aggravated by the potential downward spiral of falling prices and wages and falling demand in the event of a fall in the general price level, i.e. deflation.*

[7] *Studies performed in the context of the review of the ECB's monetary policy strategy found that an inflation rate of 1% ensures a sufficient distance from the zero lower bound of interest (for details see the studies included in Issing, 2003). Sinclair (2003) arrives at 2% for the United Kingdom, while a recent estimate based on a New-Keynesian model by Billi and Kahn (2008) comes up with an optimum range of 0.7% to 1.4% of personal consumption expenditure (PCE) inflation for the United States.*

Once we have accepted that price stability, i.e. a low, but positive rate of inflation,[8] is a goal worth pursuing, we need to answer the second question of how this can best and most successfully be achieved. This issue needs to be addressed at several levels.

A first level addresses policymakers' incentives and their interaction with economic expectations about the future course of inflation. An important idea is that policymakers may be at risk of giving priority to short-term versus longer-term economic outcomes. Thus, even if they know and accept the medium-term neutrality of money and the medium-term costs of higher inflation, they are tempted to boost real economic activity in the short run, at the cost of higher inflation later. Since economic agents understand these incentives, they anticipate monetary policymakers' short-termism and thus expect inflationary policy in the first place. Since actual inflation is driven, inter alia, by inflation expectations, the economy will indeed reach a higher than optimal inflation rate. This so-called time-inconsistency problem (Kydland and Prescott, 1977) has been influential in shaping current thinking about optimal monetary policy and central bank design.[9] Several solutions to this problem were offered by economic theory, which on the one hand aim at explicitly changing the monetary policymaker's incentives, and on the other at creating public credibility for the monetary authority's lasting and reliable commitment to price stability.

The most widely used remedy for changing the policymakers' incentive structure is to delegate monetary policy to an independent agent (the central bank), with a clear mandate of pursuing price stability as a priority.[10] A large body of theoretical and empirical economic research shows that greater central bank independence is indeed associated with lower inflation (for a recent study see Crowe and Meade, 2008).

To ensure that the mandate is duly fulfilled by the agent, tools for transparency and accountability (frequent publication of the monetary authority's balance sheet, written reports, hearings before Parliament etc., press conferences on the outcome of meetings of the decision-making body) need to accompany such independence.[11] Thus, transparency further increases the incentive for the policymaker to stick to the mandate. At the same time, central bank independence and transparency about the central bank's objective, strategy and ongoing monetary policy also serve to create clarity and credibility among economic agents for the monetary authority's goal and commit-

[8] *Note, however, that there is also discussion whether a central bank should target low rates of inflation or specific levels of the general level of consumer prices. The former, which is common practice nowadays, implies "base drift," i.e. deviation in one year from the target inflation rate does not require compensation in the next year. By contrast, specific "price level targets," while they may also imply positive inflation from one year to the next, would in the event of a deviation from target require offsetting inflation developments in the future. For an overview of the pros and cons of both approaches, see e.g. Gaspar et al. (2007).*

[9] *It can be shown that even if the policymaker has exactly the same objective (including the same time horizon) as society, the time inconsistency and credibility problem still generates suboptimal welfare outcomes.*

[10] *The economic literature of the 1980s and 1990s was full of proposals to ensure central bankers' commitment to price stability, e.g. by designing central bank governors' contracts comprising financial incentives to ensure price stability.*

[11] *Indeed, Crowe and Meade (2008) show empirically that more independent central banks are more transparent. Furthermore, increases in central bank independence have tended to occur in more democratic countries. Finally, they also show that central bank transparency is positively correlated with measures of national institutional quality.*

ment to achieving its price stability mandate. In this way, inflation expectations are anchored at a low level, which in turn stabilizes actual inflation developments (Bernanke, 2004a).

This is also where monetary policy strategies come into the picture. Quoting from www.wikipedia.org, *"a strategy is a long term plan of action designed to achieve a particular goal. … Strategies are used to make the problem easier to understand and solve."* Consistent with this general definition, Houben (2000) defines monetary policy strategies as consisting *"of the specification of the intended monetary [policy] reaction function to economic developments as well as the communication of this reaction function and of actual policy decisions to the outside world."*[12]

In practice, monetary policy strategies serve several purposes: First, they may prompt policymakers to make explicit choices about their broad philosophy and the analytical framework underlying monetary policy decisions. Particularly in multi-person monetary policy decision-making bodies, such ex ante explicitness may support a structured and focused approach to decision-making. Second, a monetary policy strategy can also play a very useful role in informing agents about the central bank's broad thinking ("model") and the indicators informing monetary policy decisions. In this way, monetary policy can be better understood by agents, thus stabilizing inflation expectations and reducing interest rate volatility.

The academic and policy discussion in the last two decades addressed a number of specific issues relevant for central banks' monetary policy strategies. The older discussion on "rules versus discretion" moved on to more detailed topics such as optimal monetary policy rules. Usually, this literature seeks to optimize a loss function under various assumptions, models and circumstances. Since the 1990s, dynamic stochastic general equilibrium (DSGE) models have formed the basis for developing this research. As opposed to this often highly technical and sophisticated literature, the formulation of the "Taylor rule" (Taylor, 1993) offered an alternative in the form of pragmatic, "simple rules" (Taylor rules are explained in section 4).

Inflation targeting has been adopted by many central banks worldwide over the past years. Pioneers included the Reserve Bank of New Zealand, the Sveriges Riksbank and the Bank of England. Originally a pragmatic approach developed by central banks to replace other nominal anchors, such as exchange rate or monetary targets, inflation targeting also became the subject of a blooming theoretical literature. Major elements of inflation targeting are: (1) an explicit focus of monetary policy on the primary objective of price stability, although, depending on the precision of the inflation target, some flexibility with respect to output stabilization is possible; (2) publication of a numerical inflation target (which may take various forms: point targets versus

[12] *Houben (2000) further elaborates that the first element comprises the key factors that determine the reaction function, including the end objective, the (intermediate) policy target that is pursued towards that end objective, and the institutional framework that is adopted for monetary policy decision-making. The second element encompasses all aspects related to the external presentation of the reaction function, in particular the precommitment to policy targets and the transparency of the policymaking process, which together aim to condition public expectations on the desired monetary policy outcome.*

ranges; measured by headline or "core" inflation; different time horizons for meeting the target); (3) explanation of interest rate decisions primarily on the basis of deviations of inflation (or the central bank's inflation forecast) from target; and (4) active communication with the public and a strong emphasis on central bank accountability, which is usually reflected in regular "inflation reports" (for surveys on inflation targeting see e.g. Mishkin and Schmidt-Hebbel, 2007; Bernanke, 1999).

A key topic is how monetary policy should deal with uncertainty. Uncertainty arises for instance from lagged or imprecise (later revised) data, uncertainty about the most appropriate economic model (in a given country under specific circumstances), and uncertainty about the transmission of monetary policy measures on the economy (Bernanke, 2007). One conclusion from this literature is that monetary policy should be designed in a robust way: Rather than aiming for an optimum which would hold only under very narrow conditions, monetary policy should aim to avoid gross mistakes in many different circumstances which might arise.[13] Another possible effect from uncertainty is that central banks move cautiously when changing the level of official interest rates; this "gradualism" (Brainard, 1967; Bernanke, 2004b) has also become a standard feature in empirical estimates of central banks' interest setting behavior (see sections 3 and 4 for a discussion of Taylor rules).[14]

The globally very low inflation rates around the turn of the century[15] triggered work concerned with the conduct of monetary policy in a low inflation environment (Bernanke, 2003b and 2004a). Issues addressed included for instance the identification of a sufficient "safety margin" from the zero lower bound of interest rates (see above on the optimal rate of inflation).

In response to the risk of not only deflation, but also of other severe adverse economic developments, particularly the Federal Reserve in recent years has focused on a so-called "risk management approach," i.e. monetary policy takes into account the likelihood and potential damage of risks. In this respect, the Federal Open Market Committee (FOMC) pays more attention to potential "nonlinear" or "fat tail" events, in order to design monetary policy in a way that helps avoid particularly adverse economic outcomes (Mishkin, 2007a and 2008). Contrary to gradualism, the risk management approach to monetary policy may imply that central banks exhibit an even more vigorous interest rate policy response than under normal circumstances.

Another strand of the literature studied the effect of a long period of low inflation on price and wage formation. One finding is that the persistence

[13] *One major contribution of the recent literature in this field is the application of robust control theory to economic policy decisions under model uncertainty (Hansen and Sargent, 2007).*

[14] *Note, however, that there is also a growing economic literature dealing with circumstances when uncertainty requires aggressive policy steps. For example, uncertainty about the persistence of inflation typically leads to optimal policy being more aggressive than otherwise.*

[15] *The term "the Great Moderation" was coined for the period of high macroeconomic stability (which included both low and stable inflation and low output growth volatility) from the 1990s until the mid-2000s. The related economic literature discussed whether the great moderation was due (a) to fewer, less severe economic shocks, (b) to a better ability of economies to absorb shocks, due to more efficient markets with fewer frictions, or (c) better macroeconomic, in particular monetary, policies (for an overview see, e.g., Bernanke, 2004d).*

of inflation, i.e. the dependence of inflation on past inflation developments, has declined in the euro area over the past decade, reflecting the central bank's high level of anti-inflationary credibility and the increased importance of inflation expectations in actual price formation (Altissimo et al., 2006).

Nominal anchors, which act as a guidepost to monetary policy and the public's perceptions about future monetary policy decisions and inflation, have long had a firm place in monetary theory. During the time of the gold standard, the price of gold served as nominal anchor for the value of currencies. Later on, nominal exchange rate targets against large and stable world currencies served as nominal anchors in many countries. More recently, many central banks have adopted a publicly announced quantitative inflation target as nominal anchor. Over the past two decades, the role of monetary aggregates in the design and conduct of monetary policy has changed. In the 1970s, a number of countries had adopted monetary targeting as part of strategies to fight what was later to become known as the "Great Inflation." This strategy proved more successful and long-lived in some countries (Germany and Switzerland) than others (United States, Canada and the United Kingdom) (Mishkin, 2000). The reasons why the U.S.A., Canada and the U.K. sooner abandoned monetary targeting include the earlier emergence of financial innovation and changes in the technology of payments and settlements, and the resulting instability of the relationship between monetary aggregates and goal variables, such as inflation or nominal income. Thus, monetary strategies were conditioned by developments in financial markets (Borio and White, 2004).

