Prepared for the conference on “Measuring Inflation for Monetary Policy Purposes”, organized by De Nederlandsche Bank, Amsterdam, November 21-23, 2000. This paper draws heavily on a book written together with Stephen Cecchetti, John Lipsky, and Sushil Wadhwani [Cecchetti, Genberg, Lipsky, and Wadhwani (2000)]. Their indirect contribution to this paper should therefore be obvious. At the same time, opinions expressed in this paper that are not contained in the book should not be construed to represent their views.

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1 INTRODUCTION

Inflation has decreased spectacularly and, so far, durably in most industrialized countries during the past decade. At the same time several changes have taken place in the monetary policy environment: (i) central bank independence has been recognized as an important factor for inflation control, and it has been implemented/consolidated in many countries, (ii) price stability has been adopted as the most important, if not only, objective of central bank policy, and (iii) central bank operating procedures have evolved so that short-term interest rates now constitute the principal operating target, and monetary aggregates are no longer very high on the list of variables that are monitored.

These changes have had an important influence on academic research related to monetary policy. Independence of central banks and a greater weight attached to inflation is often taken to imply that the potential time-inconsistency of optimal policies has ceased to be a relevant problem, and it is therefore no longer high on the research agenda. At the same time the change in operating procedures has led to a search for informative indicators of the state of the economy and for robust policy rules that can serve as useful guides for monetary policy. Important illustrations of this strand of research are the contributions found in Taylor (1998).

Much of the research is cast in a framework where the central bank in following an inflation-targeting strategy, where the objective function the central bank is assumed to minimize contains only the deviations of the inflation rate from a target rate (strict inflation targeting in the terminology of Svensson ( )) or a combination of deviations of inflation from its target and output from its target (flexible inflation targeting). Using such an objective function and a model of the economy, the performance of alternative central bank reaction functions is investigated. Often the form of the reaction function is some version of the rule John Taylor proposed in 1993:\(^1\)

\[
R_t = \gamma_0 (\pi_t - \pi_t^T) + \gamma_y (y_t - y_t^T) + \gamma_R R_{t-1} + \gamma_x x_t
\]

where

- \(R_t\) = a short-term interest controllable by the central bank
- \(\pi_t\) = the inflation rate entering the central bank's objective function
- \(y_t\) = the measure of output in the central bank's objective function

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\(^{1}\) Taylor (1993).
\( x_t = \text{other potentially useful indicator variables} \)

The benchmark against which alternative rules are judged is usually the rule Taylor himself suggested that for the United States. He argued that setting \( \gamma_\pi = 1.5, \gamma_y = 1.5, \gamma_R = \gamma_x = 0 \) would produce stable macroeconomic performance.

Recognizing explicitly that monetary policy affects inflation and output with lags, the interest rate rule is sometimes written in terms of expected inflation and output as in (2):

\[
R_t = \gamma_\pi (E_t \pi_{t+k} - \pi_{t+k}^T) + \gamma_y (E_t \gamma_{t+j} - \gamma_{t+j}^T) + \gamma_R R_{t-1} + \gamma_x x_t
\]  

(2)

Using this specification the literature inspired by Taylor's proposal has addressed a number of issues such as the relative weights to attach to inflation and the output gap, the optimal horizon for expected inflation and output, the role of interest rate smoothing, and whether there is any role for additional variables, \( x \), in the policy rule. This paper is about the last of these questions. Specifically it asks whether there is any role of asset prices in the formulation of monetary policy in an inflation-targeting framework.

The most frequent answer to this question can be illustrated by the following quote from the influential study of Bernanke and Gertler:

"The inflation targeting approach dictates that central banks should adjust monetary policy actively and pre-emptively to offset incipient inflationary and deflationary pressures. Importantly, for present purposes, it also implies that policy should \textit{not} respond to changes in asset prices, except in so far as they signal changes in expected inflation." (Bernanke and Gertler (1999), p. 78)

Similar opinions can also be found in BIS (1998) and Swedbank (1999).

The main exception to the view that asset prices do not belong in a Taylor-type interest-rate reaction function have arisen in an open-economy contest. Ball (1999) finds that adding the exchange rate to the Taylor rule improves macroeconomic performance in a model where the exchange rate has a significant role in the transmission mechanism of structural shocks and monetary policy. See also Svensson (2000).
Cecchetti, Genberg, Lipsky, and Wadhwani (2000) [CGLW hereafter] claim, however, that a more general case can be made for central banks to react to asset prices in the normal course of policy making. With respect to macroeconomic stability they argue that:

