UNIVERSITÀ DEGLI STUDI DI FERRARA

DIPARTIMENTO DI ECONOMIA ISTITUZIONI TERRITORIO

Corso Ercole I d'Este, 44 – 44100 Ferrara

Quaderno n. 14/2005

April 2005

Monetary Policy and Financial Stability: What Role for the Futures Market?ü¶

John Driffill   Zeno Rotondi   Paolo Savona   Cristiano Zazzara

Monetary Policy and Financial Stability:
What Role for the Futures Market?[♦]

John Driffill[∗]   Zeno Rotondi[+]   Paolo Savona[^]   Cristiano Zazzara[#]

Abstract

This paper examines interactions between monetary policy and financial stability. There is a general view that Central Banks smooth interest rate changes to enhance the stability of financial markets. But might this induce a moral hazard problem, and induce financial institutions to maintain riskier portfolios, the presence of which would further inhibit active monetary policy? Hedging activities of financial institutions, such as the use of interest rate futures and swap markets to reduce risk, should further protect markets against consequences of unforeseen interest rate changes. Thus smoothing may be both unnecessary and undesirable. The paper shows by a theoretical argument that smoothing interest rates may lead to indeterminacy of the economy's rational expectations equilibrium. Nevertheless our empirical analysis supports the view that the Federal Reserve smoothes interest rates and reacts to interest rate futures. We add new evidence on the importance for policy of alternative indicators of financial markets stress.

Keywords: Central Bank, Interest Rate Rule, Monetary Policy, Financial Stability, Macroeconomic Stability, Asset Prices, Stock Market, Credit Spread, Futures Market, Hedging, Basis Risk, Federal Reserve.
JEL classification: E44, E52, E58, G12, G13.

[∗] Birkbeck College, University of London. E-mail: j.driffill@bbk.ac.uk.
[+] Corresponding author; Capitalia Banking Group and University of Ferrara. E-mail: zeno.rotondi@capitalia.it and z.rotondi@economia.unife.it. Mail address: Capitalia, Area Studi, via Specchi 10, Roma 00187, Italy.
[^] University "Luiss-Guido Carli" of Rome and Scuola Superiore della Pubblica Amministrazione.
[#] Capitalia Banking Group (cristiano.zazzara@capitalia.it), University "Luiss-Guido Carli" of Rome (czazzara@luiss.it), and École Polytechnique Fédérale de Lausanne (cristiano.zazzara@epfl.ch).

1. Introduction

Central Banks in the developed world have, in the last ten or fifteen years, overwhelmingly switched to a policy of setting short-term interest rates with the primary aim of targeting inflation. Other objectives allegedly remain, but occupy a lower place on the agenda. Among them is the objective of maintaining financial stability, the responsibility for which has long been a role of central banks. The survival of this role has been cited in support of the empirical finding that interest rates seem to move gradually in response to changes in macroeconomic conditions (notably the output gap and inflation). It is argued that by making interest rate changes smaller and more predictable, Central Banks reduce the volatility of the profits of commercial banks and reduce the risk of bank insolvencies and insolvencies among the businesses who borrow from them.[1]

With the passage of time, and the growth in the sophistication of financial markets and in the range of financial instruments available for trading risks, banks like other players in these markets have become increasingly well able to hedge against the risks that variable short-term interest rates pose for their profits and balance sheets. They have turned to markets in interest rate futures and more recently to interest rate swaps in order to hedge their positions. These activities should in principle have reduced banks' exposure to such risks. Nevertheless the possibilities for hedging are less than perfect. Unanticipated changes in interest rates have residual effects on bank profits, and central banks may continue to moderate their interest rate changes for reasons of stability of financial markets.

The purpose of this paper is to explore the interaction of monetary policy and financial stability, and in particular to examine the role played by financial institutions' use of futures and other derivatives markets to hedge risks. Research on the subject of monetary policy and financial stability has mostly focused its attention on central banks' alleged practice of smoothing interest rate movements (see Goodfriend, 1987, and more recently Smith, van Egteren, 2004). It is argued that lower volatility should reduce bank insolvencies caused by unanticipated sharp increases in

---

[1] The relation between monetary policy and financial stability has been long debated and, as argued convincingly by Padoa Schioppa (2002) and Schinasi (2003), central banks' monetary policy has a natural role in ensuring financial stability

1

short-term interest rates. Widespread use of hedging by banks should further reduce their vulnerability to interest rate fluctuations, and enable central banks to change interest rates with less caution. Nevertheless, the residual risk – basis risk and other risks that remain after imperfect hedging opportunities have been exploited – may act as a moderate restraint on monetary policy.

It is possible that the macroeconomic stability obtained as a result of aggressive use of monetary policy brings its own dangers. It may induce a form of moral hazard. Commercial banks and other financial institutions may respond to a stable macroeconomic climate by taking on riskier portfolios of loans and deposits than are consistent with financial stability. Markets may act on what they believe to be an implicit guarantee of public policy that will maintain stability and possibly bail them out of difficulties. The Federal Reserve (see, for instance, Poole, 2004) is alive to these dangers and keen to avert them by making markets aware that risks of instability exist, and that the Federal Reserve would not be able to bail out large players.

Our study makes two contributions. First, from a theoretical standpoint, we analyze the inclusion of futures prices, and the associated basis risk, in the central bank's reaction function, extending the analysis of determinacy of equilibrium conducted by Bullard and Schaling (2002). We show the existence of a trade-off between macroeconomic and financial stability. We argue that this trade-off calls for caution, but does not necessarily imply that the central bank cannot smooth interest rates to reduce basis risk.

Second, from an empirical perspective, we assess the importance for monetary policy of the response to interest rate futures, focusing on the behaviour of the Fed. Following the same econometric approach as Clarida, Galì, Gertler (2000), we estimate an augmented interest rate rule with the stock index, the credit spread and the eurodollar futures rate in addition to inflation and output gap. Our empirical findings support the importance of futures market movements, and in particular of the stabilization of basis risk for the Federal Reserve's monetary policy.
This is an interesting result since the extant literature has mainly stressed the importance of the inclusion of stock market index [Rigobon, Sack (2003), Chadha, Sarno, Valente (2003), and

Rotondi, Vaciago (2004)] and the credit spread [Castelnuovo (2003), Gerlach-Kristen (2004)] in the Fed' s interest rate rule.

The paper is organized as follows. Section 2 defines the concept of financial stability from the perspective of central banks. Section 3 examines the role of interest rate futures markets, and the use of other derivatives, as part of banks' policies for hedging risk. It considers implications for financial stability. Section 4 presents a theoretical analysis of the explicit inclusion of futures prices in the central bank's reaction function within a New Keynesian framework. Section 5 measures the response to future prices of the Fed's monetary policy, while section 6 concludes.

2. Definitions of Financial Stability

Before exploring the nexus between monetary policy and financial stability, it is useful to provide some definitions and highlight the role played by the futures market.