Many studies have investigated the stability of money demand functions (i.e. how well the growth in the volume of money demand can be explained by the growth of GDP, the level of interest rates and other variables, such as asset prices) and the leading indicator properties of monetary aggregates for inflation. All in all, the findings can be summarized as follows. First, money demand has become increasingly difficult to model and explain over the past decade or two. Second, the forecasting of inflation by means of the growth of monetary aggregates has also become more difficult.[16] Third, as an empirical matter, money-growth based inflation forecasting works better in the euro area than in the United States (Kahn and Benolkin, 2007); indeed, it continues to work reasonably well in the euro area for medium to long-term horizons (Kaufmann and Kugler, 2008; Hofmann, 2008).

Money and its counterpart credit have recently gained renewed attention for monetary policy as they might provide early signals on emerging financial imbalances that could affect output and inflation (Borio and Lowe, 2004; Detken and Smets, 2004; BIS, 2007), an issue which will be further pursued in section 3.

Naturally, this brief summary cannot do justice to the full breadth and depth of the literature and its many nuanced findings and arguments. What is of interest for the remainder of the article are the broad strands of the discussion to the extent that they appear to have influenced (or, in some cases, have been influenced by) monetary

[16] *This may also be due to the generally increasing difficulty of forecasting inflation in periods of low inflation, and also applies to other methods of inflation forecasting, based, e.g. on the Phillips curve.*

policy strategies in practice. The following analysis in section 2 should accordingly be seen against these trends in monetary theory and policy over the past decades.

2 Monetary Policy Strategies in Comparison: What Central Bank Laws and Official Information Say[17]

Central banks' monetary policy strategies are embedded in their legal mandate and the tasks and powers conferred to them. However, the formal legal and institutional framework – out of necessity and with good reason – leaves central banks substantial leeway in designing their actual monetary policy strategy.[18] Major central banks nowadays invest substantial resources into continuously developing and refining their monetary policy strategies in line with latest developments in economic research and in the light of practical experience. So we need to consider legal provisions and their practical implementation simultaneously to obtain a full and adequate picture of central banks' strategies. For reasons of space, this section concentrates on a comparison of the "Big Four's" monetary policy strategies as of mid-2008.

Table 1 provides a comparative overview of key institutional and monetary policy aspects of the central banks under study, including legal provisions and features that have developed in practice. The table reveals a number of noteworthy differences.

– *Statutory Monetary Policy Mandate: Differences Remain*

The corner stone of any monetary policy strategy is a clear definition of the central bank's mandate. The prevailing differences among the four central banks reflect different views among legislators on the role of monetary policy: The Eurosystem[19] and the Bank of England[20] both have the primary objective of maintaining price stability; subject to that, they shall support general economic policies. The Bank of Japan Law puts it differently, stating that through the pursuit of price stability, the Bank of Japan contributes to the sound development of the national economy. One could conclude that the former two central banks indeed pursue price stability as a goal in itself, while the Bank of Japan Law sees price stability only as a basis for a broader economic goal. What seems most relevant for the practical conduct of monetary policy, however, is that the three central banks' objectives all imply a clear hierarchy of goals, putting price stability first.

By contrast, the Federal Reserve has multiple goals,[21] namely to *"maintain the growth of monetary and credit ag-*

[17] *The authors appreciate input by Markus Arpa to this section. A detailed account of the Eurosystem's monetary policy preparation and decision-making processes is given in Moutot et al. (2008). Scheller (2006) is a detailed and authoritative reference on institutional aspects of the ECB.*

[18] *Of course, the legal framework itself can – and does – change over time. However, such changes occur quite rarely, legal frameworks are thus, for this study, taken as given.*

[19] *The Treaty Establishing the European Community (Article 105(1)) states that "the primary objective of the ESCB shall be to maintain price stability" and that, "without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community." The Treaty thus establishes a clear hierarchy of objectives for the Eurosystem.*

[20] *The Bank of England's monetary policy framework was fundamentally redesigned in 1997 with a new Bank of England Act. The Bank of England's Monetary Policy Committee is charged with maintaining price stability, i.e. low inflation, and, subject to that, support of the Government's economic objectives. The Chancellor of the Exchequer sets and reviews the inflation target, which currently stands at 2%.*

[21] *The Federal Reserve System's goals evolved over time The Federal Reserve Act is the legal basis for the Federal Reserve System (12 U.S.C. § 225a, as amended by the Federal Reserve Reform Act of 1977 (P.L. 95–188).*

gregates commensurate with the economy's long-run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Federal Reserve officials and independent economists actually refer to the Federal Reserve's dual, rather than triple, mandate.

– *Is There a Quantified and Published Definition of the Central Bank's Goal(s)?*

The strategies pursued by the four central banks differ strongly and in several respects. A first aspect is whether there is a quantitative, published definition of the policy goal(s).

Regarding the Eurosystem, the Governing Council of the European Central Bank (ECB) at its meeting on October 13, 1998, (ECB, 1998) agreed on the main elements of the stability-oriented monetary policy strategy of the ESCB. After some minor adjustments and clarifications in May 2003 (ECB, 2003), the current vintage of the monetary policy strategy defines price stability as the year-on-year increase in the Harmonized Index of Consumer Prices (HICP) for the euro area of below, but close to, 2% over the medium term. The "medium term" as such is not defined, since it depends on the type of shocks hitting the economy, and their speed of absorption.

As part of its "New Framework for the Conduct of Monetary Policy," published on March 9, 2006, the Bank of Japan's Policy Board defined price stability as approximately 0% to 2% in the medium to long term. The Bank of Japan states that, in principle, price stability is zero inflation; there is no significant measurement bias in Japan's CPI. To avoid a vicious circle of falling prices and falling demand, a small positive inflation rate may be deemed consistent with price stability. It is further argued that since the average inflation in Japan over the past decades was lower than in other industrialized countries, the rate of inflation perceived by firms and households to be consistent with price stability is lower than in other countries, and economic decisions are guided by such a low inflation environment. The published range of 0% to 2% is the result of a discussion among the Bank of Japan's Board members. The Bank of Japan reveals that there were somewhat diverging views among Board members concerning the quantification of price stability, but that the preferred figure of most Board members was around 1%. The definition is reviewed annually (Bank of Japan, 2006). Two points appear particularly noteworthy: first, the Bank of Japan's reasoning implies that optimal inflation is deemed to be endogenous and depends on past "habits." Second, the strong consensus on a very low quantitative definition of price stability is remarkable given Japan's deflation experience during the 1990s and early 2000s.

The Bank of England has a clear inflation target of 2%. Contrary to the other central banks under consideration, the inflation target is set by the Treasury.

By contrast, the Federal Reserve has never put an official figure on what it considers to be a stable price environment. Judging from remarks by successive Federal Reserve Chairmen, the working definition of price stability evolved as follows: *"A workable definition of reasonable 'price stability' would seem to me to be a situation in which expectations of generally rising (or falling) prices over a considerable period are not a pervasive influence on economic and financial behavior."* (Volcker, 1983). *"We will be at price stability when households and businesses need not factor expectations of*

changes in the average level of prices into their decisions." (Greenspan, 1994). *"The long-run inflation rate that best promotes the dual mandate is likely to be low but not zero."* (Bernanke, 2007).

Since the late 1980s, some political and academic circles, including Fed Chairmen Greenspan (1989) and Bernanke (2003a), have attempted to put more emphasis on price stability in the U.S.A. by defining it more clearly. The Federal Reserve and the Federal Open Market Committee (FOMC) discussed the advantages and disadvantages of inflation targeting and related communication issues on several occasions. Related to these discussions, the FOMC announced in fall 2007 that it would compile and release projections four times each year rather than twice a year. In addition, the projection horizon was extended from two to three years. FOMC members provide projections for overall personal consumption expenditures (PCE) inflation, as well as for real GDP growth, the unemployment rate, and core PCE inflation. The projections by the FOMC for PCE inflation and core PCE inflation for the longer run (i.e. in three years' time) are of particular interest, as these projections are made under the assumption of "appropriate" monetary policy and should hence presumably converge at the desired level of inflation (Mishkin, 2007b). Both PCE inflation and core PCE inflation rates in three years time were put at a range of 1.5% to 2% (central tendency: 1.6% to 1.9%).

The Federal Reserve's goal of maximum employment leaves ample room for interpretation. The FOMC has short-cut the discussion on "maximum employment" by introducing the wording "sustainable economic growth" instead.

– *What is the Central Bank's Strategy to Achieve the Monetary Policy Goal(s)?*

Another important aspect of any monetary policy strategy is whether there is a structured approach to the making of monetary policy decisions so as to systematically achieve the goal(s).

The Eurosystem uses its own "two pillar strategy" to guide the Governing Council's decisions. The first pillar, economic analysis, assesses the short to medium-term determinants of price developments, with a focus on real activity and financial conditions in the economy. The second pillar, monetary analysis, mainly serves for cross-checking, from a medium to long-term perspective, the indications from the economic analysis. The two-pillar approach ensures that appropriate attention is paid to different perspectives and time horizons in making an overall judgment of the risks to price stability. The diversified approach to the interpretation of economic conditions reduces the risk of policy error caused by over-reliance on a single indicator, forecast or model (Scheller, 2006). The two-pillar structure is also systematically applied in the Eurosystem's communication on monetary policy decisions.

The Federal Reserve has no stated strategy to achieve its goals. There are no preferred indicators nor is there a set method of grouping or weighing various indicators to arrive at conclusions. The main source of information on the Federal Reserve's view regarding its goals and decision-making considerations is speeches by Federal Reserve officials. These – very insightful – speeches emphasize and explain economic concepts and ideas which by implication may be assumed to play a role in monetary policy decision-making – at least as concerns the speaker. Depending on circumstances, these concepts and ideas change. Taken to-

gether, the collection of multiple speeches and testimonials by Federal Reserve officials do reveal much information on the considerations that may be relevant for the Federal Reserve's decision-making at any point in time. So, to sum up, there is no stated overall monetary policy strategy, but fairly clear communication of – changing – strategic considerations.

The Bank of Japan has undertaken two major shifts in its monetary policy strategy over the past decade. First, on March 19, 2001, against the background of a stagnating real economy and weak financial sector, the Bank of Japan embarked on a historical monetary policy experiment by adopting a framework of so-called "quantitative easing." This term described a set of measures aimed at easing monetary and financing conditions even in a situation where the nominal interest rate already had reached (nearly) zero.[22] As the economic recovery in Japan took shape and the "emergency regime" of quantitative easing was no longer needed, the Bank of Japan, as part of the introduction of its "New Framework for the Conduct of Monetary Policy," in addition to the definition of price stability, announced on March 9, 2006, that it would in future examine economic activity and prices from "two perspectives." The "first perspective" examines whether economic growth follows a sustainable path under price stability over a 1 to 2 year time horizon. The "second perspective" takes a longer-term view, focusing on risks to sustainable growth and price stability. Low probability-high impact events are explicitly considered under this perspective (Bank of Japan, 2006). Since the start of the "New Framework," the Bank of Japan has on various occasions made reference to both "perspectives" in explaining interest rate decisions (BIS, 2007).

