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

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Abstract

Our paper contributes to the debate on monetary policy and asset prices by offering an insight on when stabilizing futures market movements may lead to indeterminacy of the rational expectations equilibrium. In particular, we show the potential risks to macroeconomic stability related to the inclusion of futures prices in the central bank’s interest rate rule. We also provide an empirical analysis aimed at measuring the Federal Reserve’s reaction to futures prices. We add new evidence on the reaction to futures market movements and provide a broad assessment of the relative importance of alternative indicators of financial markets stress.

Furthermore, 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 this important role played by futures market, 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 a first effort towards a broader comprehension of the nexus between monetary policy, derivatives and financial stability.


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.
1. Introduction

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. However, there is still no clear consensus on how one affects the other and, in particular, whether there are trade-offs or synergies between them. This issue clearly deserves further attention.

Research on this subject has mostly focused the attention on central banks’ interest rate smoothing practice, i.e. monetary inertia, to preserve financial stability (see Goodfriend, 1987, and more recently Smith, van Egteren, 2004). In fact, less volatility of short-term interest rate should reduce bank insolvencies caused by unanticipated sharp increases in short-term interest rates. However, in this paper we argue that greater attention should be devoted to banks’ basis risk vulnerability, that is the risk due to the spread between the price being hedged and the underlying spot price. In fact, should the future course of monetary policy be different than expected, hedging strategies might prove far from being perfect exposing the bank to this residual risk. This result is particular important since central banks seem well aware of its implications in terms of financial stability (see, for instance, Poole, 2004).

Our study makes two key contributions to the literature. First, from a theoretical standpoint, we analyze the issue of including explicitly future prices, and the inherent 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 pursue the stabilization of the futures basis risk.

Second, from an empirical perspective, we assess the importance for monetary policy of the response to future prices movements, focusing on the behaviour of the Fed. Following the same

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econometric approach of Clarida, Gali, 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 Fed’s monetary policy.

This is an interesting result since the extant literature have 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 concentrates on the importance of the futures market within banks’ interest rate risk hedging policies. The role of interest rate derivatives markets is explored together with the relevant 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.

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).

\(^2\)Although we only refer to banks, the analysis and definition here are applicable to other non-banks financial
intermediaries.
3. The importance of the futures market for financial stability: the case of financial institutions

Financial institutions have increasingly used derivatives products as part of their interest rate exposure risk management strategy. Interest-rate-related derivatives can be used to hedge closely the maturity mismatch of a bank, or depending on whether it has a strong belief in the future direction of interest rates can be speculatively used to realise a profit when interest rates rise or fall. An additional factor in the increase of interest-rate-related derivatives usage at these institutions has been the increase in types of interest-rate-related derivative products and in the liquidity of the market for these products. Whereas interest rate futures were long the dominant choice for interest rate risk management, 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 global trend. Interest rates were much more volatile in the years before the significant emergence of interest rate swaps and high volatility makes futures a more effective method of hedging given the uncertainty in the underlying product and the unwillingness of a counterparty to accept a converse position such as is required with swaps. In recent years as monetary authorities target low inflation, interest rates have become less volatile creating an environment more conducive to swaps trading. Low inflation is a primary component in achieving price stability and well-controlled interest rates have been the main factor in achieving this. In fact, central banks in industrialized countries generally adopt a short-term interest rate as an operative tool, but they also attempt to reduce short-term fluctuations in interest rates. Rather than immediately raising or lowering interest rates quickly by a large amount to adjust them to changes in economic conditions, they change rates in small increments over a long period of time. This practice, called interest rate smoothing, results in protracted periods in which the direction and likelihood of the next change in the target interest rate can be guessed with some accuracy, reducing the error in market predictions of short term rates. With less volatile interest rates, banks are more accurately able to judge their interest rate exposure for a period of time in the future. This makes it easier for two counterparties to enact a swap agreement, as they are both more confident in their judgement of future interest rate movements and wild swings in interest rates are less likely.

Therefore, by hedging against interest rate risks, banks are insuring themselves against the possible losses arising from adverse or volatile market conditions.

The implications for financial stability of a hypothetical bank’s hedging strategies may emerge when a bank could find itself in a position of poor liquidity causing it to default on its payment obligations. Such a shock to an individual financial institution could propagate through the rest of the financial system through contagion, whereby other institutions suffer loss resulting from their claims on customers of the defaulting bank, or perhaps through interbank lending with that particular institution. This possible sequence of events would jeopardise the financial stability of the economy.