While financial stability is undeniably an important concept that policy makers aim to strive for, the term does denote different (albeit related) meanings to different commentators on the topic. Indeed, researchers on the topic have found it more useful and convenient to analyze financial stability based on its negative counterpart, financial instability, as it probably is easier to identify situations of financial instability and their possible causes.

With respect to financial instability, however, the definitions proposed have been diverse, depending on the focus of the research. Focusing on the role of asymmetric information in inducing financial instability, Mishkin (1999) defines financial instability as a disruption to the efficiency of financial system in fund allocation by ways of worsening adverse selection and moral hazard. Concentrating on the balance sheet channel through the net worth positions of borrowers, Bernanke and Gertler (1987) defines financial fragility as a situation in which potential borrowers have low wealth relative to the size of their projects. Such a situation causes high agency costs and impairs performance in investment sector and in the economy as a whole. The IMF (2003), on the other hand, focuses on different types of "seizures" within the financial system and takes periods of financial instability to be periods of severe financial market disruptions that the system's ability to provide payment services, to price and transfer risk, and to allocate credit and liquidity is impaired and then potentially leads to a reduction in real activity.

3

While definitions above put emphasis on the underlying mechanics of financial instability, other definitions focusing on the symptoms of financial instability have also been proposed (see Issing 2003 for discussion). Symptoms of financial instability are often reflected by asset price volatility, distresses in financial institutions, and affected output performance. Crockett (1997) thus defines financial instability as a situation in which economic performance is potentially impaired by fluctuations in the price of financial assets or in the ability of financial intermediaries to meet their contractual obligation. Bernanke and Gertler (1999) define financial instability as being synonymous with asset price volatility, which takes price far away from its fundamental level, before finally reversing suddenly and violently in a "crash". Ferguson (2003), on the other hand, defines financial instability as a situation characterized by three basic criteria: (1) some important set of financial asset prices seem to have diverged sharply from fundamental; and/or (2) market function and credit availability, domestically and perhaps internationally, have been significantly distorted; with the results that (3) aggregate spending deviates (or is likely to deviate) significantly, either above or below, from the economy's ability to produce.

While there have been many proposed definitions of financial instability that are useful in various analytical contexts, a useful and practical definition of financial instability from monetary policy decision's point of view should be framed with the root cause of the instability in mind. At gist, we may affirm that financial instability arises because of excessive financial risk taking by economic agents, be it consumers, investors, the government, or intermediaries themselves. As consumers, investors, or the government accumulate more debts, their ability to repay the full amount of debt diminishes, ceteris paribus. The inability of borrowers to repay their debt by the full amount means that lenders, often banks, will have to shoulder losses. If the banks cannot shoulder such losses using their retained profits, they will need to draw upon owners' capital. By drawing upon owners' capital to cover the losses on the balance sheets, the banks will have less capital to support other existing loans. Recalls of existing loans (possibly unrelated to those already gone sour) will be made. In that case, intermediary functions of the banks will be severely disrupted as banks start to draw back loans from the economy rather than granting new ones. The recalls of loans can make matter worse as they could instigate a disruption in real economic activities, which could result in more loans turning bad and more losses to cover. Ultimately, excessive financial risk taking that

result in losses on bank balance sheets could lead to a drastic systemic disruption in the functioning of the whole banking system, and possibly later result in widespread economic failures. Financial instability is thus caused by build-ups of financial imbalances that put great risks on the intermediaries' balance sheets to the extent that the financial system can no longer allocate funds efficiently. Defining financial instability as above and focusing mainly on banks can help the process of framing monetary policy decision more clear-cut[2].

Focusing on the importance of the banking system from a financial stability perspective, a further definition of financial instability may be related to banks' interest rate risk hedging policies. In the words of Freixas and Rochet (1997), a bank is "…an institution whose current operations consist in granting loans and receiving deposits from the public". Such traditional form of intermediation leaves banks open to interest rate exposure and to duration or maturity mismatch exposure, which arises when banks borrow short and lend long. The greater the amount of interest rate risk banks will incur and the greater the increased risk in terms of financial stability. Therefore, effective hedging of interest rate risk is highly important both to the banks and to the financial system as a whole as it will reduce the banks' exposure to volatile interest rate movements. This will lessen the likelihood of extreme fluctuations in a bank's financial condition and reduce the probability of a bank becoming insolvent (Brewer et al., 2001).

3. The importance of the futures market for financial stability: the case of financial institutions

The smoothing of interest rates by central banks is widely documented. It manifests itself in the appearance of the lagged dependent variable in estimated Taylor Rules, in which the interest rate used for monetary policy is explained in terms of inflation rates and the output gap. It is often suggested that one of the many possible reasons for this apparent smoothing is to preserve the stability of financial markets. By responding slowly over a period of several months to some change in macroeconomic conditions, the central bank reduces the size of unanticipated changes in

---

[2]Although we only refer to banks, the analysis and definition here are applicable to other non-banks financial intermediaries.

short-term interest rates to which the commercial banks and other participants in financial markets are subjected. This reduces the chance that a bank's profits from its loan portfolio will be put under pressure or that its balance sheet will be weakened. This argument is often accepted uncritically. However, it should perhaps be scrutinized more closely.

The argument that central banks are concerned about financial stability, and that this concern colours their interest rate decisions, stems from the potentially serious consequences of instability. If a commercial bank were to find itself insolvent or illiquid, causing it to default on its payment obligations, it could send a shock through the whole financial system, causing other institutions to suffer losses resulting from their claims on customers of the defaulting bank, or perhaps through inter-bank lending with that particular institution. This possible sequence of events could jeopardise the stability of the entire economy.

The reason that interest rate changes, particularly rises in short-term policy rates may damage banks' profits is that banks allegedly borrow short and lend long. The consequences of such a maturity mismatch could in principle be serious. For example, a sudden inflation scare might cause a shock to the term structure of interest rates, induce a tightening of monetary policy, and thereby a sharp inversion of the yield curve. A commercial bank might be committed to funding loans for a period of time into the future at the earlier lower interest rate balanced by deposits, which it must accept at the new higher interest rate. This will have an adverse effect on the bank's profits and capital ratio and increase the likelihood of insolvency.

To some degree this is true: banks borrow short and lend long. Many deposits are held in checking accounts and may be withdrawn on sight. Bank loans typically have a longer term. However, maturity transformation has been the stock-in-trade of commercial banks for centuries, and they employ well-known methods for dealing with the risks posed by interest rate movements. Overdraft facilities or lines of credit are often made at variable interest rates, so while borrowers can be confident of the amount available to borrow, the interest rate they pay may be varied at very short notice, and effectively the risk of movements in short-term interest rates is passed to the

borrowers. Fixed term loans are generally made at rates that allow for default risk and also for the illiquidity of the loan from the lender's viewpoint. North American banks, in common with banks in other countries with the Anglo-Saxon banking traditions, resist making substantial long-term loans at fixed interest rates. These tend to constitute a relatively small fraction of their loan portfolios.