The Bank of England's policy can clearly be classified as "inflation targeting." Relying, among other things, on forecasts of inflation and other economic developments, interest rates are set so as to keep inflation in line with the target. Like other inflation-targeting central banks, the Bank of England documents the considerations that inform the monetary policy decisions for the public in quarterly "Inflation Reports."

The continued prominence of money in the ECB's two-pillar strategy contrasts with current practices in other central banks. It is often explained by historical developments, i.e. the notion that the ECB hoped to inherit credibility in its first years from the Deutsche Bundesbank's successful monetary policy strategy, which had included published monetary growth

[22] *More specifically, the Bank of Japan increased its target for commercial banks' current account balances far in excess of their required reserve levels. The initially set current account target was subsequently raised nine more times until end-2004. As a result, the already very low overnight call rate (the Bank of Japan's key interest rate) was, as desired, further pushed down to zero. The increases in current account balances were primarily achieved by means of open market purchases of Japanese government bonds. The Bank of Japan's government bond purchases had the additional desired effect of bringing down long-term interest rates. The lower deficit-financing costs implied by such organised and explicit "monetary financing of the government" may also have facilitated the Japanese government's parallel high-deficit expansionary fiscal policy. The Bank of Japan also announced and confirmed repeatedly that it would continue quantitative easing until inflation had returned to positive values. This explicit communication may have helped to dampen future interest rate expectations. The policy was accompanied by repeated foreign exchange interventions against the Japanese yen; being unsterilized, they also contributed to increasing the money supply (Spiegel, 2001). Surveying a number of studies, Spiegel (2006) shows that the quantitative easing policy achieved its goals by lowering short and long-term interest rates, by helping weaker Japanese financial institutions, and by generally encouraging greater risk tolerance in the Japanese financial system, thus eventually paving the way for economic recovery.*

targets. In fact, it is more than that. Monetary analysis continues to figure prominently both in the analyses presented to the Governing Council regularly for their meetings and in explanations of monetary policy decisions to the public. Gerlach (2007) finds that the relative importance of monetary analysis seems to vary over time, depending on the nature and source of the price pressures. In the context of the review of the two-pillar strategy, the scope and nature of monetary analysis was changed: the focus shifted away from the growth of M3 to a more flexible and broader perspective which includes developments in credit and other counterparts to M3 and aspects of financial imbalances at large. The medium to long-term perspective of monetary analysis was emphasized, as was its value for cross-checking with economic analysis.

The other three central banks under study no longer attribute any specific role to monetary or credit developments. However, the longer-term view of inflation nowadays associated with money and credit developments is reflected in the Bank of Japan's "second perspective" of the monetary policy strategy. The Federal Reserve and the Bank of England, while not putting any emphasis on developments in money and credit growth, do not categorically neglect them either. In the words of Bernanke, *"the Federal Reserve will monitor and analyze the behavior of money. Although a heavy reliance on monetary aggregates as a guide to policy would seem unwise in the U.S. context, money growth may still contain important information about future economic developments. Attention to money growth is thus sensible as part of the eclectic modeling and forecasting framework used by the U.S. central bank"* (as quoted in Kahn and Benolkin, 2007). The Bank of England's regular analysis for the Monetary Policy Committee also includes an analysis of *"developments in quantities in the monetary area and credit conditions"* (King, 2002). While money and credit are no privileged indicators or even targets in the Bank of England's strategy, the Monetary Policy Committee pays very close attention to these data when the circumstances warrant it. For instance, judging from the minutes, the MPC were for many years worried about the rapid expansion of money and credit. More recently, they have been studying the sharp contraction in money and credit growth.

– *General Trend towards More Transparency and Communication*

Over the past two decades, a general trend towards increasing central bank transparency and more active communication could be observed. This may reflect several underlying factors: greater need for accountability as a counterpart to stronger central bank independence; the increasing role of globally integrated and liberalized financial markets and the need to guide market expectations through effective communication; and an increasing forwardlookingness among economic agents, which also extends to price setting behavior. Transparency and effective communication is now generally acknowledged as a crucial element of effective monetary policy (Bernanke, 2004c). The spread of inflation targeting, which relies heavily on regular and well-structured communication with the public, may also have contributed. Finally, the launch of EMU required the new central bank system to invest heavily in explaining its role, functions and strategy as well as its ongoing monetary policy decisions to economic agents eager to understand the new monetary authority's intentions and behavior.

The four central banks' communication strategy can be loosely divided into two groups. On the one hand, the Bank of England, Federal Reserve and Bank of Japan convey details of their decision-making by publishing the minutes of the monetary policy meetings. The time lag of publication ranges from two to four weeks. These central banks release only very short press releases immediately after the meetings and offer no press conferences. On the other hand, the ECB issues a detailed "Introductory Statement" immediately after the ECB Governing Council meetings, which the President of the ECB reads out at a press conference and which is followed by an in-depth questions and answers session. The press conference is broadcast live on the ECB's website and archived on the website both as a video stream and as a transcription. The ECB, however, does not publish the minutes of the ECB Governing Council meetings.

– *General Trend towards Publication of Central Bank Forecasts*

A specific element of central bank transparency, which has attracted more attention over the past 15 years, is the publication of economic, in particular inflation, forecasts by the central bank.[23] The ECB has published staff forecasts as part of the "economic pillar" since December 2000, releasing them on a quarterly basis since September 2004.[24] The Federal Reserve, which had revealed some forecast information since 1979, considerably extended its forecast publication policy in November 2007.[25] The Bank of Japan has published forecasts since 2000.[26] As an inflation-targeting central bank, the Bank of England has published inflation reports, a key element of which are economic forecasts, since 1993.[27]

What are the main stylized facts and differences across the four central banks? First, there is a general tendency towards quarterly publication of forecasts; only the Bank of Japan continues to publish its forecasts biannually. Second, the Bank of England and, since November 2007, also the Federal Reserve, cover the next three years, whereas the Eurosystem and the Bank of Japan release forecasts for the current and coming years only. There is a tendency towards longer horizons. Third, the range of forecast variables is generally limited to one or two measures of consumer price inflation, and a

[23] *Chortareas et al. (2001) show empirically for a large sample of countries that publishing central bank forecasts is associated with lower inflation.*

[24] *Forecasts in December and June are produced by the staff of the entire Eurosystem, those in March and September by ECB staff alone. The practices of national central banks in publishing their forecasts of their respective countries differ, however. The format of such national forecast publications complies with certain rules agreed within the Eurosystem (e.g. on dates of publications, technical assumptions and presentation of the assumptions on the euro area economy).*

[25] *The Federal Reserve had since 1979 published biannually projections of economic growth, unemployment, and inflation in the Federal Reserve's Monetary Policy Report to the Congress. Summaries of those semi-annual projections were also published in the minutes of FOMC meetings. Since November 2007, the FOMC has compiled and released projections four times each year. In addition, the projection horizon was extended to three years, from previously two. Summaries and explanations of the projections are published along with the minutes of the FOMC meeting at which they were discussed (Federal Reserve Board, 2007a and 2007b; Mishkin, 2007b).*

[26] *For details see the Bank of Japan's website www.boj.or.jp/en/theme/seisaku/sakiyuki/tenbo/index.htm and Fujiwara (2005).*

[27] *The Bank of England's quarterly inflation reports start with an overview of economic developments, which is followed by analyses of money and asset prices, demand, output and supply, costs and prices, and an assessment of the medium-term inflation prospects and risks. The reports are presented to the public in press conferences, with webcasts and transcripts documented at the Bank of England website. See the Bank of England's website www.bankofengland.co.uk/publications/inflationreport/2008.htm*

limited number of real variables. All central banks publish real GDP growth forecasts, the additional coverage by the Federal Reserve of the unemployment rate reflects its triple mandate. The Eurosystem forecasts the broadest range of real variables – various components of aggregate demand, but not the unemployment rate. Fourth, all central banks but the ECB include a discussion on the risks surrounding their forecasts; however, the ECB President usually gives qualitative information on the balance of risks in his Introductory Statement at the post-Governing Council meeting press conference. Fifth, contrary to the forecasts by the other three central banks, the Eurosystem emphasizes that the forecasts are staff forecasts, which need not reflect the views of the ECB Governing Council and are just one piece of information among many others.

Finally, as regards the short-term interest rate assumptions underlying the forecast, the ECB and the Bank of England explicitly use market expectations. The Bank of England offers an alternative scenario based on the assumption of no change in the level of short-term interest rates. In the Federal Reserve, according to Mishkin (2007b), each FOMC participant makes his own forecast based on his own assessment of the "appropriate" path of monetary policy. The Bank of Japan seems to follow a similar approach. In fact, this leads to an issue raised recently, of whether or not the central bank should publish its own forecast of future policy rates, as some inflation-targeting central banks have been doing (Reserve Bank of New Zealand since 1997, Norges Bank since 2005 and Sveriges Riksbank since 2007). So far, none of the four big central banks publish their own policy rate forecast. However, as has been noted by Moessner and Nelson (2008), the Bank of Japan, the Federal Reserve and the ECB may be seen to have at times provided qualitative information about the future path of policy rates. One may argue that the Federal Reserve's forecasts are indeed based on assumptions about its future policy rate path, while these assumptions are heterogeneous among the FOMC members and not documented or published.