Banks’ hedging strategies may involve two forms of risk, maturity mismatch and basis risk, both of which may have diverse effects.

As concerns the first one, the consequences of a bank allowing a large maturity mismatch on its books to go unhedged could conceivably have adverse consequences. Suppose a sudden inflation scare caused a shock to the term structure of interest rates. This would likely draw a monetary policy tightening by the monetary authority and lead to a sharp inversion of the yield curve. The bank could, by virtue of a maturity mismatch, be committed to funding loans for a period of time into the future at the earlier lower interest rate from more expensive 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.

As regards the second risk above, even a less volatile interest rate environment does not completely eliminate risk from a bank’s hedging strategies, since residual risk may remain due to the spread between the price being hedged and the underlying spot price. This type of spread risk is called “basis risk”, and may threaten a bank’s financial balance whenever it arises. Should the future course of monetary policy be different than expected, hedging strategies might prove far from being perfect exposing the bank to basis risk vulnerability. This danger is evident in those institutions borrowing short and lending long, and central banks seem well aware of it and of its implications in terms of financial stability. In a recent speech, the President of the Federal Reserve Bank of St.
Louis, William Poole (2004), highlighted this issue for large US Government Sponsored Enterprises⁴:

“It has long been a canon of sound finance that a firm should not borrow short to finance long-term assets. There are two reasons for this principle. First, a financial firm exposes itself to interest-rate risk when the duration of assets and liabilities does not match. Second, a firm must continuously roll over short-term liabilities that are used to finance long-term assets.” [pag. 2]

“[…]Basis risk arises whenever a hedging strategy relies on a contract that is not identical to the good being hedged. In the case of ..., the yield on the short-term debt they issue may differ from LIBOR. More importantly, the spread of the agency debt yield over LIBOR may change, and has changed significantly in the past.” [pag. 3]

“The strategy of financing short and managing interest-rate risk through swaps does not completely replicate the classic strategy. FF are vulnerable to basis risk and impaired access to the market to roll over their maturing obligations.” [pag. 4]

The importance of the futures market for financial stability purposes is closely related to this latter kind of a bank’s hedging strategies. In fact, under these circumstances, the role of the futures market -- where the value of the contracts traded in it are explicitly tied to realizations of short-term interest rates -- is of utmost importance since market participants often use these markets to hedge their exposures through swap transactions. For example, with reference to the US swap market, financial institutions (and market participants in general) may exchange payments tied to the three-month Libor rate (the rate underlying the eurodollar futures) in exchange for payments based on the average overnight federal funds rate over the subsequent three months. This is precisely the “basis risk” involved with eurodollar futures, the specific futures contract in question⁵.

For the above reasons, the futures market may have a crucial role for central banks involved in minimizing the “basis risk” of financial institutions for the purpose of preserving financial stability. In the next sections, we explore this issue in detail and provide an empirical assessment of the impact of the futures market on the Fed’s monetary policy over the last decades.

⁴ Particularly, he referred to Freddie Mac, Fannie Mae and Federal Home Loan Banks (abbreviated as FF in the text).
⁵ Among others, see Sack (2004) for further details.
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)).

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. 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. 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).

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

7 See Cecchetti, Genberg, Lipsky and Wadhwni (2000) for an analysis of the major economic episodes of asset price misalignments.
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 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:

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

where $\beta$ 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:
\[ y_t = E_t y_{t+1} - \sigma (r_t - r_t^n - E_t \pi_{t+1}), \]  

(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.

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

\[ r_t^n = \omega r_{t-1}^n + \varepsilon_t, \]  

(3)

where \( 0 < \omega < 1 \) and \( \varepsilon_t \) is an iid disturbance with variance \( \sigma^2 \) 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:

\[ r_t = \rho r_{t-1} + \phi_x E_t \pi_{t+1} + \phi_y y_t + \phi_{BR} [ (\log P_t^A - \log F_t) - (\log P_t^n - \log F_t^*) ], \]  

(4)

where \( F_t \) is the futures price and \( P_t^A \) is the price of the asset underlying the futures contract. The superscript (*) indicates trend value, while the subscript BR stems for basis risk. The coefficient \( \rho \), 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 a proxy of the basis 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 substitute.\(^8\) This implies that

\[
F_t = P_t^A e^{\log R_t^*}. \quad (5)
\]