There have in the past been episodes in which interest rates have risen rapidly, which have not caused major problems for banks or financial instability. During the 1970s, interest rates rose strongly. During the period between 1979 and 1982, when the United States experimented with monetary base control, interest rates were both high in nominal terms, and very volatile. While the experience produced loud complaints from the financial markets it did not lead to financial instability. Consequently, historical experience suggests that the US banking system can withstand substantial changes in interest rates without danger of financial instability. The collapse of the savings and loan associations in the 1980s is arguably a separate issue. It resulted from the removal of interest rate ceilings, under the shelter of which those institutions had accumulated fixed-interest loans. This combined with other aspects of the regulatory regime that followed induced excessive risk-taking by Savings and Loans, many of which deliberately courted bankruptcy. So the Savings and Loan debacle can be viewed as a consequence of catastrophic regulatory failure.

Financial institutions have increasingly used derivatives as part of their strategy for managing exposure to risks of interest rate movements. Banks can use interest-rate-related derivatives to hedge maturity mismatch. In recent years the variety of these products and the liquidity of the markets in which they are traded have increased. Whereas interest rate futures were initially the dominant choice, interest rate swaps have now become the most widely used instrument. It is likely that less volatile interest rates in world markets have contributed to this shift. When interest rates are highly volatile, futures are a more effective method of hedging, given the uncertainty in the underlying product and the unwillingness of a counterparty to accept a converse position as is required with swaps. In recent years as interest rates have become less volatile the environment has become more conducive to swaps trading. With less volatile interest rates, banks are able to judge

7

their interest rate exposure for a period of time in the future more accurately. This makes it easier for two counter-parties to enact a swap agreement, as they are more confident in their judgement of future interest rate movements, and wild swings in interest rates are less likely.

However, interest rate futures and swaps may not remove all the risk arising from maturity mismatch. The hedging instruments available do not permit banks to insure precisely against fluctuations in the rate on interest they pay on short-term deposits and reserves, which is closely related to, but not identical to, the Federal Funds rate in the United States. They may be able to use futures markets to swap interest payments based on LIBOR for those based on the average federal funds rate over the same three-month period. But if their cost of deposits fluctuates relative to the Federal Funds rate, they remain exposed to the risk of these fluctuations, and full hedging may not be optimal in this case anyway. This residual risk is known as basis risk.

These arguments strengthen the view that the risks to financial stability posed by movements in short-term interest rates in the United States are small, and they should therefore have only a small influence on the interest rate setting decisions of the Federal Reserve. Nevertheless the residual risks may induce some caution on the part of the Fed.

But at this point another argument comes into play. While in the short term cautious interest-rate changes by the Fed may enhance financial stability, in the longer term they may do less to enhance it and may work in the other direction to reduce it. The achievement of low and stable inflation by the Fed, since the mid 1980s, has arguably produced economic conditions conducive to low and stable interest rates. However, it was achieved by the vigorous use of monetary policy. It may be necessary for central banks to be free to make big changes in policy in the face of large shocks in order to maintain stability in the medium term.

If the Federal Reserve were to limit changes in interest rates to protect banks' balance sheets, banks may feel they have some implicit insurance, inducing a moral hazard problem. Banks may feel able to operate on thinner margins and with riskier portfolios of assets and liabilities. Consequently it

may be argued that robust regulation of financial markets is the appropriate response, rather than a smoothing of interest rate changes, to ensure that banks operate with sufficient margins of capital and liquid reserves, so that they can withstand the consequences of all but the most extreme fluctuations in market conditions.

That the Federal Reserve is concerned that participants in financial markets should not behave as though there were an implicit guarantee against their failure is illustrated by a recent speech given by the President of the Federal Reserve Bank of St. Louis, William Poole (2004). In this Poole is clearly concerned that markets do not price the risk posed by the fact that the large US Government sponsored financial institutions (the GSEs) like the Freddie Mac, Fannie Mae, and others, maintain excessively thin capital positions, making them more vulnerable to shocks. He clearly points out that they would be allowed to fail in a crisis. This market misperception of risk worsens the problem by providing the GSEs with excessively cheap funds and allowing them to grow too rapidly.[3] This underlines the original point that financial stability remains a concern for central banks and that it may therefore affect their setting of interest rates.

4. Monetary policy and futures market movements

In this section we provide a theoretical analysis in order to explore the nexus between monetary policy and the futures market. Particularly, we focus on potential risks to macroeconomic stability stemming from the response of monetary policy to futures prices movements.

The link between monetary policy and asset price movements has been of perennial interest to policy makers and academic researchers. One of the main area of research focuses on the view that asset prices may affect real activity. The channels of the transmission mechanism from asset prices to economic activity are mainly three: households' wealth effect on consumption expenditure (Modigliani (1971)); Tobin's Q effect on investment (Tobin (1969)); financial accelerator effect on investment (Bernanke and Gertler (1989)).

---

[3] Poole remarks: "their [the GSEs] growth incentives insure that their scale will increase over time, unless they become subject to full private market incentives through convincing federal policies that lead to market recognition that the federal government will not guarantee GSE obligations in a crisis."

These three channels are undoubtedly important in affecting both output and inflation, but it is less clear whether they provide a strong argument for basing monetary policy on asset prices movements. In fact, it has been argued that the gain of including asset prices in monetary policy rules in practice adds little to stabilizing output and inflation.[4] This is due to the fact that asset channels are similar to aggregate demand channels, as they tend to increase both output and inflation. Thus inflation targeting yields most of the gains of adopting asset price targeting without the drawbacks of the appearance of interfering in the working of financial markets.

On the other hand, asset prices seem to display exogenous movements unrelated to the underlying state variables. There exist several historical examples that show that extreme movements in asset prices have coincided with prolonged periods of macroeconomic instability.[5] This raises the question of what can central banks do in order to minimize the likelihood of asset price misalignments. However, even if one accepts the role of asset prices in the propagation of shocks, asset price misalignments are difficult to detect. The problem is that asset prices are too volatile and too unrelated to real activity, as argued for instance by Gertler, Goodfriend, Issing and Spaventa (1998).

Nevertheless, the above concern about the ability to detect asset price misalignments by central banks calls for caution and does not necessarily imply that we should ignore them. As Cecchetti, Genberg, Lipsky and Wadwhani (2000) observe, the difficulties associated with measuring asset price misalignments are not substantially different from those related to potential GDP or the equilibrium real interest rate. Actually Borio and Lowe (2002) argue that what really matters for monetary policy is not to respond to asset price bubbles *per se*, but rather to reduce the risk of financial distress resulting from the occurrence of financial imbalances. In particular, they show that identifying ex ante financial imbalances is difficult but not impossible. By using data from a large number of countries they have obtained empirical evidence showing that the simultaneous

---

[4] In the literature this point has been particularly stressed by Bernanke and Gertler (1999),(2001) and Gilchrist and Leahy (2002).

[5] See Cecchetti, Genberg, Lipsky and Wadhwani (2000) for an analysis of the major economic episodes of asset price misalignments.

surge in both credit and asset prices provides a relatively reliable warning of financial imbalances ahead.