Table 1

Monetary Policy Strategies in Comparison: Eurosystem, Federal Reserve System, Bank of Japan and Bank of England

	Eurosystem	Federal Reserve System	Bank of Japan (BoJ)	Bank of England (BoE)
Statutory monetary policy mandate	Primary goal: price stability. Without prejudice to price stability, the Eurosystem shall support the EU's general economic policies.	Law: Maximum employment, stable prices, moderate long interest rates. FOMC: sustainable growth and price stability.	BoJ's monetary policy should be *"aimed at, through the pursuit of price stability, contributing to the sound development of the economy."*	Price stability – i.e. low inflation – and, subject to that, support of Government's economic objectives.
Quantification of goal(s)	Definition of price stability by the Governing Council: HICP inflation below but close to 2% over the medium term in the euro area.	No published quantitative definition of monetary policy goals. Changing preferred inflation measure.	Price stability is defined by the Policy Board as approximately 0% to 2% CPI inflation in medium to long-term.	Price stability is defined by the Government's inflation target of 2% (no "goal independence").
Monetary policy strategy	Two-pillar strategy: economic analysis and monetary analysis.	No published monetary policy strategy. Various and changing doctrines such as "risk management approach" disseminated in speeches.	"Two perspectives approach." First perspective: growth and inflation over one to two years. Second perspective: longer term, explicit mention of low probability/large impact events.	Inflation targeting.
Transparency and communication	Press conference by ECB President after Governing Council meeting (including questions and answers). Introductory Statement refers to decisions, economic activity, inflation, outlook and risks, monetary developments, fiscal and structural policy issues. Printed statement (including questions and answers) released immediately after Governing Council meeting. Governing Council minutes released after 30 years.	Short FOMC press release after FOMC meetings (no press conference). Announces decisions and short, "standardized" assessment of economic activity and inflation (relative risks) and votes. Minutes of FOMC meetings within three weeks. Word protocol: released after five years.	Very short press release after Monetary Policy Meeting (no press conference). Announces decision, votes and persons present at the meeting. Minutes released one month later (at the earliest): decision, reasoning, votes.	Short Monetary Policy Committee (MPC) press release (no press conference): decision, assessment of economic activity and inflation. Minutes, including votes, two weeks after Monetary Policy Committee Quarterly Inflation Report.
Publication of forecasts	**Frequency:** quarterly. **Forecasting horizon:** next calendar year. **Variables:** inflation, real GDP, private consumption, government consumption, gross fixed capital formation, exports and imports of goods and services. All variables are published as ranges (based on past forecast errors). **Discussion of risks:** not in publication, but in Introductory Statement. **Interest rate assumption:** market expectations. **Responsible:** staff.	**Frequency:** quarterly. **Forecasting horizon:** three years. **Variables:** PCE inflation, core PCE inflation, real GDP, personal consumption. Range, central tendency and probability distribution of views of FOMC members. **Discussion of risks:** qualitatively. **Interest rate assumption:** Each FOMC participant makes his own forecast based on his own assessment of the "appropriate" path of monetary policy. **Responsible:** FOMC (based on individual members' forecasts).	**Frequency:** twice a year. **Forecasting horizon:** next fiscal year. **Variables:** Real GDP growth, CPI (excluding fresh food), domestic corporate goods price index. For all variables: median, range, and range excluding outliers. For GDP and CPI excluding fresh food: probability distributions (based on different Policy Board views). **Discussion of risks:** detailed qualitative and quantitative information. **Interest rate assumption:** not explained. **Responsible:** Policy Board (based on members' individual forecasts).	**Frequency:** quarterly. **Forecasting horizon:** three years. **Variables:** CPI inflation and real GDP growth. Mean and probability distributions ("fan charts"). Fan charts reflect the MPC's best collective assessment of outlook and risks. **Discussion of risks:** detailed qualitative and quantitative analysis. **Interest rate assumption:** market expectations, with additional scenario based on constant interest rates. **Responsible:** MPC.

Source: Statutes and websites of the four central banks.

3 Monetary Policy and Financial Stability: Mutual Influences, Central Bank Charters, and Central Bank Strategies

3.1 Complex Mutual Influences

Monetary policy and financial stability are linked through a number of channels. On the one hand, monetary policy needs stable financial institutions and markets, since the operational implementation of monetary policy as well as the transmission of official interest rate changes to the economy crucially hinges on well-functioning financial institutions and markets. Disruption in any segment of the transmission channel may affect the effectiveness of monetary policy in non-linear and unpredictable ways. Furthermore, financial market malfunctioning may affect aggregate demand and inflation, and thus interfere with the central bank's mandate.

On the other hand, banks crucially depend on the steady provision of central bank money. An elastic supply of liquidity in the event of temporary tensions, in particular if a financial institution faces liquidity shortages, ensures a smooth operation of the financial system. Financial markets should also be expected to generally benefit from a stable macroeconomic environment. A smooth business cycle reduces bankruptcies that would otherwise impact on banks and financial markets. Stable and low inflation contributes to stabilizing financial market expectations and helps to avoid large and unexpected transfers between creditors and debtors prompted by large swings in inflation.

For a long time, therefore, there was the perception that low inflation would also support greater stability of financial markets (Issing, 2003). Against the experience of the past two decades, when inflation was low but financial crises were nevertheless recurrent, this view has been questioned (Crockett, 2003). Indeed, some have even argued that central banks' success in firmly anchoring inflation expectations in an environment of favorable supply shocks (e.g. from globalization and technological advances) may itself have become the source of financial market imbalances, by masking inflationary pressures resulting from globally loose monetary conditions and creating the conditions for over-optimism (see Borio and White, 2004; Borio, 2005).[28]

Against the background of recurring financial crises and the repeated need for massive intervention by the central banks of major industrialized countries, the central banks' role in supporting financial stability has moved into the limelight. This role dates back to the origins of, and early writings on, central banking (Bagehot, 1873; Thornton, 1802). More recently, the topic has been discussed in two main directions: first, the reaction of central banks to emerging financial imbalances; second, the evolution of the central banks' function as a lender of last resort – in other words, the central banks' role in crisis prevention and in crisis management.[29]

– *Preemptive Monetary Policy to Curb Emerging Financial Imbalances?*

The first branch of analysis addresses whether, how and to what extent monetary policy should, in a forward-looking manner, take into consideration

[28] *For a sceptical note on this "paradox of credibility" view, see Issing (2003).*

[29] *A survey of a central bank's tool kit to deal with financial instability as well as a collection of past episodes of financial crises is Estrella (2001).*

emerging financial imbalances, such as excessive credit and asset price growth, when determining the appropriate monetary stance. Put more bluntly, even if consumer price inflation is low, in line with the definition of price stability, should the central bank tighten monetary policy (and thus further curb inflation) in order to stop emerging financial imbalances (such as a housing price,[30] stock market or consumer credit bubbles, or a combination thereof) from developing further?

The main arguments in favor are that such financial imbalances, if they are allowed to grow further, will first cause an overheating of the economy, with the potential for strong inflationary pressures and then, once the bubble collapses, throw the economy into recession, potentially causing inflation to plunge below desired levels. Thus, monetary policy should act early to avoid severe damage later. The initial loss in output due to a monetary policy tightening beyond what is required to stabilize consumer prices over the short run can be viewed as an "insurance premium" (Bordo and Jeanne, 2002) against the later bigger damage of a boom and bust (Borio and White, 2004; Wadhwani, 2008).[31]

Many counterarguments have been brought forward against such leaning against the wind: With one instrument – the interest rate – central banks can only pursue one goal, namely the maintenance of consumer price stability. Furthermore, central banks are in no better position to recognize the existence of financial imbalances than market participants. And even if they knew there were imbalances, it would be difficult to calibrate the appropriate interest rate response, given possible nonlinear financial market behavior. Furthermore, raising interest rates in the face of emerging financial imbalances is a blunt instrument, which would have undesirable consequences for sectors not affected by the financial imbalances. At the political economy level, central banks would meet with opposition – and potentially come into conflict with their statutory mandate – should they tighten monetary policy to curb an emerging bubble, while consumer price inflation is low (Fisher, 2004 and 2005; Issing, 2003; Ferguson, 2003; Borio, 2006).

This view has in turn been criticized by the proponents of leaning against the wind on the grounds that failure to act preemptively against emerging financial imbalances results in asymmetric monetary policy behavior: Once the bubble bursts, monetary policy "mops up the mess" by cutting interest rates from already low levels and will likely be late in raising them to their equilibrium level later on, thus sowing the seeds for the next bubble. Furthermore, such asymmetric behavior creates moral hazard, thus increasing financial markets' proneness to further crises. In this way, the central bank itself becomes the cause of "series bubbles" (Wadhwani, 2008).

[30] *A discussion of the Federal Reserve's policy since 2000 with implications for housing imbalances is Taylor (2007).*

[31] *It has also been argued that also communication by the central bank in itself might play a useful role in counteracting the market information asymmetries, "moods" and resulting market failure which may drive asset prices away from fundament values, by providing information that is less noisy or biased than information available from the private sector (Fisher, 2005; Ferguson, 2003). Improving common knowledge of fundamental valuations and risk by means of regular publications such as financial stability reviews may thus be seen as a separate instrument contributing to financial stability (Gai and Shin, 2003). A recent review of central banks' financial stability reviews can be found in Čihák (2007).*

More recently, arguments in favor of a forward-looking approach to financial imbalances have been broadened in the direction of creating *"a new macro-financial stability framework to resist actively the inherent procyclicality of the financial system."* This framework would combine leaning against the wind by the central bank with macroprudential regulatory instruments. (BIS, 2008; Borio, 2006). This leaves open the issue of the optimal institutional implementation of such an approach.[32]

– *Changing Nature of the Lender of Last Resort: "Mission Creep." Effects on the Monetary Stance and Signaling, and Moral Hazard*

The 2007/2008 financial turmoil has highlighted the importance of liquidity for the smooth operation of the financial system. Before we proceed, it is useful to recall that the term "liquidity" may have different meanings in different contexts (Stevens, 2008; IMF, 2008). For the purposes here, the following dimensions of "liquidity" are relevant: *Central bank liquidity* refers to funds held by commercial banks at the central banks. They acquire such balances through the central bank's open market or other monetary policy operations. *Funding liquidity* is the ability of an intermediary to raise the necessary cash to fund, or continue to fund, its chosen set of assets. In the 2007/2008 financial turmoil some banks and other financial intermediaries faced severe problems in funding their assets in wholesale markets, as they had become accustomed to do. *Transactional,* or *market, liquidity* is the ability to buy and sell assets without significantly affecting the price. During the 2007/2008 financial turmoil, transactional liquidity for many credit derivatives and other financial instruments was severely affected.

The provision of central bank liquidity to the banking system is at the very core of a central bank's functions. This happens, on the one hand, in the context of regular liquidity operations aimed at implementing the central bank's monetary stance: by providing an appropriate amount of central bank money, the central bank aims at keeping the interbank short-term money market rate close to target. In crisis situations, the lender of last resort takes on a different meaning: then, the central bank's aim is to provide central bank money to financial institutions that are temporarily unable to meet their short-term payment obligations, in order to maintain or restore confidence in these institutions and in the financial system at large. This type of operation is often referred to as emergency liquidity assistance (ELA).