From (5) follows that

\[
\begin{align*}
\log P_t^A - \log F_t &= -\log R_t^*; \\
\log P_t^{A*} - \log F_t^* &= -\log R^*.
\end{align*} \quad (6)
\]

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

\[
r_t = \rho r_{t-1} + \phi_x E_t \pi_{t+1} + \phi_y y_t - \phi_{RR} r_t. \quad (7)
\]

From (7) we obtain the following policy rule

\[
r_t = \Phi_x r_{t-1} + \Phi_x E_t \pi_{t+1} + \Phi_y y_t; \quad (8)
\]

with

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\(^8\) See for instance Hull (2000) for a discussion on the validity of this assumption.
From (8) it is possible to see that as $\phi_{BR} \to +\infty$ the interest rate, and hence the basis, tends to zero.\(^9\)

Clearly, $\phi_{BR} \to +\infty$ 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

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

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

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

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

\(^9\) Recall that all variables are expressed as log-deviations from their trend level and constants are omitted for simplicity.
Woodford (2003a), the necessary and sufficient conditions for rational expectations equilibrium to be unique are:

\[ \Phi_y + \frac{1 - \beta}{\lambda} \Phi_y > 1 - \Phi_y, \tag{12} \]

and

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

The condition (12) is the generalization of the basic ‘Taylor principle’ appropriate for the case at hand.\(^\text{10}\) After substituting (9) in the conditions (12) and (13) we get

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

and

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

**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 \( \phi_y, \phi_z, \phi_y, \) satisfying the

\(^{10}\) The principle that interest rate rules should respond more than one to 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 \( \Phi_y > 1 \) is only a necessary condition for the determinacy of the rational expectations equilibrium, and even values of \( 0 < \Phi_y < 1 \) 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”.


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 $\phi_\rho, \phi_x, \phi_y > 0$ ensuring the satisfaction 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 $(1-\rho)$ we get

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

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 $(1-\rho)$ 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 $\phi_{BR}$ attached to the basis risk stabilization motive increases, the ability of achieving macroeconomic stability is reduced. An excessively high value of $\phi_{BR}$ 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

In the next sections we will provide an empirical analysis aimed at examining how important is for monetary policy the response to futures prices movements. In the present empirical analysis we will focus on the behavior of the Federal Reserve.

5.1 Baseline interest rate rule

First we have estimated by means of Generalized Method of Moments (GMM), for the period from 1987 Q4 to 2004 Q2, the following baseline interest rate rule:

\[ r_i = \rho r_{i-1} + (1 - \rho) f_i + \omega_i, \]

\[ f_i = \phi_2 E_i \pi_{t+4} + \phi_3 E_i y_i; \]

where \( f_i \) is an operational target. Constants are omitted for simplicity. The estimation approach used is the same as that of Clarida, Gali and Gertler (2000) for the case of the Federal Reserve. The partial adjustment mechanism modeled in the specification is intended to capture the degree of monetary inertia by the Fed.

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. We have used a correction for heteroskedasticity and autocorrelation of unknown form with a Newey-West fixed bandwidth, and chosen Bartlett weights to ensure

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

\[ \text{Data on the Fed funds rate, output gap and inflation are taken from FRED II, of the Federal Reserve Bank of St. Louis.} \]
positive definiteness of the estimated variance-covariance matrix.\textsuperscript{13} The instrument set includes four lags of output gap, inflation and the federal funds rate.\textsuperscript{14}

As argued first by Rudebusch (2002), the evidence on the near-observational equivalence of partial adjustment and serially correlated shocks for monetary policy rules provides a motivation for testing whether the rule expressed by (17) is misspecified. In fact the omission of persistent, serially correlated variables, that influence monetary policy, could yield the spurious appearance of a partial adjustment component in the estimated rule. Indirect testing of these two alternative hypotheses leads Rudebusch to the conclusion that monetary inertia is an illusion and the lagged interest rate is not a fundamental component in the case of the US policy rule.\textsuperscript{15} However, by testing these two alternative hypotheses directly in the estimation of the policy rule, English, Nelson and Sack (2003) show that both hypotheses play an important role in describing the behavior of the federal funds rate.\textsuperscript{16}