"[a] central bank concerned with both hitting an inflation target at a given time horizon, and achieving as smooth a path as possible for inflation, is likely to achieve superior performance by adjusting its policy instruments not only to inflation (or to its inflation forecast) and the output gap, but to asset prices as well. Typically, modifying the policy framework in this way could also reduce output volatility. We emphasize that this conclusion is based on our view that reacting to asset prices in the normal course of policy-making will reduce the likelihood of asset price bubbles forming, thus reducing the risk of boom-bust investment cycles." (p. 2)

In the remainder of this paper, the reasoning behind this conclusion will be given. Section II contains the intuition based on theoretical considerations. Section III reports the results of two simulation studies presented in the in the book plus related ones drawn from Genberg and Kadareja (1999). This section also takes up some reservations that have recently been raised concerning the simulation results. Section IV concludes and reviews some additional, more general, questions that have been raised in relation to the CGLW study.
2 TWO INTUITIVE THEORETICAL ARGUMENTS.²

This section illustrates the idea that asset price movements can provide useful information for central banks in two simple theoretical settings. The first is a variant of the well-known argument developed in Poole (1970) that states that the information contained in a movement of any endogenous variable in the economy depends importantly on the type of shock that caused the variable to move in the first place. This implies that whether the central bank should lean with or against the wind of asset price movements depends crucially on the nature of the disturbances in the economy.³

The second argument is stated in an explicitly dynamic setting in which asset price changes can have powerful effects on investment and/or consumption through a financial accelerator effect. In such a context it is possible to show that reacting to asset price movements can be stabilizing even if due account is taken of the influence of the asset price on expected inflation.

2.1 An argument based on Poole.

The first illustration of the potential usefulness of reacting to asset prices is an application of the basic insight of Poole (1970).⁴ A simplified version of the models by Smets (1997) and Reinhart (1998) can be used to drive home the basic point. Imagine a conventional macroeconomic model consisting of (i) an aggregate demand equation incorporating a wealth effect due to asset price changes, (ii) an aggregate supply relationship based on a Phillips curve, (iii) an asset market equilibrium condition that determines asset prices, and (iv) a monetary policy reaction function in which the Central Bank sets the short-term interest rate in response to inflation, the output gap, and, potentially, the price of equities or other assets. Leaving aside for the moment refinements associated with intertemporal issues and expectation formation, these relationships can be combined and illustrated in a simple diagram.

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² This section reproduces large parts of Section 2.1 in Cecchetti, Genberg, Lipsky, and Wadhwani, op.cit..
³ This ambiguity is of course not limited to reactions to asset price movements. The appropriate reaction to a given increase in inflation in an economy depends importantly whether this increase is due to a disturbance to aggregate supply or a disturbance to aggregate demand.
⁴ Poole's arguments have been extended, generalized and applied to the debate about exchange rate intervention by, inter alia, Boyer (1978), Henderson (1984) and Genberg (1989).
In Figure 2.1, the line labeled GM represents combinations of inflation ($\pi$) and asset prices ($q$) for which there is equilibrium in the goods market. The line is upward sloping because an increase in the asset price leads to an increase in aggregate demand due to a wealth effect, and the increase in demand leads to inflation. The inflationary effect is tempered by the policy reaction of the central bank, which raises the short-term interest rate in response to inflation (the left-hand panel). In the right-hand panel the central bank is assumed to tighten policy also in response to the increase in $q$, which makes the GM line steeper.

The AM line represents asset market equilibrium. It has a negative slope because an increase in inflation elicits a tightening of monetary policy, which depresses the asset price. If the central bank reacts to the fall in $q$ by tightening less, the depressing effect on the asset price is smaller and the AM line will be flatter (the right-hand panel).

**FIGURE 2.1. A temporary supply shock**

This model can be used to discuss two types of disturbances, a supply (productivity) shock on the one hand, and an asset market shock, on the other. It turns out that the desirability of monetary policy responding to the asset price will be very different in the two cases.

The dashed lines in Figure 2.1 illustrate the consequences of a positive supply shock, that increases current supply, but is not sufficiently persistent to influence the asset price directly through expected increases in dividends in the future. In this case the disturbance will only have a direct influence on the goods market. The equilibrium moves to A in the left-hand panel.

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5 The "asset" could refer to equities (or real estate) in an economy where the stock market (the housing sector) is particularly important or to foreign exchange in a highly open economy where the external sector is crucial. In the latter case, $q$ would obviously refer to the exchange rate.
panel, and this entails not surprisingly a reduction in inflation and an increase in the asset price as monetary policy is relaxed in response to the reduced inflationary pressures. In the right-hand panel where the central bank reacts directly to the asset price, the reduction in inflation is larger because 'asset price inflation' leads the central bank to be less expansionary than it really ought to be. This is a case where responding to the asset price is inappropriate. More accurately, the response to the asset price increase should be to encourage it, i.e. lean with the wind. The reason is that in this case the asset price increase is part of the transmission mechanism of the more expansionary monetary policy that the situation calls for.