Although this task of the central bank is generally accepted, it also entails problems such as moral hazard: If the central bank can be expected to intervene when problems arise, then financial institutions might act less cautiously in the first place. The simple rule to solve this problem, recommended by Bagehot (1873), was to lend freely against good collateral at a high rate of interest. The precise terms and conditions in the practical implementation of lender of last resort operations remain a challenge to this date. In their money market interventions during the 2007/2008 financial turmoil, central banks tailored their lender of last resort

[32] *It has been widely argued (IMF, 2008) that the close links between monetary and financial stability concerns require close central bank involvement in financial supervision. Others have argued that different instruments are required to deal with these two separate functions. By entrusting two different institutions with their pursuit, but requiring close cooperation between them, the potential conflicts between the two objectives would be made explicit, which would contribute to transparent and socially optimal solutions (Fisher, 2004; Restoy, 2008).*

operations in several dimensions: the circle of counterparties with access to the facilities, the eligible collateral, the maturity of the operations, and the interest rate charged on emergency lending facilities. Without going into detail,[33] the general tendency was to widen and facilitate access to central bank funding. This has raised the broader question of the widening scale and scope of the lender of last resort function in today's market-based, globalized and crises-prone financial markets (Crockett, 2008; BIS, 2008). Central banks traditionally used central bank liquidity to help banks maintain funding liquidity. In market based systems, however, maintaining market liquidity is also crucial for financial stability. Furthermore, systemic risks for financial stability may not only arise from banks, but also from other financial intermediaries. The question arises how far central banks' responsibilities to ensure financial stability should go in this new environment; and what is an appropriate sharing of responsibilities between central banks, financial supervisors and governments. The possibility of "mission creep," i.e. increasing responsibilities for central banks, resulting from actual practice rather than from design, was raised by BIS (2008) in this context, and will certainly be discussed further in the future.

Let us now explore why the lender of last resort, and its potential widening of scale and scope, may be relevant for monetary policy strategies. While seeming "technical" at first sight, the lender of last resort can interfere with the implementation of the monetary policy strategy in a number of ways. An aspect highlighted by the 2007/2008 financial crisis relates to the relationship between the central bank's monetary stance and its liquidity policy. It has been argued that these two issues may be treated separately: The monetary stance is determined and measured by the central bank's policy interest rate(s). The central bank's liquidity policy aims to achieve a short-term money market rate close to the policy rate by injecting central bank liquidity into or withdrawing it from the banking system.

During times of financial tensions, however, the close links between these two tasks becomes obvious. Since money market rates become more volatile due to rising and time-varying risk-premiums and temporary liquidity shortages at some or more institutions. If money market rates deviate lastingly and substantially from the central bank's policy rate, this de facto affects the monetary stance, since money market rates will eventually also feed through to interest rates at longer maturities and those applicable between financial institutions and their customers (BIS, 2008).

Furthermore, (perceived or actual) lack of liquidity may cause banks to tighten their lending standards, resulting in lower credit volume at a given level of interest rate, and so affecting monetary policy transmission.

Finally, lasting deviations of market rates from the policy rates may blur the signal perceived by market participants on the central bank's desired monetary stance. The very large gross volumes of liquidity operations in periods of financial market tensions, possibly combined with resort to less frequently used or new operational procedures and instruments, may also blur information on the actual net volume of central bank

[33] *For details of central banks' liquidity operations during the 2007/2008 financial turmoil see e.g. BIS (2008); Banque de France (2008); IMF, 2008, and individual central banks' official publications.*

liquidity being injected into the market. For instance, in the 2007/2008 financial turmoil, the perception among the media, market participants and the general public was that the central banks' net liquidity injections were quite large, whereas central banks mostly modified their way of providing a given amount of liquidity. Such a perception of central banks "flooding" the market with liquidity could ultimately raise inflation expectations.

It has been argued (IMF, 2008) that central banks' differences in operating procedures may also have contributed to such problems of signaling. What may also have made it difficult to distinguish between monetary stance and emergency liquidity operations, however, were actual marked differences in interest rate policy responses to the financial turmoil. While the Federal Reserve lowered rates aggressively from mid-2007 onwards, the Bank of England made only a minor rate cut late in 2007, and the Bank of Japan left interest rates unchanged. The Eurosystem, after adopting a wait-and-see approach, even raised the main refinancing rate on July 3, 2008, in the face of mounting inflationary pressures. In real time, particularly during the initial phase of the crisis, it may not have been obvious for market observers whether these differences reflected: (a) different approaches to crisis management ("risk management approach" by the Federal Reserve as opposed to "steady hand" by the other central banks), (b) a different severity of the crisis of the financial sector in the various countries (stronger measures needed for U.S. financial institutions), (c) a more severe general economic downturn in the U.S. than in the other countries, which would indeed justify a stronger loosening of the monetary stance, in parallel with and independently from emergency liquidity operations, or (d) differences in central bank mandates (Federal Reserve's dual mandate as opposed to priority for price stability in the other three central banks).

The risk of moral hazard referred to above was accentuated by the 2007/2008 financial crisis and central bank responses to it. As Goodhart (2008) put it: *"Why should banks bother with liquidity management when the central bank will do all that for them?"* Tirole (2008) argues that state intervention may in fact inject too much liquidity, due to capture by those who benefit from the injections at the cost of taxpayers,[34] and for reasons of time inconsistency, i.e. the incentive to boost the economy at a delayed cost which is not visible in the short term when the intervention occurs. The ad hoc adjustments to monetary policy operational frameworks (eligible instruments for collateral, list of counterparties, creation of entirely new facilities) made, in particular, by the Federal Reserve may be viewed as problematic because they may create the expectation that the rules of the game are subject to change at any time if only the emergency is big enough (BIS, 2008). Thus central banks' lender of last resort policy may feed back on financial stability, thus intensifying the future challenges for monetary policy strategies.

[34] *Ewerhart and Valla (2008) argue that targeted liquidity assistance is preferable to market-wide, non-discriminatory liquidity injections, since liquidity may alternatively be used for speculative purposes during the crisis.*

3.2 What Do the Four Central Bank Charters Say on Financial Stability?

Central banks generally say they are concerned with financial stability. This largely reflects necessity, as argued above. But to what extent do central bank laws support this view? Table 2 lists the relevant text passages from the four central banks' laws. A reading of the laws gives some hints, but is not fully conclusive. All central banks are charged with "ensuring" or "promoting" sound payments systems. This includes a lender of last resort function of the central bank, although only the Federal Reserve Act includes an explicit reference. Beyond this, the picture is diverse. The Bank of England's very general formulation of "supporting economic policies of the Government" is translated into rather detailed functions in a Memorandum of Understanding between the Bank of England and the Government (as quoted in Ferguson, 2003).

As do central bank laws in general, the legal texts with respect to central banks' role in financial stability change over time. With some lags, these changes are also influenced by dramatic events which act as triggers for legislative action. Currently, in the wake of the 2007/2008 financial crisis, a bigger role in financial stability and supervision is under discussion in both the United States and in the United Kingdom.

For the ECB, no general financial stability objective can be derived from the Treaty. However, some national central banks have financial stability figuring prominently among their objectives in their national statutes. The difference between the Treaty and national legislation may reflect an explicit and desired division of labor between tasks centralized at the European level (monetary policy) and those that remain national (financial stability). In addition, it may also reflect diverse views across EU Member States on the appropriate role of central banks in financial surveillance and control. While in practice, this diversity has so far never led to conflicts of interest, e.g. in crisis situation, it might, however, create difficulties when it comes to forward-looking measures against emerging financial imbalances. This might be particularly so if these financial imbalances were limited to some countries (and might even be the result of regulatory and other policies in these countries). In this case, e.g. preemptive tightening by the Eurosystem to curb these imbalances might not be considered optimal, and other, national policy measures, e.g. in the prudential area, might be deemed more appropriate and acceptable.

3.3 How Do Financial Stability Concerns Fit into Various Monetary Policy Strategies?

For the purposes of this paper, it is also useful to consider how a forward-looking approach to financial imbalances would fit into various monetary policy strategies. Basically, there are several ways in which financial imbalances can enter the central bank's reaction function. *First*, they may enter indirectly through the (likely or potential) future effects on inflation and output. If the time horizon for monetary policy decisions is sufficiently long, i.e. beyond the traditional two years it takes for interest rates to unfold their effect on consumer price inflation, then the central bank might just incorporate emerging financial imbalances and their unwinding into their longer-term forecasts, which in turn inform monetary policy decisions. *Second*, financial imbalances could be explicitly seen as

risks to forecasts. This fits well with the "insurance view" explained above, which may also take care of high-risk/low probability events. *Third*, a central bank could explicitly take a separate, longer-term view, besides the one-to-two year perspective taken in the standard forecast.

It has been argued that "flexible inflation targeting" provides a suitable framework for using the first or second approach, since it allows changes in the time horizon and also provides some leeway with respect to reaching the inflation target. The Sveriges Riksbank is an often quoted example of a central bank explicitly leaning against the wind of emerging financial imbalances within an inflation-targeting framework. The minutes of the Bank of England's Monetary Policy Committee repeatedly (e.g. March 2004, May 2005) include references to members raising concerns about unsustainable house price developments and household debt, as well as adverse consequences for demand once the imbalances unwind.

Both the Eurosystem and the Bank of Japan use the third approach. The Eurosystem's monetary pillar explicitly takes a longer-term perspective, its focus on money and credit developments seems well suited to detect financial imbalances (Detken and Smets, 2004). The Bank of Japan's "second perspective" explicitly refers to the "longer term" and to "risk factors that will sig-

Table 2

Statutory Role of Financial Stability in the Eurosystem, Federal Reserve System, Bank of Japan and Bank of England

Eurosystem	Federal Reserve System	Bank of Japan (BoJ)	Bank of England (BoE)
ESCB/Eurosystem/ECB: • *"without prejudice to the objective of price stability, support the general economic policies in the Community."* • *"promote the smooth operation of the payment system"* (Article 105(2) fourth indent of the Treaty establishing the European Community). • *"The ESCB shall contribute to the smooth conduct of policies pursued by the competent authorities relating to the prudential supervision of credit institutions and the stability of the financial system"* (Article 105(5) Treaty). NCBs: diverse involvement in banking; financial market supervision depending on national laws.	• 1913: *"… to furnish an elastic currency, to afford means of rediscounting commercial paper, to establish a more effective supervision of banking in the United States …"* • 1933: Emergency lending powers. • 1977: *"The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long-run growth of the monetary and credit aggregates commensurate with the economy's long-run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices and monetary long-term interest rates."* Ongoing discussion on bigger role.	• *"In addition … the Bank's objective is to ensure smooth settlement of funds among banks and other financial institutions, thereby contributing to the maintenance of an orderly financial system."* • *"Currency and monetary control shall be aimed at, through the pursuit of price stability, contributing to the sound development of the national economy."*	• *"subject to [maintaining price stability], support the economic policies of Her Majesty's Government …"* • Note: Memorandum of Understanding between the Bank of England and the Government that delineates the Bank's responsibilities in the area of financial stability. It assigns the Bank of England responsibility in three broad areas: stability of the monetary system, stability of financial system infrastructure particularly in the area of payments systems, and monitoring of the financial system as a whole. Ongoing discussion on bigger role, with advisory Financial Stability Committee.