Here, in order to explore further the issue of including explicitly asset prices in the central bank's reaction function we consider the analysis of determinacy of rational expectations equilibrium provided by Bullard and Mitra (2002) and Woodford (2003a). In fact, as shown by Bullard and Schaling (2002), introducing asset prices in the central bank's interest rate rule may weaken the requirement for determinacy of the rational expectations equilibrium and potentially lead to macroeconomic instability. They have shown this result for the case of equity prices. In the present analysis we consider instead the case of futures prices.

4.1 The model

In the present framework the supply function is given by a New Keynesian Phillips curve that relates inflation positively to the output gap:

$$\pi_t = \lambda y_t + \beta E_t \pi_{t+1}, \tag{1}$$

where β is the discount factor considered in the discounted sum of utilities of a representative household, with $0<\beta<1$.

We have also an IS equation which relates inversely the output gap to the real interest rate:

$$y_t = E_t y_{t+1} - \sigma(r_t - r_t^n - E_t \pi_{t+1}), \tag{2}$$

where $\sigma>0$ measures the intertemporal elasticity of substitution of aggregate expenditure.

The model represents a log-linear approximation of the equilibrium conditions under a deterministic steady state. Hence, all variables are expressed as a log-deviation from their long run level. The nominal short-term interest rate r_t is the instantaneous interest rate or continuously compounded interest rate and empirically could be approximated by the Fed funds rate. Thus, if R_t is the gross nominal interest rate on a risk-free one-period bond, then $r_t = \log R_t$. We assume absence of arbitrage opportunities and complete financial markets.

11

Following Bullard and Mitra (2002), we assume that the natural rate of interest r_t^n is an exogenous stochastic term that follows an AR(1) process given by

$$r_t^n = \omega r_{t-1}^n + \varepsilon_t, \qquad (3)$$

where $0<\omega<1$ and ε_t is an *iid* disturbance with variance σ_ε^2 and mean zero.

Monetary policy is formulated in terms of a feedback rule for setting the nominal short-term interest rate of the following form:

$$r_t = \rho r_{t-1} + \phi_\pi E_t \pi_{t+1} + \phi_y y_t + \phi_{BR}[(\log P_t^A - \log F_t) - (\log P^{A*} - \log F^*)], \qquad (4)$$

where F_t is the futures price and P_t^A is the price of the asset underlying the futures contract. Here, in order to simplify the analysis, we assume that the central bank stabilizes the ratio of P_t^A over F_t, instead of the spread. Obviously, this simplification does not affect the results. The superscript (*) indicates trend value, while the subscript BR stems for basis risk. The coefficient ρ, with $0<\rho<1$, measures the degree of inertia in the central bank's response to macroeconomic and financial shocks.

According to the policy rule (4), the central bank is concerned about the deviation of the current spread between futures price and asset price from its long run equilibrium level. It is important to observe that the spread considered above is an ex post measure related to basis risk in a hedging situation. If we consider a hedge put in place at time *t-1*, the hedging risk is the uncertainty associated with the spread realized at time *t* and is termed as basis risk. When the price of the asset increases by more (less) than the futures prices, the basis increases (decreases). This is referred to as a strengthening (weakening) of the basis.

Now, if we consider a one-period futures contract, it is possible to show that the central bank by setting the short-term interest rate according to (4) may affect the basis risk by smoothing the basis

over time. In order to see this we introduce the assumption that futures and forward prices are perfect substitutes.[6] This implies that

$$F_t = P_t^A e^{\log R_t}.$$
(5)

From (5) follows that

$$\log P_t^A - \log F_t = -\log R_t;$$
$$\log P^{A*} - \log F^* = -\log R^*.$$
(6)

Substituting (6) back into expression (4) and using the definition of the instantaneous rate we get

$$r_t = \rho r_{t-1} + \phi_\pi E_t \pi_{t+1} + \phi_y y_t - \phi_{BR} r_t.$$
(7)

From (7) we obtain the following policy rule

$$r_t = \Phi_\rho r_{t-1} + \Phi_\pi E_t \pi_{t+1} + \Phi_y y_t;$$
(8)

with

$$\Phi_\rho = \frac{\rho}{1 + \phi_{BR}};$$
$$\Phi_\pi = \frac{\phi_\pi}{1 + \phi_{BR}};$$
$$\Phi_y = \frac{\phi_y}{1 + \phi_{BR}}.$$
(9)

Obviously the effect of modeling the concern for financial stability in this way is to reduce the response of the interest rate both to its own lagged value and also to its macroeconomic determinants. From (8) it is possible to see that as $\phi_{BR} \to +\infty$ the interest rate, and hence the basis,

---

[6] See for instance Hull (2000) for a discussion on the validity of this assumption.

13

tends to zero.[7] Clearly, $\phi_{BR} \rightarrow +\infty$ implies monetary policy following an interest rate peg without reaction to inflation deviations or the output gap. Accordingly, rational agents expecting this behavior from the central bank will find the basis risk reduced and close to zero.

4.2 Determinacy of equilibrium

Following Woodford (2003a) and Bullard and Mitra (2002), the determinacy conditions for the model constituted by (1), (2), (3), (8) and (9) should be derived from the following system

$$E_t z_{t+1} = A z_t + a r_t^n, \tag{10}$$

where $z_t = [\pi_t, y_t, r_{t-1}]'$, and

$$A \equiv \begin{bmatrix} \beta^{-1} & -\beta^{-1}\lambda & 0 \\ \sigma\beta^{-1}(\Phi_\pi - 1) & 1 + \sigma[\Phi_x - \beta^{-1}\lambda(\Phi_\pi - 1)] & \sigma\Phi_\rho \\ \beta^{-1}\Phi_\pi & \Phi_y - \beta^{-1}\lambda\Phi_\pi & \Phi_\rho \end{bmatrix}, \qquad a \equiv \begin{bmatrix} 0 \\ -\sigma \\ 0 \end{bmatrix}. \tag{11}$$

In (10) there is a single predetermined state variable, namely r_{t-1}, so that the equilibrium is determinate if and only if A has exactly two eigenvalues outside the unit circle. As shown by Woodford (2003a), the necessary and sufficient conditions for rational expectations equilibrium to be unique are:

$$\Phi_\pi + \frac{1-\beta}{\lambda}\Phi_y > 1 - \Phi_\rho, \tag{12}$$

and

$$\Phi_\pi < 1 + \Phi_\rho + \frac{1+\beta}{\lambda}[\Phi_y + 2\sigma^{-1}(1 + \Phi_\rho)]. \tag{13}$$

---

[7] Recall that all variables are expressed as log-deviations from their trend level and constants are omitted for simplicity.

The condition (12) is the generalization of the basic 'Taylor principle' appropriate for the case at hand.[8] After substituting (9) in the conditions (12) and (13) we get

$$\frac{\phi_\pi}{1+\phi_{BR}} + \frac{\phi_y(1-\beta)}{(1+\phi_{BR})\lambda} > 1 - \frac{\rho}{1+\phi_{BR}}, \tag{14}$$

and

$$\frac{\phi_\pi}{1+\phi_{BR}} < 1 + \frac{\rho}{1+\phi_{BR}} + \frac{1+\beta}{\lambda}\left[\frac{\phi_y}{1+\phi_{BR}} + 2\sigma^{-1}\left(1+\frac{\rho}{1+\phi_{BR}}\right)\right]. \tag{15}$$

4.3 Main findings

When conditions (12) and (13) fail, the rational expectations equilibrium is indeterminate. Thus an interesting question to ask is the following. Consider fixed values of $\phi_\rho, \phi_\pi, \phi_y$, satisfying the requirement for determinacy of the equilibrium, and assume that the central bank considers to begin including a reaction to futures price movements in its policy rule what are the implications for the conditions (12) and (13)?