In Figure 2.2, the supply shock is assumed to be persistent enough that it leads to a direct increase in the asset price as a result of expected future dividends. This implies that both the goods market and the asset market equilibrium lines shift upwards. The new equilibrium will be at B when the central bank does not react to q and at B' when it does. Two points are worth highlighting here. The first is that when the productivity shock leads to an increase both in current output and in a wealth effect due to a higher asset price, there needs to be no inflationary consequences. The second point is that here again there is no case for intervening in response to the increase in the asset price.

FIGURE 2.2. A persistent supply shock

In Figure 2.3 the productivity shock is assumed to be permanent in the sense that it has a direct effect on the asset price as in the previous case. But in contrast to that case it is now assumed that the current supply of goods is not yet increased. Hence the goods market line does not shift upwards (it might even shift to the right if the expected future income generates higher demand now), but the asset market line does. Here the productivity shock is inflationary, and in the case where the central bank tightens policy in response to the increase
in q, the increase in inflation is smaller. In other words, in this situation it is useful for the central bank to react directly to the asset price.

**FIGURE 2.3. A shift in the risk premium**

Figure 2.3 can also be used to illustrate another case where reacting to the asset price is useful. Imagine a shock in the asset market that has no direct counterpart in the goods market; a reduction in the equity risk premium might be a case in point. The consequence of this would correspond to what is depicted in Figure 2.3. The increase in q would bring about some inflationary pressures due to the wealth effect on aggregate demand, and a monetary policy that responds directly to the increase in the asset price will limit the inflationary consequences of the shock.

These examples show that asset prices carry information about the economy that can be exploited by the policy maker to improve macroeconomic stability. To be sure, the results were described in a very simple framework and must be checked in more complete and realistic models. In particular, dynamic elements need to be taken into account. The next section shows that doing so makes the case for reacting to asset prices even stronger.

2.1.2. **Misalignments in an inter-temporal setting.**

Kent and Lowe (1997) present an argument for intervening to reduce the likelihood of the emergence of a growing misalignment (or bubble) of an asset price. Their argument is explicitly inter-temporal and based on two important assumptions, that asset price bubbles tend to grow exponentially until they burst, and that when a bubble bursts there will be a
severe reduction in inflation due to a reverse financial accelerator effect. Intuitively their case for intervention can be stated as follows.

Consider a three-period horizon, and imagine that a financial bubble emerges in period 1. As a result of the increase in the asset price, inflation will increase due to the usual wealth effect. If the central bank maintains a neutral interest rate policy, the bubble will either burst or double in size in period two. In the former case inflation will fall precipitously (to -2 in Figure 2.4), and in the later it will increase with the bubble (to +2). If we assume for simplicity that the probability of bursting is 50%, the expected (as of period 1) inflation rate is zero, which is assumed to be the target of the central bank. In period 3 we have three possibilities, either the bubble burst in period 2 in which case it is assumed not to reappear, or it did not in which case it will either continue to grow or burst in period 3. In the first case inflation in period 3 will be zero (the dashed line in Figure 2.4) and in the latter it will either be +4 (the solid line) or -4 (the dotted line). In either case the ex ante expected inflation rate will be on target.

The above scenario assumes that the central bank conducts a neutral monetary policy in period 1. This can be justified on the grounds that, as of this period, the expected inflation rate is on target during the entire policy horizon (assumed to be periods 2 and 3 since the interest rate affects inflation with a lag). If the central bank is concerned with the variance of inflation around the target, it would clearly prefer the scenario where the bubble bursts in period 2. This is the basis for the suggestion that the central bank might be well advised to react to the emerging bubble in period 1.

To show this, suppose that by raising the interest rate in this period, the central bank can increase the probability of the bubble bursting in period 2. By doing so, the likelihood of the favorable (return to fundamentals) scenario is increased, which is desirable as we just saw. Of course, this outcome comes at the price of an inflation rate in period 2 that is below target. Kent and Lowe show that it is possible to construct examples where raising the interest rate in response to the emerging asset price bubble is indeed the preferred outcome, because the large reduction in the variance of inflation outweighs the small deviation from the target level.

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6 The example as well as Figure 2.4 are taken directly from the Kent-Lowe paper, but the description leaves out some subtleties of their analysis.

7 It is below target for two reasons; the greater likelihood of a bursting bubble which brings about a big decline in inflation and the effect of the increased interest rate itself.
FIGURE 2.4. The effect of an asset price bubble on inflation

It is important to note that in the example just constructed the central bank deliberately pursues a policy, which makes the expected rate of inflation deviate from the target rate. This is appropriate because this policy reduces the expected variability of the future inflation path. In the next section this conclusion is investigated further by examining the results of simulation experiments with more detailed macroeconomic models. Specifically, the consequences for macroeconomic stability are studied in situations where central bank reaction functions for short-term interest rates include not only inflation forecasts and the output gap, but also a term containing asset prices.
3 RESULTS FROM SIMULATION MODELS.