Source: Ferguson (2003), Issing (2003). Adapted.

nificantly impact economic activity and prices when they materialize although the probability is low" (Bank of Japan, 2006). This formulation is obviously inspired by Japan's experience in the 1990s to early 2000s, but also by recent research on optimal policy.

Given its very broad mandate, and the lack of a public strategy, the Federal Reserve would appear in principle to have all the options available.

4 Monetary Policy Strategies in Practice – What Role for Financial (In)Stability? Some Empirical Results

4.1 Taylor Rules as a Tool to Study the Role of Financial Imbalances in Central Banks' Interest Rate Setting

Section 3 discussed whether and why financial imbalances may prompt central bank policy reactions, such as leaning against the wind through tighter interest rates while imbalances are building up, and "mopping up" through liquidity operations or interest rate cuts once a crisis has broken out. A number of accounts and analyses on central banks' liquidity operations in response to the 2007/2008 financial turmoil have been published recently (see e.g. IMF, 2008; BIS, 2008; as well as the official bulletins of the various central banks); they are not considered in this article. Instead, our focus here is on central banks' interest rate policy.

One way to study this question is to use Taylor rates. Since the publication of John Taylor's seminal work on monetary policy rules (Taylor, 1993), a myriad of studies have estimated reaction functions of central banks and evaluated or predicted interest rate changes based on the simple but powerful empirical relationship between interest rates, the output gap and inflation (usually after controlling for interest rate persistence and any other relevant variables). This simple rule merges the appeal of simplicity in modeling with the intuition that the central bank adjusts the policy rate to "*lean against the wind of aggregate demand shocks and take a balance approach to aggregate supply shocks*" (Asso et al., 2007). Although, in view of the discussion above, one would expect interest in quantifying the reaction of central banks to financial instability episodes, few pieces of academic literature have explicitly dealt with this problem in the framework of Taylor rules.

One option is to use simple Taylor reaction functions, which only include the inflation gap, output and, possibly, an interest-smoothing term as explanatory variables, and see whether a central bank's actual behavior during a period of financial imbalances deviates from this function. Following such an approach, in a study on 38 asset price booms between 1970 and 2002 in 18 OECD countries, Detken and Smets (2004) find that central banks generally did not raise real interest rates during periods of asset price booms, despite rising output gaps (i.e. above-potential real growth rates) and broadly constant inflation gaps, thus causing a substantial loosening of the monetary policy stance. In other words, central banks accommodated the emerging financial imbalances.

BIS (2008) compares central banks' actual interest rate behavior after mid-2007 with simple estimated Taylor rules for a number of countries. The result for the four central banks in question is that the ECB, the Bank of England and the Bank of Japan did not show any exceptional behavior in the aftermath of the crisis. By contrast, the Federal Reserve brought the policy rate down by March 2008 to roughly 1.75 percentage points below the level im-

plied by the Taylor rule.[35] This suggests that the Federal Reserve may have reacted to strong downward revisions in growth and inflation forecasts, be it in the baseline forecast or in a low probability/high impact scenario. High downward risks for growth and inflation from the ailing financial and housing sectors may have figured prominently in such a pessimistic scenario. The latter explanation is supported by a close correlation between various central banks' changes in policy rates and the extent of turmoil in money markets: Stronger financial market tensions could be seen as indicators of more severe downward risks to the economy (BIS, 2008).[36]

Another way of using Taylor rules to study the link between central banks' interest rate policy and financial crises is to include proxies for financial imbalances in the estimated Taylor reaction function. Following this approach, Cecchetti (2003) finds that, over the period from 1990 to 2003, the Federal Reserve reacted to equity market bubbles and banking system stress: judging from his Taylor rule estimates, the Federal Reserve increased interest rates in the face of an equity price bubble (as measured by a reduction in the equity premium), and cut interest rates when bank balance sheets were coming under pressure (as measured by in increase in banking system leverage). The author also reports similar results for Germany (1979–1993) and Japan (1979–2001), with the notable difference that the Bank of Japan appeared to have reacted far more aggressively than the other two central banks to asset price bubbles, while the response to changes in the banking system leverage shows the wrong sign.

Gerlach-Kristen (2004) investigates for the U.S.A. whether interest-rate smoothing found in empirical estimates of Taylor rates might partly be due to variables omitted in those estimates. She finds that including an unobserved variable correlated with risk spreads in financial markets reduces the empirical importance of policy inertia. She concludes that U.S. interest rates seem to be set gradually in reaction to inflation, the output gap and financial market conditions: In periods of financial stress, interest rates tend to be lowered more than inflation and the output gap would suggest.

Borio and Lowe (2004) include financial stability proxies (credit and equity gaps, measured as deviations from a Hodrick-Prescott trend) in Taylor-rule models for Germany, the United States and Japan and conclude that central banks respond asymmetrically (if at all) to financial imbalances. Furthermore, substantial differences appear across countries; financial imbalances appear to have comparatively more influence on the central bank's interest rate setting behavior in the United States, relative to the other countries under study. Cecchetti and Li (2005) introduce banking stress in an otherwise standard aggregate demand-aggregate supply model and derive the optimal monetary policy

[35] *The estimated Taylor interest rates in BIS (2008) are based on contemporaneous inflation, the contemporaneous output gap and the lagged interest rate. One could argue that a more realistic description of central banks' interest setting should be based on forecasts of inflation and the output gap in one or two years. The use of contemporaneous explanatory variables could exaggerate the "specialness" of the Federal Reserve's sharp interest rate cutting, since the latter might also be justified by a strong downward revision in the growth and inflation outlook.*

[36] *The correlation also remains after controlling for the effect of revisions in growth and inflation forecasts. Money market turbulences are measured by the average spread between three-month Libor and overnight index swaps of the same maturity.*

corresponding to this framework. They conclude that monetary authorities should react to the banking system's balance sheet by decreasing the policy rate as a response to banking stress. The empirical evidence presented by these authors indicates the Federal Reserve indeed reacted to banking stress in this way, while no evidence was found for Japan and Germany.

Gerlach (2007) estimates modified and extended monetary policy reaction functions for the Eurosystem, which include subjective measures of economic growth, rather than output gaps, and money growth as explanatory variables. He finds that the Governing Council reacts to real variables (and thus to demand-pull inflation) but not to supply-push inflation. Regarding the role of money, he finds that money growth influences the Governing Council's decisions in periods when expected growth is high and the risk of inflation is perceived to be greater. This result confirms the relevance for the Eurosystem's actual policy-making of regular cross-checking of short-term economic developments with the longer-term perspective embodied by the monetary pillar.

Finally, from a theoretical point of view, Bauducco et al. (2008) model the response of the central bank to financial instability in the framework of a standard New Keynesian model. Their conclusion is that the standard Taylor rule is a suboptimal reaction function of the central bank as compared to an augmented rule, whereby the central bank decreases interest rates as a reaction to financial sector instability.

4.2 Do Financial Imbalances Affect the *Speed* of Interest Rate Adjustments?

The usual approach to the empirical assessment of central bank reactions to financial instability implies the estimation of otherwise classical Taylor rules augmented with variables aimed at proxying financial imbalances. Usually, price-to-earning ratios or leverage ratio gaps are the variables which proxy for financial stability. In this section, we will follow a somewhat different approach. In particular, we do not assume that financial stability affects the policy rate directly. Instead, we hypothesize that the monetary authorities react to financial stress by adjusting the interest rate to the desired rate at a different speed in times of financial instability. This implies that it is the *persistence* of interest rates which will be affected by financial stress.

The analytical framework behind the reaction function can be described as follows (Clarida et al., 1998). Assume that monetary policy in the economies under study can be represented by an interest rate feedback rule such that the central bank sets the short-term interest rate depending on a desired target level of the interest rate, the expected future inflation rate (as compared to a target value) and the observed output gap. In order to account for the observed persistence of interest rate data, we assume that the central bank smooths interest rate changes, so that the actual interest rate is a weighted average of the policy rate implied by the interest rate rule and the last interest rate value observed. The dynamics of nominal interest rates are therefore given by

$$i_t = (1-\rho)(1-\delta)\pi^* + (1-\rho)r^* + \\ + (1-\rho)\delta\,\pi_{t+n} + (1-\rho)\gamma g_t + \rho\, i_{t-1} + \varphi_t$$

where r^* is the natural real interest rate (defined as the nominal interest rate desired by the central bank for zero inflation and zero output gap, minus target inflation, π^*), ρ is the smooth-

ing parameter and δ and γ are the elasticities of the policy rate to inflation (π) and the output gap (g), respectively. The error term, φ_t, is partly composed by the forecast errors in predicting the inflation rate, the natural rate of interest and the output gap. Since this means that some of the explanatory variables in the model are potentially correlated with the error term, usually instrumental variables or generalized method of moments (GMM) methods need to be used in order to obtain estimates of the response elasticity of the interest rate to inflation and the output gap, as well as the persistence parameter.

We estimate the Taylor rule using quarterly data for the economies under study using GMM methods (the source of the data is the OECD statistical compendium) for the samples available for each country. The output gap is estimated as the filtered estimate of the cyclical components of GDP in an unobserved components model resembling simple trend-extraction procedures such as the Hodrick-Prescott filter.[37] The natural rate of interest is proxied by the average ex ante real interest rate for the corresponding country (as in Clarida et al., 1998). Lagged values of the explanatory variables were used as instruments for the estimation, as is standard in the modern literature of Taylor rule estimations. The parameter estimates are presented in the appendix.

The estimated Taylor rates (the rate of interest preferred by the central bank according to the estimated reaction function) are presented in chart 2 together with the actual interest rate, the inflation rate and the output gap series, as well as a measure of financial market volatility for the period from 1999 to 2005.[38] We use observed historical return volatilities for the following indices in order to proxy for financial (in)stability: DJ EURO STOXX price index (euro area), S&P 500 Composite price index (U.S.A.), Nikkei 225 stock average price index (Japan) and FTSE 100 price index (U.K.). By using this measure of financial instability we somehow move away from the existing empirical literature, which tends to concentrate on equity and asset price levels. Since the second moment of asset price returns data for low frequencies is a plausible measure of stability in financial markets, we believe that the use of this variable is also an interesting value added of this contribution.