We can prove the following proposition:

Proposition 1 - *When monetary policy is conducted so as to ensure that the short-term interest rate follows a rule of the form of (4), with given fixed values of $\phi_\rho, \phi_\pi, \phi_y > 0$ ensuring the satisfaction*

---

[8] The principle that interest rate rules should respond more than one for one to changes in inflation is called 'Taylor principle': see for instance Walsh (2003). However, Bullard and Mitra (2002) and Woodford (2003a) have shown that in general the necessary and sufficient condition required for stability may have a more complex form than that expressed by the Taylor principle. In particular it is possible to show that $\Phi_\pi > 1$ is only a necessary condition for the determinacy of the rational expectations equilibrium, and even values of $0 < \Phi_\pi < 1$ can be consistent with stability. However, as argued by Woodford (2003a, p. 254) the Taylor principle continues to be a crucial condition for determinacy if it is reformulated as: "[...] *At least in the long run, nominal interest rates should rise by more than the increase in the inflation rate*".

of conditions (12) and (13), then $\phi_{BR} > 0$ works against the satisfaction of the requirement for determinacy of the equilibrium compared to the case of $\phi_{BR} = 0$.

PROOF. Multiplying both sides of the inequality (14) by *(1-ρ)* we get

$$\phi_\pi + \phi_y(1-\beta) > 1 - \rho + \phi_{BR}, \tag{16}$$

where it is clear that for $\phi_{BR} > 0$ the requirement for determinacy of the equilibrium provided by condition (12) becomes stricter. On the contrary, multiplying both sides of the inequality (15) by *(1-ρ)* we can see that for $\phi_{BR} > 0$ the requirement for determinacy of the equilibrium provided by condition (13) becomes less binding. Thus, in the case of $\phi_{BR} > 0$ the most relevant condition (not the unique) for determinacy is (12), which as we have shown supports the proposition made. QED.

Proposition 1 implies that for monetary policy there exists a trade-off between macroeconomic stability and financial stability. As the relative weight ϕ_{BR} attached to the basis risk stabilization motive increases, the ability of achieving macroeconomic stability is reduced. An excessively high value of ϕ_{BR} can even compromise the achievement of macroeconomic stability by creating indeterminacy of the equilibrium, when such indeterminacy did not otherwise exist. Clearly the existence of this trade off between macroeconomic stability and financial stability calls for caution and does not necessarily imply that the central bank cannot pursue the stabilization of the basis risk.

5. Measuring the response to futures prices

This section of the paper offers an empirical analysis. It examines the Federal Reserve's response to movements in the price of interest rate futures when it sets interest rates.

5.1 Baseline interest rate rule

The baseline interest rate rule assumes the target rate $\bar{r}_t$ depends on the output gap (y_t) and expected inflation ($E_t\pi_{t+4}$), and that the actual interest rate (r_t) adjusts gradually towards the target. It may be represented as:

$$r_t = \rho r_{t-1} + (1-\rho)\bar{r}_t + \omega_t,$$

$$\bar{r}_t = \phi_\pi E_t \pi_{t+4} + \phi_y E_t y_t;$$

(17)

Constants are omitted for simplicity. The estimation approach used is the same as that of Clarida, Galì and Gertler (2000) for the case of the Federal Reserve.[9] The data used are the Federal funds interest rate, defined as the average effective Federal funds rate over the quarter, the output gap, defined as percent deviation of actual real GDP from the potential output estimated by the Congressional Budget Office, and inflation, measured as four-quarter change in the GDP deflator.[10] GMM has been used. We have used a correction for heteroskedasticity and autocorrelation of unknown form with a Newey-West fixed bandwidth, and chosen Bartlett weights to ensure positive definiteness of the estimated variance-covariance matrix.[11] The instrument set includes four lags of output gap, inflation and the federal funds rate.[12]

English, Nelson and Sack (2003) have reformulated the basic policy rule, by the addition of a serially correlated error term, as:

---

[9] The econometric approach used relies on the assumption that, within our short sample, short term interest rates, inflation and output gap are I(0). However, standard Dickey-Fuller test of the null that the above series are I(1) is not rejected for the US. Nevertheless, as argued for instance by Clarida, Galì and Gertler (1998), standard Dickey-Fuller test has lower power against the alternative of stationarity for short samples. For this reason the assumption of stationary series is standard in the empirical literature of interest rate rules, as this literature is in general based on short samples with a stable monetary regime like in our case.

[10] Data on the Fed funds rate, output gap and inflation are taken from FRED II, of the Federal Reserve Bank of St. Louis.

[11] The optimal weighting matrix is obtained from first-step Two-Stage Least Squares (2SLS) parameter estimates.

[12] The J-test reported in the tables is the test for the validity of the instruments used. The associated statistic is distributed as a χ^2.

$$r_t = r_{t-1} + (1-\rho)\Delta\bar{r}_t + [(1-\rho)(1-\theta)](\bar{r}_{t-1} - r_{t-1}) + (\rho\theta)\Delta r_{t-1} + \varepsilon_t. \tag{18}$$

$$\omega_t = \theta\omega_{t-1} + \varepsilon_t \tag{19}$$

In expression (18) the parameter ρ reflects monetary inertia (i.e. interest rate smoothing), while θ reflects the presence of serially correlated omitted variables. English, Nelson and Sack (2003) found both parameters significant, and thus argued that both factors are valid and important in explaining the behavior of the central bank. In this they take issue with Rudebusch (2002), who argued that monetary inertia is an illusion.

The GMM estimates obtained from (17) and (18) are reported in table 1. The estimates of both ρ and θ are highly significant, suggesting that both partial adjustment and serially correlated errors are present. Allowing for serially correlated errors reduces the estimated degree of partial adjustment to some extent, but the effect is relatively small, with the ρ parameter falling from 0.83 to 0.71.

5.2 Augmented interest rate rule

Here we take up the argument made by Rudebusch (2002), to the effect that the presence of serially correlated errors in the interest rate rule may reflect the omission of some additional persistent, serially correlated variable or linear combination of variables. In line with the theoretical arguments made above, we add a number of variables that may reflect the effect of concerns about financial stability on interest rate setting. The variables in question are an index of the level of stock market prices, a measure of the spread between returns on US Treasury bonds and commercial bonds, and the excess of the interest rate in euro-dollar interest rate futures contracts.