Three models will be used for the simulations: the closed-economy model used in Bernanke-Gertler (1999) to investigate the appropriate reaction of monetary policy to stock market bubbles, a small-scale open-economy model due to Batini and Nelson\(^8\) in which the exchange rate plays an important role, and a multi-country model due to John Taylor. In the first two models examples will be given where including an explicit response to asset prices (equities and the exchange rate respectively) in the central bank’s reaction function improves macroeconomic stability. As these models are not estimated using actual data, it can of course be argued that the examples are just that, examples. For this reason, the multi-country model will be used to provide more general evidence. Since this model is estimated with actual data, it is perhaps more representative of what reacting to asset prices (the exchange rate in this case) would imply in the real world.

3.1 Monetary policy and stock market bubbles.

At the 1999 Federal Reserve Bank of Kansas City symposium on ‘New Challenges for Monetary Policy’ Ben Bernanke and Mark Gertler presented an influential analysis of how central bankers should respond to asset price volatility. Their conclusion was an unequivocal recommendation that a monetary policy should react directly and aggressively to inflation (forecasts) and not to movements in stock prices. The latter should be taken into account only to the extent that they could be shown to have an impact on future inflation. These conclusions were based in part on simulations of a model in which asset prices affect the economy through their influence of firms’ balance sheets and therefore on their ability to find external sources of funds with which to finance investments.

CGLW, using the same model but a slightly modified simulation strategy than that of Bernanke and Gertler, found that in a number of circumstances a central bank can improve macroeconomic stability by reacting to stock prices in addition to inflation forecasts and the output gap.\(^9\) This section summarizes the results of these simulations.

The simulation model, which is closely related to that developed in Bernanke, Gertler and Gilchrist (1998), can be characterized as a standard dynamic new-Keynesian model, modified

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\(^8\) Batini and Nelson (2000).

\(^9\) The principal modification consisted of (i) making monetary policy respond to the output gap in addition to the expected inflation rate and stock prices, and (ii) considering deterministic bubbles with a fixed five-period life rather than stochastic bubbles with probabilistic length.
to allow for financial accelerator effects and exogenous bubbles in asset prices. Briefly, the economy comprises three sectors: households who consume and save; a government that manages fiscal and monetary policy; and a business sector composed of firms that hire labor, invest in new capacity, and produce goods and services.

Firms finance the acquisition of capital both through the use of internal funds and through external borrowing. The existence of credit market frictions means that there is a premium on external finance that affects the overall cost of capital and thus the real investment decisions of firms. This external finance premium depends inversely on the financial condition of potential borrowers. An improvement in a borrowing firm’s position translates into a fall in the premium, which serves to magnify investment and output fluctuations. So, for example, an increase in a firm’s share price, raising the net worth of the owners, will make the firm more creditworthy, reduce the external finance premium, thereby increasing borrowing and investment.

This financial accelerator mechanism provides an additional channel through which monetary policy can affect spending. With a fall in real interest rates, for example, asset prices will rise, reducing the cost of external borrowing and providing an extra stimulus for investment.

Price stickiness in the model is reflected in staggered nominal price setting, where not all prices are adjusted every period. Optimization and forward-looking behavior are assumed throughout, except in the case of the Phillips curve, where expectations are modeled as being formed by a combination of forward and backward looking behavior. In their simulations, Bernanke and Gertler presume that these expectations are roughly 60% forward looking and 40% backward looking.

The crucial innovation of the analysis is to allow for the possibility that observed stock prices differ persistently from fundamental values, and that this difference grows exponentially. That is, they incorporate bubbles into the model. The consequence of this is that the bubble affects the quality of a firm’s balance sheet, and so the cost of capital falls systematically when stock prices exceed fundamental values. The result is an increase in investment, resulting in both higher current aggregate demand and higher future potential output.

A deterministic bubble process in stock prices lasting five periods is introduced into the model. Through the financial accelerator mechanism already described this shock will lead to fluctuations both in inflation and output. The central bank sets the short-term interest rate according to the reaction function
\[ R_t = \gamma_R E \pi_{t+1} + \gamma_y (y_t - y_t^*) + \gamma_s s_{t-1} + \gamma_R R_{t-1}, \]  

(3)

where \( R \) stands for a policy-determined short-term interest rate, \( y \) for real output, and \( s \) for stock prices. The objective is to minimize a loss function of the form

\[ L = \alpha \text{var(\pi)} + (1-\alpha) \text{var}(y) \]  

(4)

The issue is whether or not the optimal value of \( \gamma_s > 0 \). Table 1 summarizes some of the results obtained by CGLW.