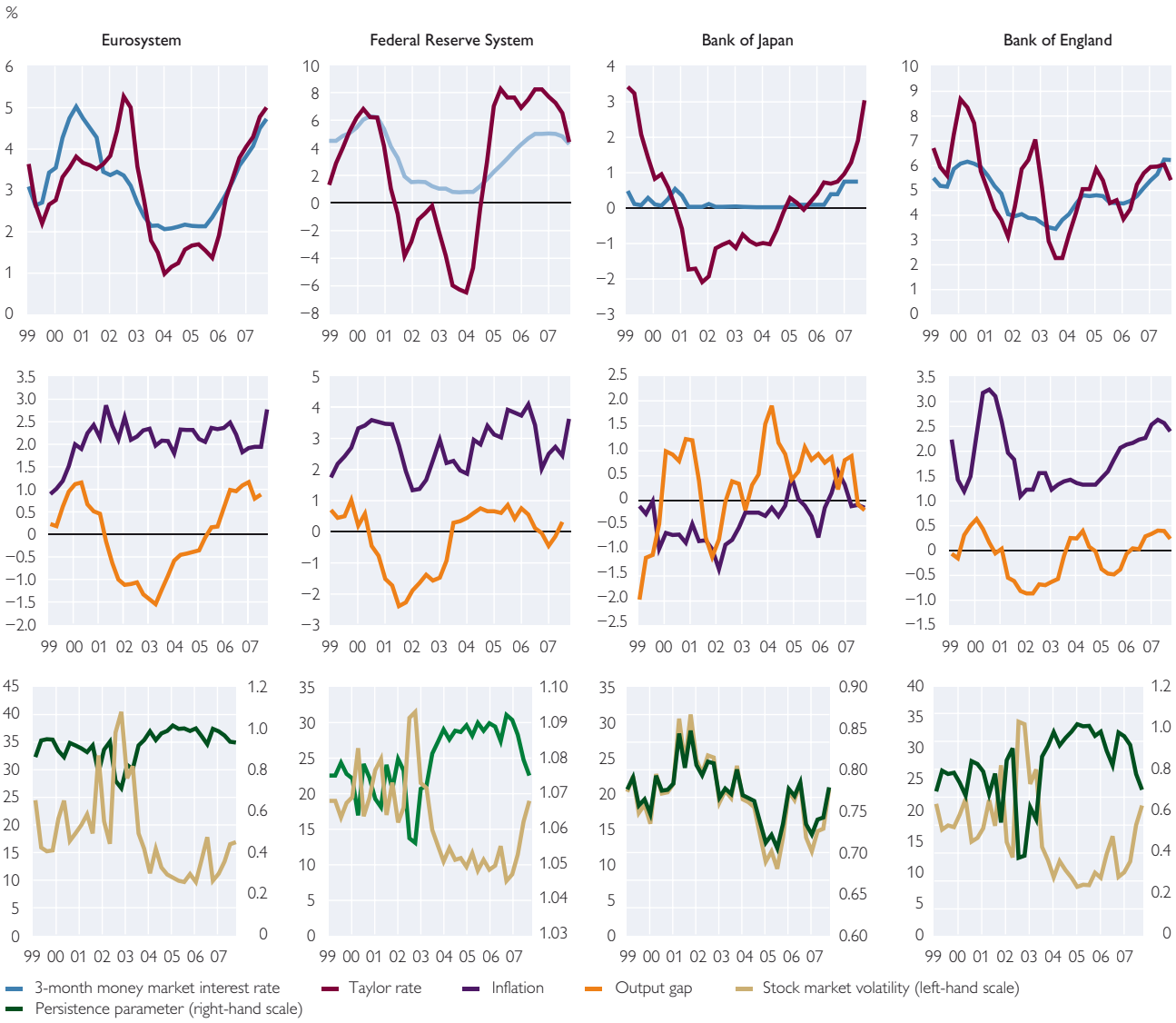
The resulting Taylor rates shown in chart 2 present the usual characteristics expected from the policy rate in a reaction function: it tends to be positively correlated to inflation and output gap developments, and it reacts in a particularly strong manner to inflation dynamics. Surprisingly, negative values of the Taylor rule appear for the case of the U.S.A. and Japan in the first years of the current decade. While this is in line with the observations of many other economic analysts and empirical research for the case of Japan, it does not appear justified for the U.S. case. This counterintuitive result may be taken as a sign of misspecification of the Taylor rule related to the linearity which is assumed in the interest rate setting behavior of the central bank. In the light of the discussion concerning the zero lower bound of interest rates, nonlinear monetary policy response functions may prove helpful in correcting these estimates. Such an analysis is,

[37] *We use filtered estimates (instead of the usual smoothed estimates) to allow for the fact that central bank policies at a given point in time are carried out solely on the basis of information available up to that time period.*

[38] *We smoothed the Taylor rate by taking three-year moving averages, in order to avoid short-lived spikes.*

Chart 2

Monetary Policy and Financial Market Volatility: Do Central Banks Change the Speed of Interest Rate Adjustment?



Source: OeNB.

however, outside the scope of this contribution. The low speed of adjustment of actual interest rates to the estimated desired policy rate implies that persistence plays an important role in interest rate dynamics for the economies in our study. Casual observation of the volatility series and the interest rate data, as well as estimation results, do not unveil any significant direct effect of financial stability on the level of the policy rate set by the central banks under study. Financial stability concerns, however, may affect the interest rate setting behavior of central banks in more indirect ways, for instance by changing the momentum of past interest rates in current monetary policy decisions (without necessarily changing the optimal policy rate chosen by central banks).

We thus enlarge the specification by allowing financial instability to affect the adjustment of the policy rate to the targeted interest rate. The premise underlying this approach can be found in Mishkin (2008), who assesses the monetary policy challenges implied by financial market turmoil. In particular, Mishkin (2008) argues that central banks should exhibit flexibility in dealing with risks emanating from financial markets, to the extent that they may affect macroeconomic risks. As a simple test for this type of behavior in the framework of the Taylor rule model put forward above, we can check whether the inertia of interest rate setting, measured by the persistence parameter of interest rates, ρ, is different in volatile versus quiet times in financial markets. We therefore re-estimate the above specification assuming that the persistence parameter is a linear function of financial stability.

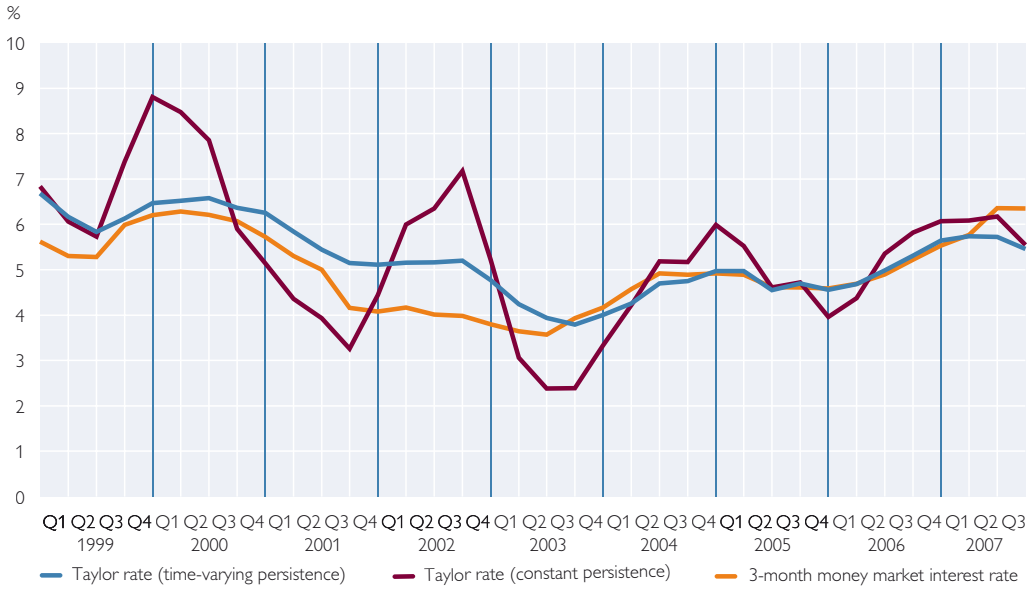
Our results are presented in the lower panels of chart 2, which presents the implied persistence parameters from the estimations of this model. With the exception of Japan, on average higher volatility in the respective financial market tends to run in parallel with lower inertia in the central bank's interest rate setting. The effect is, however, not significant for the Eurosystem and the Federal Reserve, but strongly significant for the Bank of England.

In the case of the Bank of England, the effect is also quantitatively strong, with the estimated persistence parameter of interest rates fluctuating between 0.4 for the episodes of highest volatility and unity for the times with lowest volatility. The results imply that interest rate setting by the Bank of England is consistent with the view put forward in Mishkin (2008), which allows for less inertia in monetary policy when financial market risks are sizeable. Barker (2007) assesses the interest rate policy of the Bank of England in the last ten years, thus corresponding to the sample used here. She stresses the differential importance of financial market conditions for the inertia of interest rates setting in the U.K. In particular, she shows that interest rates in the U.K. are less persistent than in the U.S.A. (a result which is consistent with our estimations) and that the equity risk premium can partly explain this difference. She concludes that the differences observed between Taylor rule estimates for the U.S.A. and the U.K. can be partly explained by the different importance of financial market variables for interest rate policy. Our results give strong empirical evidence to support this view.

Further evidence on this view is provided by Cobham (2003), who studies the minutes of the Policy Committee in order to assess the determinants of interest rate smoothing in the Bank of England's monetary policy. He finds that the Bank of England's reactions to financial market volatility often take the form of unexpected interest rate changes, thus concluding that the desire to avoid financial market volatility has contributed to less inertia in monetary policy in the U.K. The improvement in the estimates implied by explicitly modeling the effect of financial stability on interest rate persistence can also be observed in the corresponding Taylor rate resulting from the model with time-varying persistence, which is shown in chart 3. The Taylor rate for the model where interest rate persistence depends on financial (in)stability appears less volatile than the rate implied by the standard Taylor rule and traces the dynamics of the actual interest rate in a more realistic fashion.

Chart 3

Estimated Taylor Rates for the Bank of England, Modeled with and without Financial Stability Variable



Source: OeNB.