The inclusion of the stock market index is widely supported in the literature. It may reflect the central bank's desire to offset the expected effect of stock market shocks on aggregate demand (Rigobon and Sack 2003). In addition, as Cecchetti, Genberg, Lipsky and Wadwhani (2000) have argued, reacting to asset price movements in the "normal" course of monetary policy may reduce the likelihood of bubbles forming or getting out of hand. However, Bernanke (2002) argues that, for

such a policy of leaning-against-the-bubble to provide some insurance against perceived bubbles, a small increase in the interest rate should imply a corresponding smooth reduction in the likelihood or size of a bubble. Unfortunately the existing empirical and theoretical evidence does not support such a smooth link. Following Rotondi and Vaciago (2004) we use the Wilshire 5000, instead of the Standard & Poor's 500 or the Dow Jones, which is a broader stock market index.[13] As in Chadha, Sarno and Valente (2003) and Rotondi and Vaciago (2004) the stock market index enters lagged in the policy rule in order to avoid the arising of the simultaneity bias identified by Sack and Rigobon (2003).[14]

Castelnuovo (2003) and Gerlach-Kristen (2004) have argued in favour of including the credit spread in the Federal Reserve's interest rate rule. These authors use the current value of the spread. Using the Hausman test, Gerlach-Kristen argues that the simultaneity problem is negligible. However, as in the case of the stock market index, we will also examine the use of the lagged spread.

Finally, we have added the change of the spread between the futures rate settled in the previous quarter and the current quarterly average of the Fed funds rate. This term is related to a particular notion of basis risk for financial institutions, as discussed for instance by Sack (2004). The notion of basis risk considered for the Fed is the excess expected return of the three-month Eurodollar

---

[13] Rotondi and Vaciago (2004) examine also the inclusion of a new variable, termed as 'Fed model' spread, intended to capture the importance of the relationship between the stock market and the bond market for the assessment of the presence of bubbles in the stock market. They find some evidence supporting the presence of this variable in the Fed's interest rate rule, but they show also that the response to the 1990s bubble was non-linear. Thus, given our aim of measuring the response to futures market movements, we excluded for simplicity this variable from the present empirical analysis. Anyway our sample includes a relatively long post-bubble period.

[14] The first empirical analysis that addresses explicitly the issue of the response of the Fed to stock market movements is that of Bernanke and Gertler (1999). By using monthly data, they estimate a forward-looking policy rule where the federal funds rate reacts to expected inflation and output gap as well as to the current and lagged changes in stock prices. Their findings show an insignificant reaction of monetary policy to stock market movements. However, Sack and Rigobon (2003) argue that Bernanke and Gertler's result may be affected by the presence of a simultaneity bias due to the endogenous reaction of stock market prices to the interest rate.

deposit over the Federal funds rate. From a financial stability standpoint, the Federal Reserve might stabilize this kind of basis risk by reducing the volatility of the spread between the futures rate quoted in the previous period and the realized Fed funds rate.

Thus we have estimated the following augmented interest rate rule:

$$r_t = \rho r_{t-1} + (1-\rho)\bar{r}_t + v_t,$$

$$\bar{r}_t = \phi_\pi E_t \pi_{t+4} + \phi_y E_t y_t + \phi_{SM} \Delta p^S_{t-1} + \phi_{CS}(R^{CB}_t - R^{10Y}_t) + \phi_{BR}\Delta(r^F_{t-1} - r_t);$$

(20)

where p^S_t is the log of the quarterly average of the Wilshire 5000 index; $(R^{CB}_t - R^{10Y}_t)$ is the quarterly average of the credit spread, namely the spread between the Moody's BAA corporate index yield and the 10 year US treasury note yield; r^F_t is the rate on a eurodollar futures contract that settles 3 months ahead.[15] In this case, the instrument set used for the GMM estimation includes four lags of output gap, inflation, the Fed funds rate, the stock index, the credit spread and the futures rate.

Before estimating (20) with GMM we need to collect terms involving respect to the short-term interest rate. Simple manipulation yields the following expression

$$r_t = \left[\frac{\rho + (1-\rho)\phi_{BR}}{1 + (1-\rho)\phi_{BR}}\right] r_{t-1} + \left[\frac{(1-\rho)}{1 + (1-\rho)\phi_{BR}}\right] \tilde{r}_t + v_t,$$

(21)

with

$$\widetilde{r}_t = \phi_\pi E_t \pi_{t+4} + \phi_y E_t y_t + \phi_{SM} \Delta p_{t-1}^S + \phi_{CS}(R_t^{CB} - R_t^{10Y}) + \phi_{BR} \Delta r_{t-1}^F. \tag{22}$$

The GMM estimates obtained from (21) are reported in table 1. Allowing for these additional variables reduces the estimated degree of partial adjustment very slightly. In table 1 we have reported both estimates obtained with the current quarterly average of the credit spread, and also estimates obtained with the lagged credit spread for end-of-quarter data.[16] In the latter case the target value for the interest rate (22) should be rewritten as

$$\widetilde{r}_t = \phi_\pi E_t \pi_{t+4} + \phi_y E_t y_t + \phi_{SM} \Delta p_{t-1}^S + \phi_{CS}(R_{t-1}^{CB} - R_{t-1}^{10Y}) + \phi_{BR} \Delta r_{t-1}^F. \tag{23}$$

As can be seen from the table 1, in both the cases the estimated coefficients are significant and their sign and dimension are consistent with previous estimates found in the literature. Moreover our new variable, i.e. the change in futures prices, is highly significant and of the expected sign.

5.3 Discussion of the results

On a comparison of goodness fit, the additional variables seem to do a good job of explaining the serially correlated shocks considered in specification (18). This finding is consistent with the view that indicators of financial stress are among the persistent, serially correlated, omitted variables. These findings also suggest a role for futures market movements, and in particular of the stabilization of basis risk, in the monetary policy of the Fed.

In order to appreciate the relative importance of futures market movements compared to the other indicators, we can follow the analysis developed in Rotondi and Vaciago (2004), and examine the contribution in percentage terms of each explanatory variable to the target value for the interest

---

[16] The estimates obtained with the lagged quarterly average of the credit spread imply a worse goodness of fit compared to the case of previous period credit spread for end-of-quarter data. Details on this estimation, not reported for brevity reason, are available upon request.

rate. This is done in figures 1 and 2 for the interest rate based on specifications (22) and (23) respectively. Figure 1 shows that the component corresponding to the credit spread is of overwhelming importance, even when is compared to the inflation component. This is implausible. When the lagged credit spread is taken into account, as in figure 2, a more plausible picture emerges. Here inflation plays a dominant role, even if the credit spread remains a relatively very important component. In both cases a component related to futures prices is also relatively important, approximately of the same magnitude as the output gap component, and bigger than the component related to stock market movements. As relatively little attention has been paid to futures prices movements (and the stabilization of the basis risk) in the literature on monetary policy, this finding may be surprising.