**Table 1. Optimal weights in the central bank reaction function and the associated value of the loss function**

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \gamma_R )</th>
<th>( \gamma_y )</th>
<th>( \gamma_s )</th>
<th>( \gamma_R )</th>
<th>( L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>3.00</td>
<td>0.0</td>
<td>0.05</td>
<td>0.0</td>
<td>0.1516</td>
</tr>
<tr>
<td>0.5</td>
<td>1.01</td>
<td>3.00</td>
<td>0.25</td>
<td>0.25</td>
<td>0.1160</td>
</tr>
<tr>
<td>0.75</td>
<td>3.00</td>
<td>0.5</td>
<td>0.05</td>
<td>0.15</td>
<td>0.0686</td>
</tr>
</tbody>
</table>

Memo: loss with fixed weights as in the Bernanke-Gertler simulations and no reaction to stock prices

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \gamma_R )</th>
<th>( \gamma_y )</th>
<th>( \gamma_s )</th>
<th>( \gamma_R )</th>
<th>( L )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2941</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2041</td>
</tr>
<tr>
<td>0.75</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1180</td>
</tr>
</tbody>
</table>

What is striking in these results is that some reaction to stock prices is desirable regardless of the relative weight placed on inflation and output in the loss function. This is contrary to the conclusion of Bernanke and Gertler, which calls for some explanation. Part of the difference in conclusions stems from the optimization of the response coefficients as well as from allowing the output gap to enter into the reaction function.\(^{10}\) In addition, Bernanke and Gertler rely on simulations where the bubble in stock prices arrives stochastically every period, and has a probabilistic lifetime. This could also play a role, although the intuition for this is not clear. Finally, as noted in section 2, when productivity shocks hit the economy, it is in general not desirable to lean against the wind of the resulting stock price movements. Bernanke and

\(^{10}\) The interest rate smoothing term is not very important for the results.
Gertler base their overall assessment on the premise that the nature of shocks can not in
general be observed when they occur, and that productivity shocks are sufficiently frequent to
make systematic reaction to all stock price movements undesirable.

Conditional on these remarks, the CGLW conclusions stand. When asset price bubbles occur
and can be identified as such, there is a definite case to adjust monetary policy directly in
response to this information over and above whatever the indirect effect of the bubble is on
the expected inflation rate. If the nature of the shock cannot be determined, the relative
frequencies and variances of asset market shocks versus other types of shocks must be taken
into account when the optimal strategy for monetary policy is designed.

3.2 The optimal interest rate rule in a minimal open economy model.

In view of the important role the exchange rate plays in the transmission of shocks in highly
open economies, one of the key issues in the design of monetary policy is such countries is
what, if any, attention the central bank should pay to exchange rate movements when it sets
interest rates.

To investigate this issue CGLW used a variant of the Batini-Nelson (2000) model. This is a
relatively conventional small open economy model based on an aggregate demand and an
aggregate supply relationship together with an equation determining the exchange rate. The
structural equations of the model, when all variables are expressed in terms of deviations from
equilibrium, are

\[ y_t = E_t y_{t+1} - \alpha(R_t - E_t \pi_{t+1}) + \delta \bar{q}_{t-1} + e_{yt} \]  

\[ \pi_t = \alpha \pi_{t-1} + (1 - \alpha)E_t \pi_{t+1} + \phi_y y_{t-1} + \phi_q \Delta \bar{q}_{t-1} + e_{\pi_t} \]  

\[ E_t q_{t+1} = q_t + R_t - E_t \pi_{t+1} + \kappa_t \]

In addition to notation already introduced, \( q_t \) is the log of the real exchange rate (where by
construction a rise is a depreciation), and \( \bar{q}_t = \frac{1}{4} \sum_{j=0}^{3} q_{t-j} \) is a four-quarter moving average of
\( q_t \), and \( e_{yt} \), \( e_{\pi_t} \), and \( \kappa_t \) are exogenous IS, Phillips curve, and uncovered interest parity (UIP)
shocks, respectively.
The model’s IS equation is represented by equation (5). This states that output, $y_t$, depends on a lead of itself, on the real rate of interest, and on lags of the real exchange rate. Equation (6) is an open-economy Phillips curve. Batini and Nelson set $\alpha = 0.8$, $\phi_y = 0.1$, $\phi_q = 0.025$.

Equation (7) represents the uncovered interest parity condition augmented with a disturbance term $\kappa_t$, which can be thought of as a stochastic risk premium.

Two types of shocks were considered separately in the simulations, pure financial shocks on the one hand and pure aggregate demand shocks on the other. The former correspond to $\kappa_t$ in equation (7), i.e. to random deviations from strict uncovered interest parity, and the latter to $e_{yt}$ in equation (5). As before, CGLW were interested in finding out whether the central bank’s interest-rate reaction function in an economy described by equations (5) – (7) should or should not contain a feedback from the exchange rate in addition to the expected inflation rate.