In order to assess the presence of monetary inertia we estimate the following re-specification of (17), which allows for both partial adjustment and serially correlated errors:

\[
\begin{align*}
\Delta r_t &= r_{t-1} + (1 - \rho)\Delta r_{t-1} + \left[(1 - \rho)(1 - \theta)\right] \left(r_{t-1} - r_{t-2}\right) + (\rho \theta) \Delta r_{t-1} + \epsilon_t. \\
\end{align*}
\]  

(18)

with

\[
\omega_t = \theta \omega_{t-1} + \epsilon_t.
\]

(19)

The derivation of (18) is in English, Nelson and Sack (2003). In expression (18) the parameter $\rho$ is related to the presence of monetary inertia (i.e. interest rate smoothing), while $\theta$ is related to the presence of serially correlated variables. If both parameters are significant, then both hypotheses are

\textsuperscript{13} The optimal weighting matrix is obtained from first-step Two-Stage Least Squares (2SLS) parameter estimates.
\textsuperscript{14} The J-test reported in the tables is the test for the validity of the instruments used. The associated statistic is distributed as a $\chi^2$.
\textsuperscript{15} Rudebusch argument is based on term structure evidence of the low predictability of policy rates.
\textsuperscript{16} The debate on the importance of monetary inertia in empirical Taylor rules is quite controversial. See also Driffill and Rotondi (2004) for an alternative analysis.
valid and important in explaining the behavior of the central bank. English, Nelson and Sack have found that for the case of the Fed both hypotheses are valid. Hence, contrary to what found by Rudebusch monetary inertia is not an illusion.

The GMM estimates obtained from (17) and (18) are reported in table 1. As shown in table 1, the estimates of $\rho$ and $\theta$ in specification (18) are both highly significant. This result suggests that both partial adjustment and serially correlated errors are present. Moreover, allowing for serially correlated errors does reduce the estimated degree of partial adjustment to some extent. But the effect is relatively small, with the $\rho$ parameter falling from 0.83 to 0.71.

5.2 Augmented interest rate rule

In the previous section we have shown that both the partial adjustment component and serially correlated errors are present in the policy rule. According to Rudebusch (2002), the presence of serially correlated errors should reflect the omission of some additional persistent, serially correlated variable or linear combination of variables. Let’s try to explore what are the likely candidates and, in particular, let’s try to see if futures prices are among the omitted variables. Many variants of the original specification of Taylor have been estimated in the literature. A common finding from this literature is that the lagged interest rate enters estimated policy rules with overwhelming significance. This stylized fact is mainly interpreted with central banks’ belief that smoothing interest rates promotes financial stability of the banking system. More recently also the

\footnote{An alternative rationale for explaining why monetary authorities act gradually is the concern for adverse reactions of financial markets to frequent modifications in the direction of short-term interest rates (see for example Goodfriend 1991). Moreover, the optimality of central banks gradualism is supported by three recent lines of research. First, gradualism may be optimal in presence of uncertainty about the structure of the macroeconomic model, about the values of the parameters of the model or about measurement errors of contemporaneous data release. The importance of such uncertainties for gradualism is examined by Sack (2000), Orphanides (2003) and Rudebusch (2001) among others. Second, the linkage between future monetary policy and aggregate demand can be exploited by central banks in order to stabilize optimally the economy. This implies that in presence of forward-looking expectations on inflation it may be optimal to adjust the interest rate with some inertia (Woodford 1999). Third, the optimality of interest rate smoothing can be shown also in a normative context under a discretionary monetary regime, by delegating monetary policy to a central banker with an explicit interest rate smoothing objective (Woodford 2003b).}
empirical evidence on the reaction of monetary policy to stock market and credit spread movements has been interpreted with a financial stability motive. Therefore we can argue that the omitted variables are likely to be indicators of financial markets stress.

Thus, as second step, we have estimated the following augmented interest rate rule:

\[
r_t = \rho r_{t-1} + (1 - \rho) r_t + \nu_t,
\]

\[
r_t = \phi_\pi E_\pi \pi_{t+4} + \phi_\gamma E_\gamma y_t + \phi_{SM} \Delta p_y^{S} + \phi_{CS} (R_t^{CB} - R_t^{10Y}) + \phi_{BR} \Delta (r_t^F - r_t);
\]

where \( p_y^S \) is the log of the quarterly average of the Wilshire 5000 index; \( R_t^{CB} - R_t^{10Y} \) 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; \( r_t^F \) is the rate on a eurodollar futures contract that settles 3 months ahead.\(^{18}\) 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.