Caution is needed, however, in the interpretation of these results. While the inclusion of these additional variables is prompted by considerations of financial stability, their empirical significance is open to alternative interpretations. Although lagged values of the variables have been used, all three, the stock market index, the yield on long bonds, and the interest rate futures variable are forward-looking variables, and reflect the expectations of market participants on the future path of interest rates, among other things. A rise in the stock market may result from market beliefs about stronger future earnings growth, which subsequently induces the Federal Reserve to raise interest rate to contain inflation. The effect of higher yields on Treasury bonds relative to commercial bonds may be there because the bond markets anticipate that interest rates are about to rise. The effect of a higher rate on interest rate futures contracts in the preceding period may reflect market anticipations of higher interest rates this period. In the absence of a complete structural model, using only a single equation, there are many possible causal connections among these variables, among which it is not possible to distinguish. Consequently the findings here have to be viewed as being suggestive only, and not conclusive

6. Conclusions

This paper contributes to the literature in several directions. Using a theoretical argument, the paper shows how stabilizing futures market movements may lead to indeterminacy of the rational

expectations equilibrium, extending an analysis of Bullard and Schaling (2002). The empirical analysis allows for a Federal Reserve reaction to futures prices in the Taylor Rule. Many variants of Taylor's original specification have been estimated. A common finding is that the lagged interest rate enters estimated policy rules with overwhelming significance. This is generally interpreted as central banks' smoothing of interest rates to promote financial stability. More recently empirical evidence has emerged that monetary policy reacts to stock market and credit spread movements. This has also been interpreted as an attempt to promote financial stability. We add new evidence that interest rates react to futures market movements and provide a broad assessment of the relative importance of alternative indicators of financial markets stress. Our results show that the component in the interest rate rule related to futures prices has the same degree of importance of the output gap component, while it appears to dominate the stock market component. However, the empirical evidence advanced in the paper needs to be read with some caution. The results are based on single equation model not a structural model. The variables with which the interest rate rule has been augmented are all expectational variables, and may merely show up the financial markets' anticipations of events, which later on cause changes in the Federal Reserve's policy rule. More work is needed to distinguish among the several possible causal connections among these variables.

In both the theoretical and empirical analyses we argue that the futures market, and in particular the basis risk implied by the hedging strategies of financial institutions, is a key component of monetary policy aimed at achieving financial stability among other objectives. Surprisingly, the literature on monetary policy and financial stability has devoted little attention to the role played by futures markets, focusing mainly on the issue of stabilizing short-term interest rate fluctuations or reacting to other indicators of financial markets stress. From this perspective our paper may represent an effort towards a broader comprehension of the nexus between monetary policy and financial stability.

A graphical decomposition of the interest rate targets shows that, starting from the late 1980s, variables related to macroeconomic stability have decreased in prominence, whilst the financial stability variables have gradually come to the fore. This may have gone hand in hand with a shift in the central bank's objective function towards financial stability motives, due to both a low inflation environment and the globalization of financial markets. If monetary policy should pay greater

attention to the build-up of financial imbalances in a globalized world, the symptoms of financial instability should even be more relevant under moderate inflation dynamics. In fact, during prolonged periods of price stability, build-up of debt and overinvestment by firms are more likely to occur, as under this circumstance it is more likely that excess demand pressures show up first in credit aggregates and asset prices, rather than in real market prices. The central bank's objective function in a globalized world clearly deserves further investigation, since better understanding of it could help in the formulation of arrangements and policy responses to promote both monetary and financial stability. As shown by the present empirical analysis, the standard textbook treatment of central bank's objective function, mostly based on price and output stabilization, may be a too restrictive description of central banking in practice.

Table 1 – GMM estimation of alternative forward-looking Taylor rules

	Baseline	Baseline with serially correlated errors	Augmented with current credit spread	Augmented with lagged credit spread
ρ	0.83 (0.04)	0.71 (0.10)	0.80 (0.02)	0.78 (0.03)
ϕ_π	2.12 (0.45)	1.93 (0.49)	2.63 (0.30)	2.64 (0.31)
ϕ_y	0.93 (0.20)	0.75 (0.20)	0.98 (0.10)	0.75 (0.09)
ϕ_{BR}			2.55 (0.45)	3.45 (0.57)
ϕ_{CS}			-2.83 (0.47)	-1.66 (0.41)
ϕ_{SM}			0.10 (0.03)	0.16 (0.03)
θ		0.60 (0.13)		
Adj. R-Squared	0.95	0.97	0.98	0.98
S.D. dep.var.	2.08	2.08	2.08	2.08
S.E. regression	0.45	0.35	0.30	0.29
J-test	0.55	0.94	0.99	0.99

Notes: Newey-West robust standard errors in parentheses. *J*-test is the test for overidentifying restrictions. For this test only p-values are reported. Sample period for estimation is 1987 Q4 – 2003 Q2. To be consistent across policy rules estimated in levels and differences, all R^2 statistics are reported for the level of the Fed funds rate. The earlier end date for the sample is required for the forward-looking specification. Constants omitted for brevity.

References

Bernanke, B., October 15, 2002. Asset-Price "Bubbles" and Monetary Policy. Speech made before the New York Chapter of the National Association for Business Economics, New York.

Bernanke, B., Gertler, M., 1987. Financial Fragility and Economic Performance. NBER Working paper no. 2318.

Bernanke, B., Gertler M., 1989. Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review*, 79:14-31.

Bernanke, B., Gertler M., 1999. Monetary Policy and Asset Market Volatility. *Federal Reserve Bank of Kansas City Economic Review*, 84:17-52.

Bernanke, B., Gertler M., 2001. Should Central Banks Respond to Movements in Asset Prices? *American Economic Review Papers and Proceedings*, 91:253-257.

Borio, C., Lowe P., 2002. Asset prices, Financial and Monetary Stability: Exploring the Nexus. Bank of International Settlements Working Paper, No. 114.

Brewer III, Elijah, Jackson W. E., Moser J.T., 2001. The Value of Using Interest Rate Derivatives to Manage Risks at US Banking Organisations. *Economic Perspectives*. Federal Reserve Bank of Chicago, 49-66.

Bullard, J., Mitra, K., 2002. Learning about monetary policy rules. *Journal of Monetary Economics*, 49:1105-1129.

Bullard, J., Schaling, E., 2002. Why the Fed Should Ignore the Stock Market. *Federal Reserve Bank of St. Louis Review*, 84:35-41.

Castelnuovo, E., 2003. Taylor rules, omitted variables, and interest rate smoothing in the US. *Economic Letters*, 81: 55-59.

Cecchetti, S., Genberg, H., Lipsky, J., Wadhwani, S., 2000. *Asset Prices and Central bank Policy*. Center for Economic Policy Research, London.

Chadha, J., Sarno, L., Valente, G., 2003. Monetary Policy Rules, Asset Prices and Exchange Rates. Center for Economic Policy Research Discussion paper, No. 4114. Forthcoming in *International Monetary Fund Staff Papers*.

Clarida, R., Galì, J., Gertler, M., 1998. Monetary rules in practice: some international evidence. *European Economic Review*, 42:1033-1067.

Clarida, R., Galì, J., Gertler, M., 2000. Monetary policy rules and macroeconomic stability: evidence and some theory. *Quarterly Journal of Economics*, 115:147-180.