Not surprisingly, the answer depends on the nature of the shock that is being considered. When only financial shocks hit the economy, it is desirable to ‘lean against the wind’ of exchange rate changes, because doing so prevent these shocks from destabilizing the real sector of the economy. When the objective of the central bank is to minimize some combination of variability of inflation and output from their respective target values, taking action to eliminate the effects of financial disturbances is a good thing. On the other hand, when aggregate demand shocks are present, changes in the exchange rate (and in asset prices more generally as illustrated in section 2) typically serve a useful function of absorbing some of the adjustment, thereby lessening the fluctuations in prices and output. Leaning against the wind of such exchange rate changes is then counterproductive. The simulation results presented in CGLW confirm this reasoning.

The conclusion from these simulations must then necessarily be that the relative importance of different types of shocks will determine how a central bank should react to a given change in the exchange rate, if it is impossible to determine the underlying reason for this change.11 In a recent paper Batini and Nelson show that this is indeed the case.12 Using a particular configuration of the relative size of the variances of the three structural shocks in their model, they find that responding to the exchange rate is no longer desirable, contrary to the case when only financial shocks are present. Batini and Nelson furthermore illustrate the interaction between the nature of shocks and the structure of the economy. When the

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11 This is the standard conclusion from the literature on the optimal degree of intervention in the foreign exchange market. See, for example, Genberg (1989).
uncovered interest parity relationship is replaced by a more backward-looking equation for exchange rate determination, it turns out that exchange rate smoothing is again desirable.

The importance of the nature of the shocks and the structure of the economy for monetary policy will be investigated further in the next section where simulations with an estimated multi-country model will be used to address the question of the optimal reaction to exchange rate movements.
3.3 Interest rate policy and the exchange rate in a model of the Swiss economy.

The principal objective of Genberg and Kadareja (2000) is to study the consequence for macroeconomic stability if, hypothetically, Switzerland were to join the Euro-area monetary union. In so doing, however, they provide evidence on the desirability of making Swiss monetary policy react contemporaneously to exchange rate movements, the question of interest in this paper. In order to capture trade and financial interactions not only with EMU members but also with important non-members such as the United States, the United Kingdom and Japan, G-K use a multi-country model as the tool of analysis. Specifically they adapt the model developed by John Taylor in the early 1990s to study monetary policy interactions and spillovers between the countries, and the role of different types of exchange rate arrangements. The changes in the original model consisted in eliminating Canada from the countries modeled by Taylor and including Switzerland. The entire model was also re-estimated with data from 1980 to 1996.

3.3.1 The multi-country Taylor model.

Taylor's model can perhaps most easily be described as a sophisticated Mundell-Fleming model with two important additions: a set of wage-price relationships on the one hand, and rational expectations that are important notably in interest parity relationships, wage setting, and the determination of long-term interest rates.

The model, which is nonlinear, contains equations for the standard expenditure items (consumption, investment, exports and imports) that together with exogenous government spending determine aggregate demand. The supply side is modeled with a set of wage and price equations. Actual wages are determined by contract wages that are set on the basis of expected future wages and a measure of aggregate demand. Prices of domestic output are determined by labor costs and import prices.

Monetary policy and the exchange rate influence the real side of the model through the usual channels, long-term interest rates in consumption and investment and relative prices (which depend on the exchange rate) in exports and imports. Long-term interest rates depend on future expected short-term rates through a relationship explaining the term structure of interest rates. Exchange rates and short-term interest rates are linked by an ex ante open interest parity relationship, where the future exchange rate is the rationally expected one. The

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13 The countries retained were France, Germany, Italy, Japan, Switzerland, the United Kingdom, and the United States.
model is closed with an equation for the short-term interest rate, which is determined, either
directly by the Central Bank in a policy reaction function (a type of Taylor rule), or indirectly
through a money market equilibrium condition with an exogenous money supply.

3.3.2. Simulation strategy.

To evaluate the consequences of counterfactual scenarios the estimated model was simulated
under specific assumptions concerning the nature of the shocks disturbing the equilibrium of
the economies, and making different assumptions about the policy reactions of the authorities
in the represented countries. As for the shocks, it was assumed that they were of the same
'type' as those that occurred during the estimation period. To implement this idea, the
difference between the actual and estimated values of the endogenous variables in the model
during the estimation period was assumed to be the result of unanticipated shocks to the
estimated equations of the model. From the time series of the shocks estimated in this fashion,
sample variances and co-variances were derived. In the stochastic simulations the equations
of the model were then shocked with random draws from a multivariate normal distribution
with the same variance and covariance structure as that estimated from the data.