Let’s discuss, before estimating, the inclusion of the additional variables considered. The importance of the inclusion of the stock market index in the Fed’s interest rate rule is supported by Rigobon and Sack (2003), Chadha, Sarno and Valente (2003) and Rotondi and Vaciago (2004) among others. 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.\(^{19}\) As in Chadha,

\(^{18}\) The source of Moody’s BAA corporate index yield, 10 year government yield and Wilshire 5000 index is DATASTREAM. The data on the futures rate are the same as those used in Rudebusch (2002). In this latter case quarters are defined to start at the eurodollar futures contract settlement dates which occur about two weeks before the start dates of the usual quarters. This choice is due to the desire to capture true one-quarter-ahead expectations. We thank Glenn Rudebusch for having kindly provided the data. Since his data end in 2000 Q2, by means of ECONWIN we have updated them to 2004 Q2.

\(^{19}\) 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
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 individuated by Sack and Rigobon (2003).20

Moreover, the importance of the inclusion of the credit spread in the Fed’s interest rate rule is supported by Castelnuovo (2003) and Gerlach-Kristen (2004). These works take into account the current credit spread. By using the Hausman test, Gerlach-Kristen finds empirical evidence suggesting that the simultaneity problem in this case is negligible. However, similarly to the case of the stock market index, we will examine also the case of the lagged credit 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 deposit over the Federal funds rate. From a financial stability standpoint, the Fed 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.

Let’s detail the rationale underlying this likely behavior of the Fed.

Due to investors ability to substitute between a three-month eurodollar deposit and a strategy of rolling over loans in the overnight Federal funds market, the eurodollar futures rate will be strongly influenced by the Federal funds rate expected to prevail. Hence the eurodollar futures rate can be seen as predicting the three-month return from rolling over the overnight Federal funds loans.21

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.

20 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.

21 This argument implies that the daily Federal funds rates should be compounded and that it could be approximated by the average Federal funds rate over the three-month period. See again Sack (2004) for a detailed analysis.
However, this relationship between the eurodollar futures rate and the Federal funds rate expected to prevail is not exact as it includes also the eurodollar risk premium, besides a term reflecting basis risk.

Now the central bank, through adjusting the supply of reserves, can effectively control the Fed funds rate. In a forward-looking financial market, expectations regarding the future path of short-term rate can importantly affect the futures rate and the associated basis risk perceived by investors. Therefore, a central bank pursuing systematically some degree of stabilization of the spread between the previous period futures rate and the realized short-term rate - with (rational) investors expecting this behavior – might be able to stabilize to some extent the basis risk.

This implies that, in analogy with the theoretical analysis on the basis risk previously developed, a financial stability argument might also justify the inclusion of the spread between the futures rate set in the previous period and the current Fed funds rate as an independent argument in the interest rate rule.

Let’s examine the estimation of (20). Before estimating with GMM we need to collect with respect to the short-term interest rate. After simple algebraic passages, we get the following expression

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

(21)

with

\[ \tilde{r}_t = \phi_{E, \pi} E_{t+4} \pi_t + \phi_{E, y} E_t y_t + \phi_{SM} \Delta y_t^S + \phi_{CS} (R_{C}^{CB} - R_{t,10Y}) + \phi_{BR} \Delta \nu_{t-1}. \]  

(22)

The GMM estimates obtained from (21) are reported in table 1. As shown in table 1, allowing for usually omitted variables based on a financial stability argument, does reduce the estimated degree of partial adjustment to some extent. But the effect is very small. In table 1 we have reported either the estimates obtained with the current quarterly average of the credit spread,
either the estimates obtained with the previous period credit spread for end-of-quarter data. In the latter case the target value for the interest rate (22) should be rewritten as

\[ \tilde{r}_t = \phi_{\pi} E_r \pi_{t+4} + \phi_{E} E_r y_t + \phi_{SM} \Delta p_{t-1} + \phi_{CS} (R_{t-1}^{CB} - R_{t-1}^{10Y}) + \phi_{BR} \Delta r_{t-1}. \] (23)

As it is possible to see from the table 1, in both the cases considered 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

By comparing the goodness fit, we can argue that the additional variables seem to explain well the serially correlated shocks considered in specification (18). Hence we can conclude that the persistent, serially correlated omitted variables are represented by financial market stress indicators. Moreover our empirical findings support the importance of futures market movements, and in particular of the stabilization of basis risk, for the monetary policy of the Fed. In order to appreciate the relative importance of futures market movements compared to the other indicators of financial stress included in the policy rule we can follow the analysis developed in Rotondi and Vaciago (2004). In particular, we can examine the contribution in percentage terms of each explanatory variable to the target value for the interest rate.