Crockett, A., 1997. Why is Financial Stability a Goal of Public Policy. In: *Maintaining Financial Stability in a Global Economy*, Federal Reserve Bank of Kansas City, pp. 7-36.

English, W., Nelson, W., Sack, B., 2003. Interpreting the significance of the lagged interest rate in estimated monetary policy rules. *Contributions to Macroeconomics*, 3:1-16.

Ferguson, 2003. Should Financial Stability Be An Explicit Central Bank Objective? Speech at the Conference "Achieving Monetary and Financial Stability", Banks for International Settlements, April.

Freixas, X., Rochet, J.C., 1997. *Microeconomic theory of banking*. MIT Press.

Gerlach-Kristen, P., 2004. Interest-rate smoothing: monetary policy inertia or unobserved variables? *Contributions to Macroeconomics*, 4: 1-17.

Gertler, M., Goodfriend, M., Issing, O., Spaventa, L., 1998. *asset Prices and Monetary Policy: Four Views*. Center for Economic Policy Research, London.

Gilchrist, S., Leahy, J., 2002. Monetary Policy and Asset Prices. *Journal of Monetary Economics*, 49:75-97.

Goodfriend, M., 1987. Interest rate smoothing and price level trend-stationarity. *Journal of Monetary Economics*. 19: 335-348.

Goodfriend, M., 1991. Interest rates and the conduct of monetary policy. *Carnegie-Rochester Conference Series on Public Policy*. 34:7-30.

27

Hull, J.C., 2000. *Options, Futures and Other Derivatives*. Fourth Edition. Prentice-Hall.

International Monetary Fund, 2003. Financial asset price volatility: a source of instability? In *Global Financial Stability Report*, Chapter 3, September.

Issing, O., 2003. Monetary and financial stability: is there a trade-off?. Conference on Monetary stability, financial stability and the business cycle, March 28-29, 2003, Bank for International Settlements, Basle.

Mishkin, F.S., 1999. Global Financial Instability: Framework, Events, Issues. *Journal of Economic Perspectives*. 13:3-20.

Modigliani, F., 1971. Monetary Policy and Consumption. In: *Consumer Spending and Monetary Policy: The Linkages*, 9-84. Federal Reserve Bank of Boston, Boston.

Oprhanides, A., 2003. Monetary policy evaluation with noisy information. *Journal of Monetary Economics*, 50:605-31.

Padoa-Schioppa, T., 2002. Central banks and financial stability: exploring a land in between. Paper presented at the Second ECB Central Banking Conference "The transformation of the European financial system", Frankfurt am Main, October 2002.

Poole W., 2004. Panel on Government Sponsored Enterprises. Speech at the 40th Annual Conference on Bank Structure & Competition, Federal Reserve Bank of Chicago, May, Chicago, Illinois

Rotondi, Z., G., Vaciago, 2004. The Fed's reaction to asset prices. Forthcoming in *Rivista di Politica Economica*.

Rudebusch, G., 2001. Is the Fed too timid? Monetary policy in an uncertain world. *Review of Economics and Statistics*, 83:203-217.

Rudebusch, G., 2002. Term structure evidence on interest rate smoothing and monetary policy inertia. *Journal of Monetary Policy*, 49:1161-1187.

Sack, B., 2000. Does the Fed act gradually? A VAR analysis. *Journal of Monetary Economics*, 46:229-256.

Sack, B., 2004. Extracting the expected path of monetary policy from futures rates. *Journal of Futures Markets*, 24: 733-755.

Sack, B., Rigobon R., 2003. Measuring the Reaction of Monetary Policy to the Stock Market. *Quarterly Journal of Economics*, 118:639-669 .

Schinasi, G.J., 2003. Responsibility of central banks for stability in financial markets. International Monetary Fund, Working Paper 03/21, Washington, US.

Smith, R.T., van Egteren, H., 2004. Interest Rate Smoothing and Financial Stability. Working paper, University of Alberta, July, Edmonton, Canada.

Tobin, J., 1969. A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit, and Banking*, 1:15-29.

Walsh, C.E., 2003. *Monetary theory and policy*. MIT Press, Cambridge, MA.

Woodford, M., 1999. Optimal monetary policy inertia. *The Manchester School Supplement*, 67:1-35.

Woodford, M., 2003a. *Interest and prices: Foundations of a theory of monetary policy*. Princeton University Press, Princeton and Oxford.

Woodford, M., 2003b. Optimal interest rate smoothing. *Review of Economic Studies*, 70:861-86.

Figure 1 - Interest rate target decomposition

(current credit spread; components ordered from the bottom)

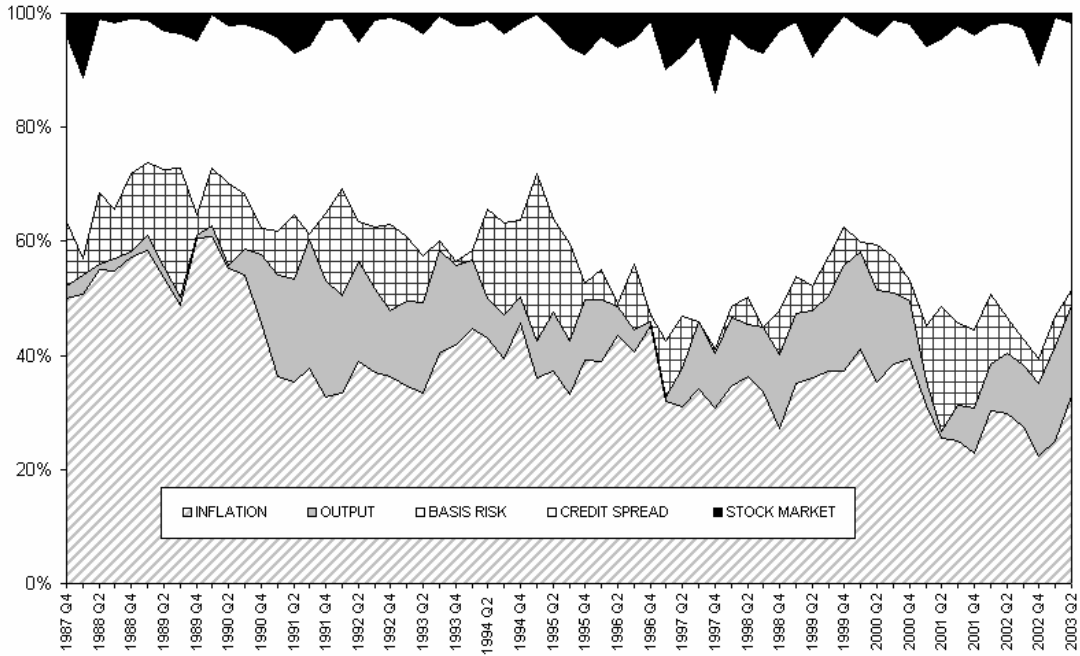Legend: INFLATION | OUTPUT | BASIS RISK | CREDIT SPREAD | STOCK MARKET

Figure 2 - Interest rate target decomposition
(lagged credit spread; components ordered from the bottom)

31