In all cases the simulated outcomes were compared, variable-by-variable, with a baseline
simulation of the model assuming no shocks. When comparisons between different exchange
rate regimes and monetary policy rules were made, the standard of reference was the root
mean square percentage deviation from the baseline path.

3.3.3. Free floating vs. EMU membership.

In one set of simulations G-K asked what would happen if the value of the Swiss Franc was
irrevocably fixed to the Euro. Theoretically, the results should be ambiguous, because, as
argued above, the stability properties of different exchange rate regimes depends crucially on
what type of shock is the most prevalent. Certain types of asset market shocks are best
handled with a fixed exchange rate, whereas real shocks and foreign monetary shocks can be
absorbed most effectively with a floating exchange rate. The outcome of stochastic
simulations experiments then will depend on the size and type of the random shocks
introduced into the model. Interestingly, when these shocks were drawn from a distribution
that best reflects the patterns of the shocks that occurred during the 1980-96 estimation period
the simulations showed that staying outside the EMU would be beneficial for the goal of price
stability, but that real output, consumption and investment would be more stable if Switzerland were part of the monetary union.\textsuperscript{15}

3.3.4 \textit{The role of the exchange rate in the interest rate reaction function.}

Turning now to the question whether asset prices, here the exchange rate, should be taken into account when Central Banks set interest rates, the results reported by Genberg and Kadareja are revealing. Figure 3.1 shows the value of an index of instability of prices and output as a function of the degree of exchange rate smoothing carried out by the central bank. The index of instability is given by a weighted average of the root mean squared deviations of the CPI and real GDP from their respective base line paths. Five combinations of weights are considered, ranging from 100\% weight on GNP at one extreme to 100\% weight on the CPI in the other.

Different degrees of exchange rate smoothing were generated by considering interest rate rules in which the current exchange rate was given increasing weights. Specifically, monetary policy by the Swiss National Bank was represented by the following interest rate rule:

$$R_t^c - R_t^B = (p_{t+4}^{\text{exp}} - p_t^B) + 2.0 (p_t - p_t^B) + 0.3 (y_t - y_t^B) + ?_E (E_t - E_t^B) \quad (8)$$

Starting with a value of \( ?_E = 0 \) representing a free float and increasing the size of this coefficient led to decreasing simulated exchange-rate volatility. For ease of comparison, this volatility was expressed as an index taking the value 1.0 when the simulated volatility was the same as that observed for the SFr/DM rate during the estimation period. A value of 0 for the index means that the exchange rate is completely fixed (i.e. EMU membership, \( ?_E = 8 \)), and the maximum value of 2.5 corresponds to a case of a freely floating exchange rate (\( ?_E = 0 \)).

The results in Figure 1 indicate that reacting to the current exchange rate in addition to expected inflation and the output gap always reduced the instability index relative to the case of free floating. In addition, the ‘optimal’ value of the reaction coefficient depends on the relative weights on the CPI and real GDP in the loss function.\textsuperscript{16} For example, in the extreme

\textsuperscript{15} It was assumed that when the Swiss Franc was not part of the EMU, monetary policy was conducted using a policy rule of the following type, \( R_t^c - R_t^B = (p_{t+4}^{\text{exp}} - p_t^B) + 2.0 (p_t - p_t^B) + 0.3 (y_t - y_t^B) \).

\textsuperscript{16} Optimal is put in quotation marks because no attempts were made to optimize all reaction coefficients in the interest rate rule. It is likely that the optimal reaction to the exchange rate depends on how strongly the Central Bank reacts to the price gap or the output gap.
case when a weight of 100% is placed on GNP stability and 0 on CPI stability (the top line in the figure), then a completely fixed exchange rate generates the smallest loss. Finally, it is interesting to note that the amount of exchange rate smoothing the Swiss National Bank has (implicitly or explicitly) carried out in the past appears to be optimal if output and price stability is assigned approximately equal weight in the synthetic stability index (the line marked with triangles).

3.4 Taking stock.

In view of the different conclusions reached by Cecchetti-Genbert-Lipsky-Wadhwani and Genberg-Kadareja on the one hand and those of Bernanke-Gertler and Batini-Nelson on the other concerning the desirability of central banks’ reacting to the to asset prices, there is a need to try to understand the underlying reason for the disagreement. There are several. The first is no doubt differences in assessment or assumptions regarding the importance of
different types of shocks in the economy. If one argues that there is no hope of distinguishing between shocks arising in asset markets and those arising in the real sector of the economy, and if in addition one argues that the majority of shocks in practice are of the latter type, then it is reasonable to be skeptical about the ability of the Central Bank to react in the proper manner to asset price developments. Conversely, if one believes that the policy maker can identify significant misalignments in asset prices, and/or that shocks in asset markets are large relative to shocks in goods markets, then there is a strong case in favor of taking asset prices into account when monetary policy is set.