In figures 1 and 2 we have reported the contribution in percentage terms of each explanatory variable to the target value 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 compared to the inflation component. This finding seems rather not plausible. On the contrary figure 2, where the lagged credit spread is taken into account, describes a more plausible picture of the relative importance of the given components. Here inflation plays a

\[ ^{22} \text{The estimates obtained with the lagged quarterly average of the credit spread imply a worse goodness of fit compared to the case of previous period credit spread for end-of-quarter data. Details on this estimation, not reported for brevity reason, are available upon request.} \]
dominant role, even if the credit spread remains a relatively very important component. In both cases it is possible to see that the component related to futures prices is also relatively important, approximately of the same degree of importance of the output gap component. Moreover, the component related to futures prices is more important than the component related to stock market movements, a widely studied additional component of the Fed’s interest rate rule. Thus, given the relatively little importance attributed to futures prices movements (and the stabilization of the basis risk) in the literature on monetary policy and asset prices, our findings can be considered surprising.

6. Conclusions

Our paper contributes to the literature in several directions. On one hand, we contribute to the debate on monetary policy and asset prices by offering an insight on when stabilizing futures market movements may lead to indeterminacy of the rational expectations equilibrium. In particular, we show the potential risks to macroeconomic stability related to the inclusion of futures prices in the central bank’s interest rate rule by extending the analysis conducted by Bullard and Schaling (2002).

On the other hand, we provide an empirical analysis aimed at measuring the Federal Reserve’s reaction to futures prices. Many variants of the original specification of Taylor have been estimated in the literature. A common finding from this literature is that the lagged interest rate enters estimated policy rules with overwhelming significance. This stylized fact is mainly interpreted with central banks’ belief that smoothing interest rates promotes financial stability. More recently also the empirical evidence on the reaction of monetary policy to stock market and credit spread movements has been interpreted with a financial stability motive. We add new evidence on the reaction 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.

Furthermore, 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 this important role played by futures market, 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 a first effort towards a broader comprehension of the nexus between monetary policy and financial stability.

Finally, an intriguing aspect of our study emerges from the graphical analysis of the interest rate target decomposition (see Figures 1, 2). As shown, starting from the late 80s, it is evident a decreasing importance of the variables related to macroeconomic stability, whereas the financial stability variables gradually dominate. This phenomenon 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 put 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, under 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 the real market prices.

In the end, the issue of the central bank’s objective function in a globalized world clearly deserves further investigation, since it could help devise arrangements and policy responses to promote both monetary and financial stability.
Table 1 – GMM estimation of alternative forward-looking Taylor rules

<table>
<thead>
<tr>
<th></th>
<th>Baseline with serially correlated errors</th>
<th>Augmented with current credit spread</th>
<th>Augmented with lagged credit spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \rho )</td>
<td>0.83 (0.04)</td>
<td>0.80 (0.02)</td>
<td>0.78 (0.03)</td>
</tr>
<tr>
<td>( \phi_{\pi} )</td>
<td>2.12 (0.45)</td>
<td>2.63 (0.30)</td>
<td>2.64 (0.31)</td>
</tr>
<tr>
<td>( \phi_{\pi y} )</td>
<td>0.93 (0.20)</td>
<td>0.98 (0.10)</td>
<td>0.75 (0.09)</td>
</tr>
<tr>
<td>( \phi_{BR} )</td>
<td></td>
<td>2.55 (0.45)</td>
<td>3.45 (0.57)</td>
</tr>
<tr>
<td>( \phi_{CS} )</td>
<td>-2.83 (0.47)</td>
<td>-1.66 (0.41)</td>
<td></td>
</tr>
<tr>
<td>( \phi_{SM} )</td>
<td></td>
<td>10.41 (2.54)</td>
<td>16.43 (2.67)</td>
</tr>
<tr>
<td>( \theta )</td>
<td>0.60 (0.13)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 | 0.62 | 0.59 | 0.50 |

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. The earlier end date for the sample is required for the forward-looking specification. Constants omitted for brevity.
References


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Figure 1 - Interest rate target decomposition
(current credit spread; components ordered from the bottom)
Figure 2 - Interest rate target decomposition
(lagged credit spread; components ordered from the bottom)