5 Conclusions

This study has investigated to what extent the monetary policy strategies of the big four central banks of major industrialized countries differ, with a special emphasis on the role of financial stability concerns. The study found a number of – formal and actual – differences regarding the central banks' objective(s), approaches to achieve the objective(s), and communication. This may reflect many underlying reasons, such as history (when and under which circumstances were central bank charters designed and passed by legislators), the overall geographical and political structure of the currency area (uniform state, federation, multi-country area), different economic structures (financial systems, price and wage setting mechanisms, monetary transmission), different views on how the economy works, but also different national preferences on the central bank's role and appropriate approach to pursuing its mandate.

Regarding the relationship between monetary policy and financial stability, there is overwhelming consensus among the four central banks that financial stability is a major concern for central banks also in the conduct of their monetary policy. Many see the recent 2007/2008 financial crisis as yet another strong reminder that central banks need to take a longer-term and broader view than might have been suggested only a few years ago by proponents of, e.g., strict inflation targeting. In adopting its two-pillar approach, the Eurosystem appears to have recognized this at a very early point in time. The Bank of Japan's "two perspectives approach," while phrased slightly differently, harbors a similar aim, namely to use in parallel various time horizons – shorter and longer – in making monetary policy decisions. The "risk approach to monetary policy," pioneered by the Federal Reserve, is equally present in the Eurosystem's and Bank of Japan's strategies.

The other reason for central banks' obvious concern with financial markets and stability is their role as lender of last resort, with all its implications for, and potential interactions with, not only the operational implementation of monetary policy, but also for their credibility as competent and reliable policy institutions. To fail in the role of lender of last resort would have repercussions on a central bank's reputation in its macroeconomic monetary policy function. It has also been shown that the lender of last resort function can pose challenges, not least for communication, such as keeping the macroeconomic aspect of the monetary stance separate from the microeconomic aspect of liquidity operations. Intervening in the market during times of stress, as the major central banks have also done during the 2007/2008 financial crisis, also creates risk of moral hazard. While central banks have been praised for their flexibility in dealing with the recent crisis, this very flexibility may also create the risk of expectations of increasing emergency interventions by central banks, a phenomenon which the BIS (2008) has appropriately termed as "mission creep."

Empirical estimates of Taylor-type reaction functions, augmented for a measure of financial (in)stability, confirm that the differences in the level and variability of policy interest rates across the four central banks cannot simply be taken to suggest one-for-one differences in the policy stance. We found some relevant differences in the reaction elasticities to inflation and the output gap, as well as significant effects of financial instability on the interest rate setting behavior of the Bank of England which are in line with the theoretical view that less inertia in monetary policy should be allowed for in times of financial market risks. Future econometric studies will be able to benefit from more evidence of central banks' reaction to the current financial crisis.

As the evolving economic literature and the debates in policy circles seem to indicate, the 2007/2008 financial crisis may become a defining moment in economic history, triggering some fundamental rethinking of received wisdom, and adjustments in established practices. A number of issues will have to be resolved, such as: Should some "leaning against the wind" of emerging financial imbalances, which has so far mainly been theorized about (except for a few notable exceptions), become a standard feature in central banks' policy repertoire? Would it fit in with central bank mandates as they now stand? Could the potential politico-economic resistance be overcome with good arguments? Should there be closer coordination between central banks and supervisors, to create a forward-looking macro-financial stability policy as proposed by the BIS (Borio and Shim, 2007; BIS, 2008)? In the event of another crisis, how could monetary and supervisory authorities as well as governments worldwide cooperate even more efficiently? Is there an optimal institutional model for organizing financial market supervision? Can individual monetary policies, geared towards price stability, in the face of important spill-over's from inflationary pressures, financial imbalances and their unwinding, successfully achieve their aim? How can global demand and supply, and thus inflation, developments be adequately incorporated in the various monetary policies, in order to recognize that, in a globalized economy, there are no more "external shocks" but, in the aggregate, only endogenously generated ones? (BIS, 2008).

It will take some time to address these many important and complex questions, and agreement will not be reached on all of them. In this process, the four central banks will continue to refine their monetary policy strategies to provide adequate solutions to the monetary policy challenges in a changing world.

Annex

Taylor Rule Estimates

For the estimates we follow Clarida et al. (1998) and assume that the monetary policy in the economies under study can be represented by an interest-rate feedback rule such that the central bank sets the short-term interest rate ($\tilde{i}_t$) according to

$$\tilde{i}_t = i^* + \delta[E(\pi_{t+n} - \pi^* \mid \Omega_t)] + \\ + \gamma[E(g_t \mid \Omega_t)] \quad (1)$$

where i^* is the nominal interest rate target. Monetary policy reacts to changes in the deviation of expected inflation (we hence consider a forward-looking rule) from some target value (π^*) and to changes in the output gap, g_t. In terms of the real interest rate, this implies that

$$\tilde{r}_t = \tilde{i}_t - E(\pi_{t+n} \mid \Omega_t) = r^* + \\ + (\delta - 1)[E(\pi_{t+n} - \pi^* \mid \Omega_t)] + \\ + \gamma[E(g_t \mid \Omega_t)] \quad (2)$$

where r^*, which we interpret as the real natural rate of interest, is defined as the difference between the nominal interest rate target and the inflation target. We further assume interest rate smoothing, so that the actual interest rate is a weighted average of the policy rate implied by (1) and the last interest rate value observed,[39]

$$i_t = (1 - \rho)\tilde{i}_t + \rho\, i_{t-1} + \varsigma_t \quad (3)$$

where $\rho \in [0,1]$ is the smoothing parameter and ς_t is assumed to be an i.i.d. error. Combining equations (2) and (3), we can write

$$i_t = (1 - \rho)(1 - \delta)\pi^* + \\ + (1 - \rho)r^* + (1 - \rho)\delta\, \pi_{t+n} + \\ + (1 - \rho)\gamma g_t + \rho\, i_{t-1} + \varphi_t \quad (4)$$

where r^* is the natural real interest rate (defined as the natural nominal interest rate minus target inflation), and the error term, φ_t, is a linear combination of the error in (3) and the forecast errors in predicting the inflation rate, the natural rate of interest and the output gap. The output gap was estimated using the filtered unobserved components of a state space model resembling the Hodrick-Prescott filtering procedure, by means of Kalman filtering in the spirit of Harvey (1989) and Harvey and Jaeger (1993). We therefore assess at least partly the issue of interest rate setting under uncertainty of the output gap estimate: we use the filtered estimate of the stationary component of GDP, which exploits information on the variable up to time *t* instead of the smoothed estimate, which is usually used in the literature and exploits information of the full sample.

The estimates of the parameters in (4) using the data described in the text can be found in table A1. The Sargan test for overidentifying restrictions does not present any evidence of misspecification in any of the countries considered, and all the significant parameters are correctly signed. The

[39] *The issue of the nature of persistence in interest rate setting behavior is not without controversy. We abstract from implying that interest rate momentum is exclusively a result of sluggish partial adjustment of policy interest rates, as it may also reflect the effect of omitted variables. For an enlightening discussion, see Rudebush (2006).*

Table A1

Monetary Policy Reaction Functions

Parameter	Euro area	U.S.A.	Japan	U. K.
ρ	0.89*** (0.023)	0.957***(0.023)	0.933*** (0.032)	0.864*** (0.047)
δ	3.579** (1.619)	2.430* (1.327)	2.257*** (0.558)	1.819*** (0.259)
γ	2.495*** (0.537)	3.075 (2.385)	0.867 (0.778)	−0.058 (0.394)
Implied p*	2.239 (0.164)	3.835*** (0.689)	1.052* (0.565)	0.959*(0.646)
# Observations	47	127	97	102
Sample period	Q2 96 bis Q4 07	Q1 74 bis Q3 07	Q4 80 bis Q4 05	Q4 82 bis Q4 07
Sargan test	11.192 (p = 0.594)	15.550 (p = 0.274)	11.746 (p = 0.548)	11.843 (p = 0.541)

Source: OeNB.

*Note: Robust standard errors in parenthesis. * (**) [***] stands for significance at the 10% (5%) [1%] significance level. Estimation carried out by GMM, using lagged values up to one year of interest rates, inflation and the output gap as instruments. „Sargan test" is the test statistic and corresponding p-value of the test statistic for the validity of the overidentifying restrictions in the GMM setting.*

estimated responses to inflation imply that all of the central banks under study carried out disinflationary policies in the periods considered.

The specification enlarged by allowing financial instability to affect the adjustment of the policy rate to the targeted interest rate is given by

$$i_t = (1-\rho(v_t))(1-\delta)\pi^* + \\ + (1-\rho(v_t))r^* + (1-\rho(v_t))\delta\,\pi_{t+n} + (5) \\ + (1-\rho(v_t))\gamma g_t + \rho(v_t)\; i_{t-1} + \varphi_t$$

where the persistence parameter is a (linear) function of the financial stability variable

$$\rho(v_t) = \rho_0 + \rho_1 v_t \qquad (6)$$

We use the observed historical return volatilities for the indices reported in the text since 1997 in order to estimate the model given by (5)–(6). The estimates of (6) are presented in table A2, and were used to compute the time-varying persistence parameters presented in the text.[40]

Table A2

Financial Market Volatility and Interest Rate Inertia

Parameter	Euro area	U.S.A.	Japan	U. K.
ρ_0	1.089*** (0.161)	1.103*** (0.099)	0.646* (0.343)	1.202*** (0.070)
ρ_1	−0.009 (0.009)	−0.002 (0.006)	0.007 (0.014)	−0.024*** (0.005)
# Observations	41	40	32	41
Sample period	Q1 97 bis Q4 07	Q1 97 bis Q3 07	Q1 97 bis Q4 05	Q1 97 bis Q4 07
Mean volume	18.352	16.573	21.399	16.395
Standard deviation of volume	7.617	5.891	5.581	6.646
Minimum volume	8.135	7.557	10.318	7.702
Maximum volume	40.418	31.331	34.533	34.298

Source: OeNB.

*Note: Robust standard errors in parenthesis. * (**) [***] stands for significance at the 10% (5%) [1%] significance level. Estimation carried out by GMM, using lagged values up to one year of interest rates, inflation and the output gap as instruments.*

[40] *The GMM estimates presented in table A2 are obtained using the same set of instruments as in the standard Taylor rule estimates. Alternative specifications were also estimated assessing the potential endogeneity of financial stability by using lagged values of the return volatility variable as instruments, leaving the conclusions of the paper unchanged. These results are available from the authors upon request.*

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