Secondly, the differences in model specification might explain the different conclusions. In particular, the significant non-linearities in the Taylor model could explain why it is desirable to react to the exchange rate in that model whereas it is not in the linear model of Batini and Nelson.17

Thirdly, in small models which consist mainly of an aggregate demand and an aggregate supply curve, two pieces of information (e.g. about the expected inflation rate and the output gap) may be sufficient to describe the state of the economy and therefore to guide policy. On the other hand, if there are many potential shocks in the economy, it is unlikely that only two variables will be sufficient. In this realistic case, therefore, asset prices may provide additional useful information about the state of the economy, and they should therefore be used to guide policy.

I therefore venture the following overall conclusions to this section: (i) When we have some independent information about the reason for large movements in asset prices, it is likely to be useful to react to these asset price changes (in addition to expected inflation and the output gap) when we set interest rates, (ii) If we are not able to distinguish clearly between shocks, but we have evidence suggesting that external or internal disturbances originating in asset markets are large relative to other types of shocks, it is again desirable to let monetary policy be guided by asset price developments.

17 Recall that the argument of Kent and Lowe reviewed in section 2 relied in part on a non-linearity in their model.
CONCLUDING REMARKS

The success of independent inflation-targeting central banks in reducing inflation is surely not a coincident or the result of favorable exogenous events. By focusing their attention primarily on the inflation target, they have influenced expectations in the economy and otherwise generated an environment conducive to price stability.

Does this success mean that expected future inflation at some chosen horizon should be the only guide for monetary policy? In some highly stylized models it can be shown that this is indeed the case. As the saying goes, expected inflation is a ‘sufficient statistic’ for the state of the economy. Information in other variables is only useful in so far as it has an impact on the inflation forecast at the chosen horizon.

It is the contention of this paper that this exclusive focus on a single indicator may be risky, even in a context where a low and stable inflation rate is the only objective of monetary policy. Even if the central bank’s best forecast of inflation in the future is on target, it may be useful to contemplate adjusting monetary policy if there are other signs of imbalances building up in the economy. Just as the exclusive focus on the growth of monetary aggregates turned out to be unsatisfactory when structural changes brought about instability in the demand for money, the reliance on an inflation forecast as the single indicator for monetary policy may prove to be too limiting.

In this paper it has been argued that asset prices may convey information about imbalances that could lead to undesirable inflation and output movements in the future. Misalignments in exchange rates, share prices, or housing prices may have undesirable effects on resource allocation, and when they unwind, they may lead to financial stress. The housing booms and busts in Scandinavia and elsewhere during the late 1980s and early 1990s, the stock market and property bubble in the Japanese economy of the late 1980s provide examples where asset price gyrations have lead to great harm. The development of the US dollar exchange rate leading up to the Plaza accord in 1985 is another example where the real economy was influenced by asset price developments, which many observers at the time qualified as unjustified by fundamentals.

The argument in Cecchetti, Genberg, Lipsky, and Wadhwani, op.cit., was that adjusting monetary policy in light of information in asset prices can improve macroeconomic outcomes even in countries where the central bank is following an inflation-targeting strategy. The arguments presented in that study have been summarized in this paper, and some additional
evidence has been provided leading to the same conclusion. At the same time, however, it must be recognized that mechanically adjusting interest rates or other monetary policy instruments to asset price movements will not be appropriate in all circumstances. The underlying reason for the change in the asset price should be taken into account when deciding on which policy to adopt. In other words, even though monetary policy has been expressed in terms of explicit reaction functions in the simulation models referred to in section 3, this does not mean that interest rates in the real world should be determined by some autopilot without judgmental input from the central bank staff. Monetary policy remains an art.

This being the case, would it not be confusing for the public if the central bank were seen to pay attention to other variables than its inflation forecast? I think not. Provided the inflation objective of central bank policy is clearly stated, it should not be difficult to explain why a number of variables and pieces of information other than inflation forecasts are taken into account in pursuing that objective. These additional variables should of course not be elevated to the status of targets themselves, but their importance for achieving the central bank’s goals should be clarified. In some cases, explicitly ignoring some highly visible variable may in fact lead to more confusion than taking it into account in the policy making process. The example of the Euro/US dollar exchange rate at the present time may be an example.

Similarly, accountability should not have to suffer if additional variables than the inflation forecast are taken into account in setting policy. Accountability has to do with how closely the central bank achieves its ultimate objective. Provided this objective is stated clearly in terms of some verifiable indicator, the public can hold the central bank accountable for its actions. Making the means with which the central bank attempts to reach its objective sound simple by explaining them only in terms of one single number, the inflation forecast, is not necessarily desirable. It may in fact lull the central bank itself and the public into thinking that it is the only relevant indicator of the state of the economy, when other variables may be carrying important additional information.
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